Project Symphony

Our energy future

Platform Functional and Non-Functional Requirements

Work Package 4.2, 4.3 & 4.4

28th February 2022

In partnership with:

western power synergy AEMO GOVERNMENT OF WESTERN AUSTRALIA Energy Policy WA

Project Symphony

Our energy future

Purpose

This report has been prepared for ARENA to provide information about the functional and non-functional requirements for the Distributed System Operator (DSO), Distribution Market Operator (DMO) and Aggregator Platforms, to be used in an off-market pilot to simulate aggregated Distributed Energy Resource (DER) integration into the Western Australian Energy Market (WEM), as at the date of publication.

ARENA Disclaimer

This project received funding from the Australian Renewable Energy Agency (ARENA) as part of ARENA's Advancing Renewables Program.

The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

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Neither this report, or the inputs to it, should be taken to represent the views of Synergy, AEMO, Western Power or the Government of Western Australia. The report was commissioned, and certain inputs provided on a hypothetical basis, for the purposes of Project Symphony. AEMO provided advice on the Wholesale Electricity Market and public data sets for the development of this report.

The Symphony partners support this report, however the methods described herein should not be considered as a basis for investment and interested parties should undertake independent modelling to inform such decisions. It should not be relied on as a substitute for obtaining detailed advice about the WEM, the WEM Rules, any other applicable laws, procedures or policies or the capability or performance of relevant equipment. This report does not include all of the information that an investor, participant or potential participant in the WEM might require, and does not amount to a recommendation of any investment.

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1 Introduction

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 will be delivered by Western Power in collaboration with Synergy, the Australian Energy Market Operator (AEMO) and Energy Policy WA (EPWA). The Project aims to understand how the opportunities and challenges of increasing Distributed Energy Resources (DER) can be managed through orchestration of Virtual Power Plant's (VPP's) by piloting a version of the "Open Energy Networks" (OpEN) Hybrid Model[1] which defines roles and responsibilities for transitioning to a two-way power grid, allowing better integration of customer DER.

The Hybrid Model outlines three key roles that Project Symphony participants will be required to fulfill:

- Distribution System Operator (Western Power).
- Aggregator (Synergy).
- Distribution Market Operator (AEMO).

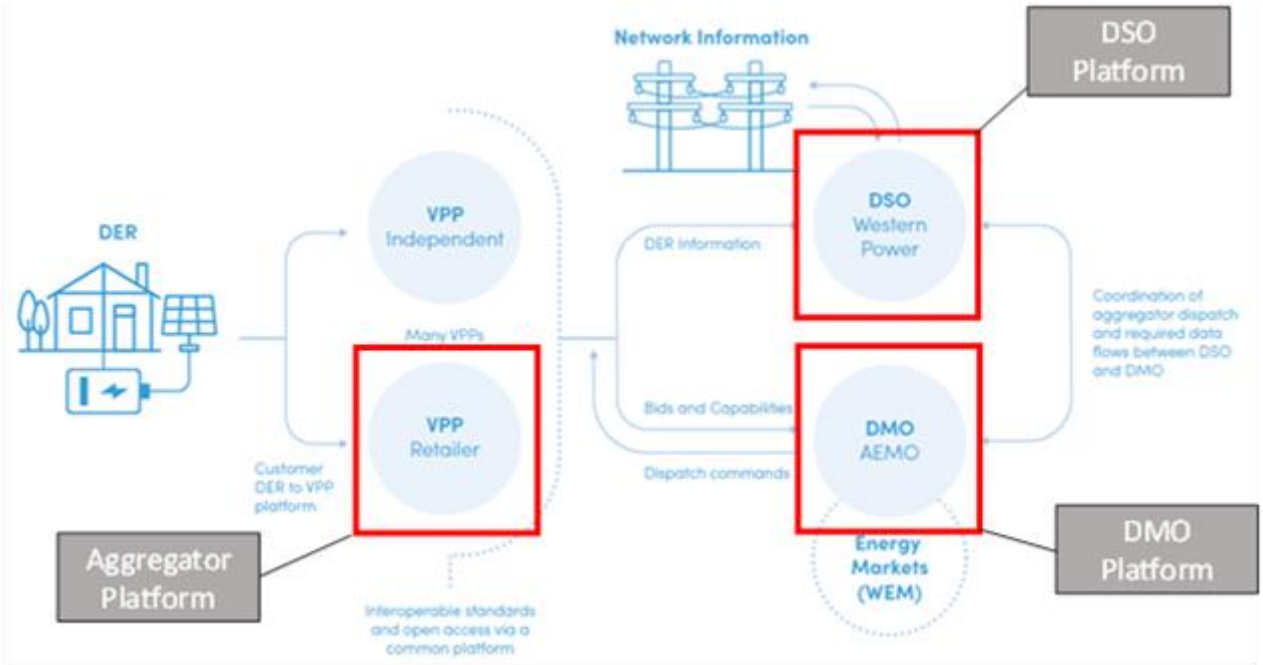

Figure 1: DSO Platform in the context of the Hybrid Model[2]

Each party will be required to build and test separate platforms that, when integrated, will create 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 will develop an understanding of the capabilities and technical complexity involved in managing a system to

[1] Interim Report: Required Capabilities and Recommended Actions, AEMO and Energy Networks Australia, July 2019, pgs. 21-22. *Last accessed 15/12/2021.*
[2] Modified diagram. Original diagram available in the DER Roadmap, Figure 18, pg. 66.

support a working Hybrid Model, collecting learnings that can be used to evolve the model and inform policy and legislative requirements to support implementation. *Figure 1: DSO Platform in the context of the Hybrid Model* provides a conceptual view of the model and how each participant's technology platform will interact.

The Project aims to gain an understanding of the capabilities and technical complexity involved in managing DER within the Hybrid Model. Each individual actor (DSO, DMO, Aggregator) will obtain detailed knowledge of the competencies required to execute their respective roles. Project learnings will be used to evolve the Hybrid Model and inform future implementations. In addition, the Project will consider non-technical factors of the Hybrid Model, including customer sentiment and experience.

The Project will deliver an end-to-end solution through the design, procurement, development, implementation and testing of software based 'platforms' capable of registering, aggregating and orchestrating customer DER. Thus, the Hybrid Model is enabled by the effective integration of three platforms;

- A Market or 'DMO Platform' (AEMO);
- An 'Aggregator Platform' (Synergy); and
- A 'DSO Platform' (Western Power).

Significant systems interfaces will be required between the platforms to simulate functionality of AEMO's existing Market Platform; registration and processing of aggregated facilities and constraints, management of bid and offers, dispatch instructions and settlement and validation of the services provided. The DSO Platform developed for the Project will enable Western Power to perform in the role of Distribution System Operator for the first time in a simulated wholesale market for the WEM as defined within the Hybrid Model.

The end-to-end solution will demonstrate real value via four 'must have' scenarios[3] through simulation of market services (Bi-directional energy and Essential System Service – Contingency Raise scenarios) and non-market services (Network Support Services and Constrain To Zero scenarios).

1. **Scenario 1 Energy Services – Bi-directional Energy - Balancing Market:**

    a. The balancing market is a mandatory 'gross pool' market for dispatch and 'net pool' for settlement that determines the most economically efficient dispatch of generation to meet system electricity demand at a given time.

    b. All registered facilities, including DER aggregated generation facilities must be available to participate and must comply with the resulting dispatch instructions from the Market Operator (AEMO).

    c. The Aggregator is able to offer (sell) or bid (buy) energy into the balancing market whilst incorporating or adhering to a 'dynamic operating envelope' (DOE), provided by the distribution system operator, which is designed to maximise or increase the amount of

[3] Project Symphony Project Management Plan, pg. 11.

renewable hosting capacity on the network by publishing the total available power transfer capacity (load and generation) at a given time.

2. **Scenario 2 Network Support Services (as part of Alternative Options):**

   a. A contracted service provided by a generator, retailer, or DER Aggregator to the Network Operator/DSO (Western Power) to help manage or solve localised network constraints.

   b. A network support service could alleviate distribution level peak electricity demand or reverse power flow and/or local voltage issues identified by the DSO at a cost that is less than traditional augmentation such as larger transformers, more 'poles and wires' or otherwise expanding capacity.

3. **Scenario 3 'Constrain to Zero':**

   a. To demonstrate the ability of the AEMO Platform to instruct the Aggregator Platform to constrain energy output from DER to zero export (net) or zero output (gross) at the NMI connection point. The intention is that this be offered as a market service.[4]

4. **Scenario 4 Essential System Service (ESS) - Contingency Raise:**

   a. Market provided response to a locally detected frequency deviation to help restore frequency to an acceptable level in the case of a 'contingency event' such as the sudden loss of a large generator or load.

   b. An example of raise is the discharge of rapid generation such as starting a fast response generator on the network to bring frequency back to an acceptable level.

Identifying and measuring the costs and the benefits (the value) of each of these scenarios, individually and cumulatively, will be key to understanding their longer-term viability at scale, along with the technical solutions required to achieve them. The technical capability will be piloted via an Aggregator Platform (Synergy), a market or DMO Platform (AEMO) and a DSO Platform (Western Power). The DSO Platform will largely analyse network conditions and DER monitoring data and publish the Dynamic Operating Envelopes (DOE) at prescribed intervals aimed at maximising the renewable energy (predominantly rooftop solar) hosting capacity at any given time on the local medium voltage (MV) and low voltage (LV) networks.

Data will also flow end-to-end through each of the project participants' platforms, from customer to off-market settlement via the DMO (AEMO). This will establish the framework that can be extended beyond Project Symphony to mainstream DER orchestration via an on-market DMO Platform.

Two 'nice to have' scenarios will be developed and tested should time, resources, and budget permit:[5]

- **ESS - Contingency lower:** Market provided response to a locally detected frequency deviation to help restore (lower) frequency to an acceptable level in the case of a 'contingency event' such as a sudden surge in supply or a sudden drop in demand.

[4] The intention is that customers will be renumerated appropriately if CTZ is offered as a future market service.
[5] Project Symphony Project Management Plan, pg. 12.

- **ESS - Regulation Raise/Lower:** Market provided response to automatic generation control signals to correct for small deviations in frequency during a dispatch interval. This is considered the most technically complex of the scenarios given the likely requirements for ~4 second communication capability between the participant platforms.

While technology plays an important role in realising the safe and reliable integration of increasing DER, customer participation in sufficient numbers via a positive customer experience will be critical to the success of the Project. In addition to consideration and research of the customer experience, the Project includes installing and securing a meaningful aggregation of customer DER assets via direct engagement and multiple third-party Aggregators.

The Project will secure a minimum of 900 DER assets from approximately 500 customers, with a target mix as follows:

- Generation management of rooftop solar.
- HVAC control.
- Hot water control.
- Behind the meter storage.
- Front of meter storage.

Research partners have been engaged by the Project participants to undertake social science-based research into customer attitudes and sentiment towards participation in DER aggregation and orchestration, as well as social equity considerations for mass market adoption.

Under future DER participation arrangements, it is expected Aggregators will be required to register as Market Participants (excluding third party or child Aggregators). They will also need to enable end-to-end data flows through each of their own platforms, from customer devices to AEMO for settlement, monitoring and compliance purposes. The Project will implement a simulated market environment to demonstrate the framework that can be efficiently extended into a mainstream model for DER orchestration in the WEM and SWIS via AEMO's Market Platform.

2 Background

2.1 Project Symphony Overview

Project Symphony is an exciting and innovative project, part-funded by the Australian Renewable Energy Agency (ARENA), where customer Distributed Energy Resources (DER) like rooftop solar, battery energy storage and other major appliances, such as air conditioning and pool pumps will be orchestrated as a Virtual Power Plant (VPP).

The VPP will aggregate and optimise DER, providing value to the customer, the network and energy markets, 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 Wholesale Electricity Market (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 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, the Australian Energy Market Operator (AEMO) released a report titled *Integrating Utility-scale Renewables and Distributed Energy Resources in the SWIS*[6], and an update in 2021 titled *Renewable Energy Integration – SWIS Update*[7]. The latter report found that the implementation of WA State Government reform initiatives, AEMO operational measures and Western Power initiatives have enhanced AEMO's ability to manage the stability of the power system in the South West Interconnected System (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*[8] for periods of time before 2024.

In recognition of this risk outlined in the 2019 report, the WA State Government published a DER Roadmap for Western Australia[9] (the DER Roadmap) to support the integration of DER into the SWIS and the Wholesale Electricity Market (WEM), and to support changes to energy policy and regulation stemming from the evolution of the energy value chain. Energy Policy WA (EPWA), as the government agency responsible for the delivery of energy policy advice to the WA Minister for Energy, is responsible for supporting the delivery of the government's Energy Transformation Strategy as outlined in the DER Roadmap.

The Western Australian Government owns three corporations with active roles in the WA electricity supply chain. Two of these corporations are involved in Project Symphony: Western Power, which

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

is solely responsible for building, maintaining, and operating the electricity transmission and distribution network within the South West Interconnected System (SWIS); and Synergy, which sells and generates power within the SWIS. Synergy is the sole retailer available to most small use customers (customers using less than 160MWh/year) in the SWIS. Further, retail and export tariffs are regulated and set by the State Government for small use customers using less than 50MWh/year as part of the State Budget processes and are subject to varying degrees of subsidisation

Unlike in the electricity system supporting the National Electricity Market, the SWIS is an islanded power system that must balance all demand and generation internally without reliance on interconnectors. The independent Australian Energy Market Operator (AEMO) has the role of ensuring this balance is maintained at all times as it manages the security of the SWIS and the WEM.

Energy Networks Australia (ENA) and AEMO have jointly led the "Open Energy Networks" (OpEN) project to identify how best to transition to a two-way power grid that allows better integration of customer DER. Project Symphony will be testing a version of the Hybrid Model, a conceptual solution outlined in the OpEN project position paper.[10] 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 more active participants (as consumers and generators of electricity) requiring access to energy markets.

Project Symphony will actively test the Hybrid Model on a section of the SWIS located in the Southern River area south east of Perth[11] (the pilot area). It will evaluate the model's effectiveness, as well as substantiate learnings that can be used to evolve the model and inform policy and legislative requirements to support implementation.

Project Symphony is regarded as delivering the best long-term outcomes for customers and the power system via active DER participation through market-based mechanisms. Project Symphony will lay the groundwork for enabling WA consumers to opt-in to aggregated virtual power plants and 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 is 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, than the alternative of significant network investment and transmission level responses.

The Project is being part-funded by ARENA and is a collaboration between Western Power, Synergy, AEMO and EPWA, working together with residential and small business electricity customers located in the pilot area of Southern River. The Project is scheduled to be completed in June 2023.

2.2 Project Roles and Responsibilities

Understanding respective roles and responsibilities is a critical element of the Project. The Hybrid Model outlines three key roles that the participants in the Project will be required to fulfill – the *Distribution System Operator*, the *Aggregator*, and the *Distribution Market Operator*:

[10] Interim Report: Required Capabilities and Recommended Actions, pgs. 21-22.
[11] The pilot will cover an area that includes locations in the Perth suburbs of Southern River, Piara Waters ad Harrisdale.

- A ***Distribution System Operator (DSO)*** enables access to and securely operates and develops an active distribution system comprising networks, demand, and other flexible DER.[12] Expanding the network planning and asset management function of a Distribution Network Service Provider (DNSP), the DSO enables the optimal use of DER within distribution networks to deliver security, sustainability, and affordability in the support of whole system optimisation. As the existing Network Operator in the SWIS, Western Power will assume the role of DSO. In taking on this role, Western Power will be responsible for developing a DSO Platform which will include 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 power system markets (both wholesale and retail) or selling services to the DSO.[13] As the existing retailer for most small use customers, Synergy will assume the role of market facing Parent Aggregator for the Project. As the Parent Aggregator, Synergy is responsible for DER valuation, customer acquisition and procuring a minimum of two Third Party Aggregators. Synergy will lead the customer interactions to achieve a suitable mix and concentration of at least 900 DER assets and procure, design, build, integrate and test an Aggregator Platform that will be used to orchestrate DER assets to participate in the energy market. Building an understanding of DER customer sentiment in relation to more active participation in markets is also key for the Aggregator.

- A ***Distribution Market Operator (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.[14] As the sole operator of the WEM, AEMO will expand its role as the System and Market Operator and perform the role of DMO. As the DMO, AEMO is responsible for providing a Market Platform (DMO Platform) that will facilitate Aggregator access to wholesale energy and essential system service markets.

2.3 Purpose of this Report

This document outlines the functional and non-functional requirements and high-level solution design for a DSO Platform, DMO Platform and Aggregator Platform operating under a version of the OpEN Hybrid Model. As such, the document:

- Summarises activities and influences that have informed and shaped the DSO, DMO and Aggregator Platform requirements.
- Specifies all identified functional and non-functional requirements for the DSO, DMO and Aggregator Platforms.
- Describes the DSO, DMO and Aggregator Platforms at a conceptual level.

[12] DER Roadmap, pg. 76.
[13] Ibid, pg. 76.
[14] Issues Paper - DER Roadmap: Distributed Energy Resources Orchestration Roles and Responsibilities, Energy Transformation Taskforce, August 2020, pg. 25. *Last accessed 15/12/2021.*

The specifications contained in this report will be used to build all three Platform solutions, to be used for the duration of the Project Symphony pilot. This report contributes to the overarching Project objectives as referenced in *Appendix A: Project Symphony Objectives*.

Following delivery of the Platforms, Project Symphony will detail the technical specification of the platforms (in Work Package 5.1, 5.2 and 5.3 Platform (as built) Report), including documenting the level of conformance with the requirements and designs outlined in this report.

The build report will share key learnings from the build process and will help inform how The Project can scale technically for a wider SWIS-wide enablement of DER orchestration to provide network and market services.[15]

The intended audience of this document is anyone who is interested in learning more about Project Symphony and the technical capabilities required to support an effective DSO, DMO and Aggregator platform.

This document has been structured so that it can be read in its entirety or it can be read as stand-alone sections relevant to each of the platforms.

[15] Documented learnings should also support the resolution of identified issues related to DSO functions outlined in Issues Paper - DER Roadmap: Distributed Energy Resources Orchestration Roles and Responsibilities, pgs. 23-25.

3 Distribution System Operator (DSO) Executive Summary

Project Symphony (the Project) is an innovative pilot where customer Distributed Energy Resources (DER) will be orchestrated as a Virtual Power Plant. The Project aims to understand how the opportunities and challenges of increasing DER can be managed to ensure a reliable, secure, and affordable electricity system, delivering the best long-term outcomes for customers. This aligns with the WA Government's DER Roadmap vision for the South West Interconnected System to deliver a future where DER is integral to a safe, reliable and efficient electricity system, and where the full capabilities of DER can provide benefits and value to all customers.[16]

Project Symphony will pilot a model for delivering a two-way power grid that supports better integration of DER. The model defines three key roles; Distribution Market Operator (DMO), Aggregator, and Distribution System Operator (DSO). This report sets out the requirements and conceptual designs for a DSO Platform to support the DSO role for the duration of the Project Symphony pilot. When integrated with DMO and Aggregator Platforms, the DSO Platform will form part of a DER orchestration system.

This document details factors that have informed DSO Platform specifications, including:

- **DER Optimisation Functions**: High-level functions identified as necessary for the delivery of DER optimisation.
- **Project and Business Requirements**: Identified business requirements derived from Project Symphony's delivery approach, Western Power's strategic intent, and relevant technical policies.
- **Design Concepts:** Technical concepts that have influenced platform specifications, including the use of Dynamic Operating Envelopes (DOEs).
- **Delivery Approach:** Constraints introduced by the chosen solution delivery approach.

The DSO Platform will be delivered by procuring several functionally discrete solutions, including a DOE calculation solution, and integrating them with components sourced from existing Western Power systems. The platform will support Western Power in the role of DSO in context of the Project Symphony pilot, including supporting functional evolution in response to learnings gained as part of the Project's test and learn strategy.

The specifications documented in this report are focused on delivering a DSO Platform suitable for conducting the Project Symphony *pilot*. As such, the platform described in this document may not be the best long-term solution. As the pilot progresses, findings and learnings will be documented and incorporated into a revised set of requirements to inform any future evaluation of technology and options to support the wider delivery of DSO functions.

The intended audience of this document is anyone who is interested in learning more about Project Symphony and the technical capabilities required to support an effective DSO.

[16] DER Roadmap, December 2019, pg. 38. *Last accessed 15/12/2021.*

3.1 DSO Platform Delivery Approach

Project Symphony's pilot DSO Platform requirements and designs have been influenced by the following:

- DER Optimisation Functions. Several high-level functions and activities are identified by OpEN as necessary for the delivery of DER optimisation. These have provided a basis for identifying DSO Platform requirements.

- Project and Business Requirements. Project requirements based on Project Symphony's approach – using scenarios to coordinate resources across Western Power, AEMO and Synergy to pilot DER orchestration on an active segment of the SWIS distribution network – have been instrumental in shaping platform requirements and designs. Also, Western Power business requirements related to strategic intent, relevant technical policies and industry best practise have been taken into consideration. These include Western Power policies related to ICT Governance, cyber security, and network safety.

- Design Concepts. Technical concepts such as dynamic operating envelopes have been used to specify pilot DSO Platform requirements. Using these concepts ultimately influences the design of the pilot DSO Platform.

- DSO Platform Delivery Approach. The process Western Power used to evaluate different options for delivering a pilot DSO Platform as per the requirements outline in section 5. Project and Business Requirements, and the selected approach. Western Power's delivery approach impacts how lower-level requirements are specified and constrains the overall solution design.

The following sections describe how each of these factors have influenced the requirements and designs contained in this document.

3.1.1 DER Optimisation Functions

The OpEN project has identified 13 high-level functions for developing distribution level optimisation capabilities.[17] These functions and how they relate to the DMO, Aggregator and (in particular) DSO roles in Project Symphony are summarised in *Table 1: DER Optimisation Functions*. The integrated system created by the DSO, Aggregator and DMO Platforms will explore the technological capabilities required to support these functions. As such, these functions provide a foundation for the requirements and designs detailed in this document.

[17] *See* Interim Report: Required Capabilities and Recommended Actions, pg. 23. Also EA Technology, Open Energy Networks Report, July 2019, p. 23. *Last accessed 15/12/2021.*

Table 1: DER Optimisation Functions[18]

ID	Function[19]	Description[20]	Project Symphony
1	Distribution system monitoring and planning	Network monitoring and the assimilation of wider data (e.g., weather patterns) to inform long-term forecasts, including network constraints, for the creation of long-term investment plans.	The pilot DSO Platform will store and utilise weather, solar irradiation, metering and network monitoring data collected from the pilot area distribution network. The Project will investigate how this information may be used to inform network management and planning, including the costs/benefits of establishing monitoring sufficient to support DER optimisation.
2	Distribution constraints development	Development of forecast network constraints into long-term static operating envelopes for network customers and, through engagement with DER, the determination of long-term requirements for network services.	The pilot DSO Platform will use available information to model and forecast network behaviour and identify constraints. The usability of this information will be assessed, including ability to 1) inform operational planning, 2) inform network policies for DER integration, and 3) ability to identify areas of the distribution network that require/may benefit from NSS.
3	Forecasting systems	Network monitoring and the assimilation of wider data (e.g., weather patterns) to inform short-term forecasts, including network constraints, to inform market operation	The pilot DSO Platform will use available data to develop detailed short-term forecasts, including identifying network constraints. Operating envelopes will be dynamically calculated to respect these constraints. The operating envelopes will be used by the Aggregator to determine facility capacity and inform their interactions with the market.
4	Aggregator DER bid and dispatch	Aggregators engage with DER resources to develop portfolios of customers and services, and engage with Network Operators and markets to submit bids and offers	Function will be performed by the Aggregator.
5	Retailer DER bid/offer and dispatch	Retailers engage with DER resources to develop portfolios of customers and services, and engage with Network Operators and markets to submit bids and offers	Function will be performed by the Aggregator.
6	DER optimisation at the distribution network level	Optimise operating envelopes in engagement with the markets to ensure DER bids and offers can feed into market dispatch optimisations while taking account of distribution network constraints	DSO will dynamically calculate, allocate and publish operating envelopes for the Aggregator to use in DER optimisation. The DSO will monitor compliance with published operating envelopes.
7	Wholesale - distributed optimisation	Receive market bids and offers and run market dispatch optimisation, integrating network constraints and/or operating envelopes into the market engine	Function will be performed by the DMO.

[18] *See* EA Technology, Open Energy Networks Report, Pg. 23.
[19] Ibid, pg. 23.
[20] Ibid, pg. 23.

ID	Function[19]	Description[20]	Project Symphony
8	Distribution network services	Procurement and use of distribution network services, such as power quality/voltage control, which can be provided by DER, either through bilateral contracts or through a market optimisation	The DSO and Aggregator will enter bi-lateral agreement(s) for NSS. NSS agreements will cover periods when forecast demand on the distribution network is expected to exceed planning criteria. The costs/benefits of NSS (compared with network augmentation) will be assessed by the Project.
9	Data and settlement (network services)	Financial settlement of network support and control ancillary services at distribution and transmission level	The DSO and Aggregator will agree a process for validating and settling NSS provided under bi-lateral agreement(s).
10	Data and settlement (other services)	Financial settlement of wholesale, RERT, FCAS and SRAS[21] transactions at distribution and transmission level	Function will be performed by the DMO.
11	DER register	Establish, maintain and publish or share DER register data	DER registration information will be used by all parties. The pilot DSO Platform will use available information on registered DER to determine NMI capacity, which will support the forecasting of network hosting capacity and dynamic operating envelope allocation.
12	Connecting DER	Regulatory, technical and commercial arrangements around the connection, and active management of connections, to the distribution network	The pilot DSO Platform network monitoring, modelling and forecast capabilities will provide information that will inform technical requirements for managing DER and service connections, as well as data to monitor adherence with operating envelopes and relevant contractual agreements.
13	Network and system security with DER	DER contribution to, and influence on, system security as well as contingency planning for market or network failure events.	The Project will test pilot DSO Platform outputs to ensure their application in downstream processes does not impact network safety in the pilot area. The Project will employ strategies to ensure network safety is maintained for the duration of the pilot, including in the event of market or network failure. The Project will also test and investigate services, such as NSS, that may support distribution networks in cases of incident or adverse event, such as events that require outages and/or network modifications.

[21] These services will be known as Frequency Co-optimised Essential System Services in the WEM.

3.2 DSO Project and Business Requirements

3.2.1 Project Symphony Scenarios

Project Symphony will use four 'must have' scenarios to describe capabilities required to operate a market that supports the integration of DER into local distribution networks. The system delivered through the integration of the DSO, DMO and Aggregator Platforms will need to execute these scenarios end-to-end.

The following four 'must have' scenarios are in scope for the Project Symphony pilot:[22]

1. **Energy Services – Bi-directional Energy - Balancing Market Offer (BMO).** The balancing market is a mandatory 'gross pool' market for dispatch and 'net pool' for settlement that determines the most economically efficient dispatch of generation to meet system electricity demand at a given time.
2. **Network Support Services.** A contracted service provided by a generator, retailer or DER Aggregator to the Network Operator/DSO (Western Power) to help manage or solve localised network constraints. AEMO will have visibility of the contracted operational requirements and provide the pre-dispatch instruction to the Aggregator on receiving the operation request from the DSO.
3. **'Constrain to Zero'.** To demonstrate the ability of the AEMO Market Platform to instruct the Aggregator Platform to constrain energy output from DER to zero export (net) or zero output (gross). This could be offered as a market service in the context of reducing the number of minimum operational demand events requiring intervention by the DSO, or incorporated into normal dispatch arrangements if customers are remunerated appropriately.
4. **Essential System Service (ESS) - Contingency Raise.** Market provided response to a locally detected frequency deviation, to help restore frequency to an acceptable level in the case of a 'contingency event' such as the sudden loss of a large generator or load.

[22] Project Symphony Project Management Plan, pg. 12.

3.2.1.1 Energy Services – Bi-directional Energy - Balancing Market

Table 2: Scenario 1 - Energy Services – Bi-directional Energy - Balancing Market

Scenario Definition	The Project will develop an end to end (E2E) solution that will test an energy generation and load scenario. The findings from this will inform a working product/capability definition of a market offer and provisioning for energy within the boundaries of a hybrid operating model. This scenario demonstrates the potential economic and commercial value of DER via an Aggregator in the SWIS by allowing access to the WEM (market service).
Hypothesis Statement	The pilot DSO Platform will be able to forecast available network hosting capacity and allocate it to participating customer connections by: • Implementing appropriate distribution monitoring systems in the pilot area • Obtaining third party data on weather and solar irradience • Obtaining accurate data from the Aggregator and DMO on NMI participation status and DER capacity • Organising the data • Using available data to forecast available network capacity within the physics-based contraints of the pilot distribution network • Allocating available network capacity to participating customer service connections using timebound Dynamic Operating Envelopes (DOEs) • Using distribution network monitoring data to monitor Aggregator compliance with DOEs
Measures	Success measures include: • Accuracy of network capacity forecasts (compared against actuals) • End-to-end processing time, from data collection and processing through to DOE calculation and publication. • Published DOEs are calculated using monitoring data that includes the most recently collected telemetry data.
Exclusions	• Ancillary Services/ESS • NSS
Assumptions	• The pilot DSO Platform will access available Western Power LV/MV/HV monitoring data for the pilot area • The pilot DSO Platform will access available Western Power network data to support the modelling of the pilot area distribution network • Distribution network (LV) monitoing will be deployed accross the pilot area network • DOEs will be refreshed prior to the start of each trading interval
Constraints	• Policy: Existing static operating envelopes will initially be respected to safeguard network operations • Process: None • Technology: For individual service connections, detailed usage can be calculated based on historical, bi-monthly readings where AMI metering data is available.
Acceptance Criteria	1. DSO Platform accurately forecasts available hosting capacity (tolerance levels to be confirmed) 2. DSO Platform equitably allocates DOEs across participating NMIs 3. DSO Platform publishes DOE allocations before the start of each trading interval 4. Published DOE allocations cover 72 hours (forecast 3 days ahead)

3.2.1.2 Network Support Services (NSS)

Table 3: Scenario 2 - Network Support Services

Scenario Definition	The Project will develop an E2E solution that will test the NSS scenario. NSSs will be delivered according to a bi-lateral contract between the DSO and Aggregator. NSS requirements will be anticipated based on forecast network constraints.
Hypothesis Statement	The pilot DSO Platform will forecast and communicate NSS requirements by: • Allowing available data to be analysed to identify constraints and anticipate NSS requirements months in advance, allowing bi-lateral arrangements to be negotiated and agreed • Being able to forecast the need for an instance of NSS in advance, giving the Aggregator at least 24 hours notice • Being used to validate and verifiy NSS delivery
Measures	Success measures include: • Ability to identify NSS requirements to allow contracts to be established • Ability to identify network constraints and request NSS at least 24 hours in advance • Delivery of NSS can be validated • Cost/benefit of NSS compared with network augmentation
Exclusions	• Ancillary Services/ESS • Energy Bid/Offers
Assumptions	• Contractual terms can be agreed between the Aggregator and the DSO • NSS conditions can be simulated for the pilot • Delivery of NSS is compatible with DOE compliance
Constraints	• Policy: None • Process: None • Technology: NSS conditions will be simulated as the pilot area distribution network is robust and does not require actual NSSs
Acceptance Criteria	1. NSS requirements can be identified and defined 2. A bilateral NSS contract can be agreed between the DSO and Aggregator 3. A contracted service (between the DSO and Aggregator) can be registered with the DMO 4. NSS deployment requests and dispatches can be successfully orchestrated 5. The performance of the provision of the NSS can be assessed by the DSO using monitoring data collected from the pilot area distribution network

3.2.1.3 Constrain to Zero

Table 4: Scenario 3 - Constrain to Zero

Scenario Definition	The Project will develop an E2E solution that will test the ability of the Aggregator to provide a new Constrain to Zero export service, whereby instructions can be sent by AEMO to the Aggregator and executed to enable: • **Zero Net Flow**: Limit energy export at the NMI (apply zero export or lower). The ability to keep DER devices online behind the meter and restrict export to zero as a paid service. • **Zero Gross Flow**: Turn off DER devices to achieve zero generation. The ability to turn off devices as a paid service. The findings from this will inform procedures, processes, and supporting system functionality that would be required in a live market.
Hypothesis Statement	• Constrain to Zero events do not impact the DSO's ability to accurately forecast hosting capacity • Constrain to Zero events do not impact the DSO's ability to allocate and publish DOEs
Measures	Success measures include: • No impact on the DSOs ability to accurately forecast network capacity and allocate DOEs. • Visibility of Constrain to Zero events in pilot distribution network monitoring data.
Exclusions	• ESS • Distributed solar PV Management (DPVM) - compulsory curtailment of solar PV when system security is threatened
Assumptions	• Constrain to Zero will be a paid service • Constrain to Zero is compatible with DOE compliance
Constraints	• Policy: None. • Process: None. • Technology: None.
Acceptance Criteria	1. DSO can accurately forecast hosting capacity and allocate DOEs after a Constrain to Zero event 2. Constrain to Zero events do not impact pilot DSO Platform data collection processes

3.2.1.4 Essential System Service (ESS) - Contingency Raise

Table 5: Scenario 4 - Essential Support Services

Scenario Definition	The Project will develop an E2E solution that will test the provision of the essential system service Contingency Raise. The findings from this will inform a working product/capability definition of a market offer and provisioning for energy within the boundaries of the Hybrid Model.
Hypothesis Statement	• ESS events do not impact the DSO's ability to accurately forecast hosting capacity • ESS events do not impact the DSO's ability to allocate and publish DOEs
Measures	Success measures include: • ESS deployment does not impact the DSO's ability to accurately forecast hosting capacity and allocate DOEs. • ESS deployment can be identified in distribution network monitoring data.
Exclusions	• Energy Services • NSS
Assumptions	• There are no bilateral contracts between parties for this service. • The Aggregator will make offers into the market for all services and time trading intervals that they wish to supply
Constraints	• Policy: None. • Process: None. • Technology: None.
Acceptance Criteria	1. DSO can accurately forecast hosting capacity and allocate DOEs after an ESS event 2. ESS events do not impact pilot DSO Platform data collection processes

3.2.2 Project Symphony Test and Learn Strategy

In addition to the functions described in *Table 1: DER Optimisation Functions* and the hypothesis outlined in the tables in section *5.1 Project Symphony Scenarios*, a key consideration in the development of the pilot DSO Platform is Project Symphony's approach to learning.[23] Project Symphony will be piloting a version of the OpEN Hybrid Model, which is a pragmatic approach combining aspects of the two other defined models – the single integrated platform and the two-step tiered model.[24] There is no single definition of the Hybrid Model as it is a conceptual solution that ideally incorporates the best aspects of these other models.[25] Therefore, Project Symphony will attempt to maximise benefits and minimise weaknesses within this conceptual framework via a test and learn strategy.

The Project's test and learn strategy will allow each partner to specify and test a series of hypotheses through the end-to-end execution of the scenarios on the pilot area local distribution network. The DSO Platform will need to evolve throughout the pilot to support increasingly complex scenario tests

[23] Project Symphony Project Management Plan, pg. 41.
[24] Open Energy Networks Project Networks Australia Position Paper, pgs. 7, 38.
[25] Ibid, pg. 5.

and to respond to learnings as they become apparent. Project Symphony learnings will be used to inform future enhancements to the Hybrid Model.

3.2.3 Western Power Strategic Alignment

DER are transforming the electricity system, presenting both challenges and opportunities.[26] Increasing levels of renewable generation, much of it located on homes and businesses, produce electricity that fluctuates depending on the time of day and the weather.[27] By 2031, Western Power is expected to support a network where up to half the community's electricity is supplied through renewable generation.[28] If not properly managed, DER and renewable generation present a risk to power system security and network reliability, potentially leading to extra costs and disruption to customer energy supply.[29] The vision for Western Power is to '*deliver on the changing energy needs of Western Australians, powered by community trust and the passion of our people.*'[30] Responding to the challenges and opportunities posed by DER and renewable generation will be fundamental to Western Power achieving this vision.

The WA Energy Transformation Taskforce DER Roadmap envisions a SWIS *'where DER is integral to a safe, reliable and efficient electricity system, and where the full capabilities of DER can provide benefits and value to all customers.'*[31] To realise this goal, the taskforce sees the role of DSO as '*a natural evolution of Western Power's role as network service provider*.'[32] As such, Western Power has a strategic action to develop a functioning DSO capability by 2025.[33] This capability will enable increased levels of renewable generation by improving DER network integration and coordination.[34]

To deliver a functioning DSO, Western Power will need to develop solutions to:

- Improve visibility of power flows and DER to manage the network within technical limits
- Support real-time calculation and communication of safe network operating limits with system actors including Aggregators and the DMO, and
- Interact with the broader energy system to avoid any action on the distribution network compromising system security.[35]

As Project Symphony will identify and explore technical requirements and solutions for orchestrating DER - including piloting solutions on a section of the SWIS distribution network using the scenarios listed in 5.1 Project Symphony Scenarios - the solutions delivered, and learnings discovered by Project Symphony will be foundational to the development of Western Power's DSO capability.

3.2.4 Western Power Design Principles

The pilot DSO Platform will be designed and delivered according to the following principles that align with relevant Western Power values, policies, and operating procedures:

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[26] DER Roadmap, pg. 6.
[27] Ibid, pg. 12.
[28] Western Power - Statement of Corporate Intent 2021/22, Western Power, October 2021, pg. 4. *Last Accessed 15/12/2021.*
[29] DER Roadmap, pg. 12.
[30] Western Power Annual Report 2021, Western Power, October 2021. *Last Accessed 15/12/2021*
[31] DER Roadmap, pg. 38.
[32] Ibid, pg. 44.
[33] Western Power Corporate Strategy 2021-2031 (Summary), Western Power, November 2021. *Last Accessed 15/12/2021*
[34] Western Power - Statement of Corporate Intent 2021/22, pg. 4.
[35] DER Roadmap, pg. 44.

- **Equitable Network Access**. As the pilot will be conducted on a local distribution network in a residential area, the DSO Platform must support a safe, reliable, and accessible electricity network for all network customers in line with government regulations and relevant Western Power policies.[36] Project Symphony will ensure all recommendations resulting from the pilot consider customer equality with regard to network access.
- **Network Safety.** The pilot DSO Platform and associated processes will be designed, operated and fully tested so as not to introduce unnecessary risks to local energy supply. This includes ensuring:
    - The platform supports operations in line with the ESSR[37]
    - Platform operations do not impact Western Power service delivery obligations, and
    - Customer power supply in the pilot area is safely maintained.
- **Forward Focused.** The pilot will be forward focused, informing how Western Power may need to change to operate as an effective DSO. As such, the pilot may at times work outside of existing Western Power operational constraints, such as existing static operating envelope limits, where it is a) safe to do so, and b) deemed necessary for the pilot to fully explore how to perform DSO functions.
- **Learning Opportunities Over Barriers**. Western Power is aware of issues regarding the quality and coverage of network data in the pilot area. As network monitoring data will be fundamental to the dynamic calculation of operating envelopes, the pilot DSO Platform must deal with network modelling and monitoring gaps in a manner that furthers understanding on the minimum data requirements for the provision of an effective DSO.
- **Evolve and Learn**. As the pilot progresses, the pilot DSO Platform will need to evolve incrementally to support the execution of increasingly complex scenario tests and to incorporate learnings.
- **Minimum Viable Product**. The DSO Platform developed as part of Project Symphony will be used for the duration of the pilot. As such, the level of investment in the DSO Platform should be just enough to support the pilot, Project Symphony's test and learn strategy, and to inform future potential scalability requirements.
- **Reusable**. Individual platform components may be repurposed for other projects and/or to enhance Western Power systems. Therefore, the pilot DSO Platform's design should support the redeployment or repurposing of its component parts.

[36] It is important Western Power ensure there is no actual or perceived preferential treatment between network customers. As such, Western Power will not treat pilot participants any differently to non-participants with regard to the delivery of business-as-usual services.
[37] Essential System Safety Rules (ESSR) 2016 Edition v1.1, Western Power. *Last accessed 15/12/2021.*

3.3 DSO Design Concepts

3.3.1.1 Dynamic Operating Envelopes

To support the functions described in *Table 1: DER Optimisation Functions*, the pilot DSO Platform will be required to dynamically identify the maximum renewable energy hosting capacity[38] of the pilot area local distribution network within physics-based operational constraints.[39] This information will be published for the Aggregator and DMO to incorporate in downstream processes to orchestrate DER as part of a holistic, responsive distribution system. Dynamic Operating Envelopes (DOEs) have been proposed as an effective mechanism for communicating safe DER hosting capacity limits with the Aggregator and DMO.[40]

Under current network connection rules,[41] customer energy use is limited by static operating envelopes. These defined operating limits specify a connection's permitted power consumption and generation, and therefore impact on a connection's import and export capacity. This is shown in *Figure 2: Current State - Static Operating Limits*.

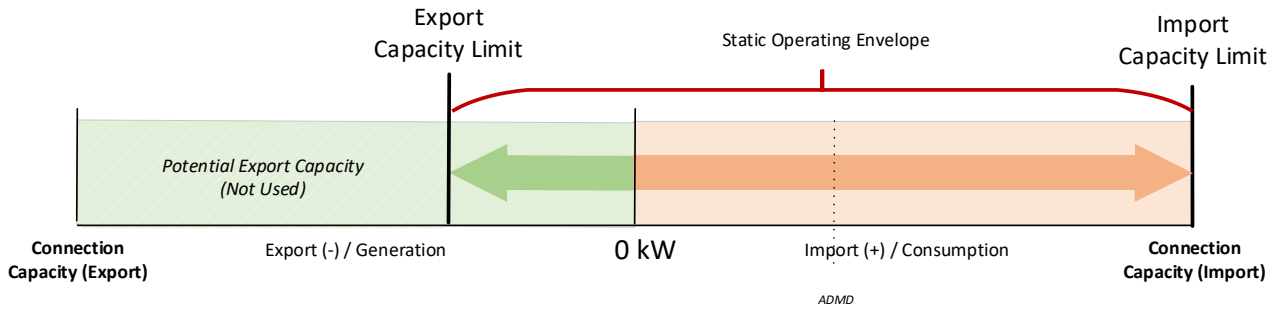


Figure 2: Current state – Static Operating Envelopes

Static operating envelope capacity limits are informed by supply arrangements and After Diversity Maximum Demand (ADMD) calculations. Supply arrangements specify the import capacity of a connection point, which is sized to meet the customer's expected peak demand. Since the occasions where large percentages of connection points concurrently consuming at maximum capacity are infrequent, distribution networks are designed to leverage diversity in demand. ADMD is the total maximum customer demand at specific upstream network locations (usually distribution transformers) after consideration of demand diversity, averaged over the number of customers. As such, it is typically less than the individual connection point import capacity limit. Designing

[38] While energy generated from DER may not necessarily be from renewable sources and the DSO should be agnostic in terms of the method of DER energy generation, "[i]t is a no brainer that we should be seeking to optimise the level of renewable energy across our electricity system", DER Roadmap, pg. 4.
[39] Project Symphony Project Management Plan, pg. 23.
[40] *See* Lachlan Blackhall, On the calculation and use of dynamic operating envelopes, Battery Storage and Grid Integration Program, September 2020. *Last accessed 15/12/2021.*
[41] Western Power presently has 5kVA (single phase) and 15kVA (three phase) Inverter Embedded Generation connections. See Network Integration Guideline – Inverter Embedded Generation. *Last accessed 15/12/2021.*

distribution networks based on ADMD provides a balance between competing expectations to provide sufficient network capacity, and prudently manage network investment.

ADMD is also used to determine the export capacity from a connection point while preserving equity amongst customers and utilising existing infrastructure. This is typically implemented as a limit on the size of a DER system. Currently, the majority of DER resources connected to the distribution network are PV systems. PV systems predicably generate at or near capacity under favourable conditions, which often coincide with periods of low consumption (i.e., middle of the day). Therefore, there is a point at which unmanaged PV capacity on a local network will result in concurrent generation regularly exceeding the upstream network capacity. As such, SWIS distribution networks are not designed to deal with the excess energy generation that will result from an increase in the number and size of DER systems.

The use of static operating envelopes limits the amount of energy that can be exported from a service connection, which in turn technically restricts the DER capacity customers are able to install[42] to ensure network operations are maintained within safe limits. Consequently, static operating envelopes result in lower utilisation of energy from renewable sources.[43]

Project Symphony will use DOEs as a mechanism for controlling energy generated by DER to ensure generation remains within the safe network operating limits of local distribution networks. DOEs will be calculated based on a simulation of power flows through the distribution network based upon forecasts of demand and generation. This analysis will be capable of identifying when network operating limits will be exceeded by DER generation. A Distribution Constraints Optimisation Algorithm (DCOA) will be used to optimise the allocation of DOEs while adhering to three (at times conflicting) ideals:

- Maintain safe network operating limits.
- Maximise use of energy from renewable sources / available hosting capacity.
- Ensure equitable access to the network.

DOEs, calculated at the NMI level, [44] will be used by Aggregators to orchestrate DER assets located at participating customer service connections within DOE import and export limits. Forecast power flows will account for the energy flows at all distribution network service connections.[45]

Where network conditions permit, DOEs may be allocated to allow connections with DER to export above a defined firm export capacity limit. The firm export capacity will define a minimum level at which service connections will be allowed to export electricity.[46] The range between the firm export capacity and the connection capacity is the variable capacity as shown in *Figure 3: Project Symphony – Dynamic Operating Envelopes*.

[42] Export capacity restrictions are enforced by limiting the inverter capacity customers can install at a service connection.
[43] When compared to the potential renewable energy generation if customers were allowed to install larger DER systems and export more energy where it is safe to do so.
[44] NMI level DOE calculation will allow the DSO to ensure MV and LV network safe operating levels are maintained. The Project may investigate the publishing of DOEs upstream in the network, but only if it is deemed safe to do so.
[45] Active NMIs will be assigned DOEs that account for the energy usage of passive NMIs whose operation cannot be constrained below existing static operating envelopes.
[46] Firm capacity limits are yet to be defined and may be informed by ADMD, service agreements, Government policy, Western Power requirements and/or the technical constraints of DER.

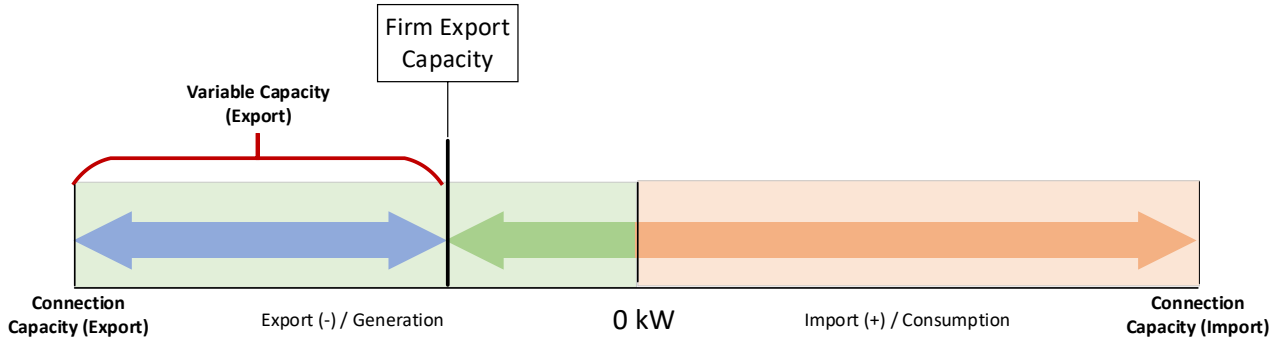


Figure 3: Project Symphony - Dynamic Operating Envelopes[47]

The DSO calculates DOEs based on an understanding of and direct access to network monitoring data and constraints.[48] Published DOEs will be timebound, setting import and export limits for specific periods in line with forecast network demand. DOEs should be calculated and published frequently based on the latest network monitoring and forecast weather data, with DER orchestration and market processes responding to any published changes. DOEs will need to be responsive not only to changes in weather and network energy consumption/generation, but also to changes in network conditions that result from planned or unplanned outages, and/or any temporary or permanent changes in network topography. As such, Project Symphony will aim to increase the frequency of the end-to-end calculation of DOEs throughout the pilot to further understand network modelling and monitoring requirements for ensuring DOE calculations are suitably responsive to changes in network conditions, as well as understand the impact on downstream DMO and Aggregator DER orchestration processes.

To illustrate how DOEs may impact a customer service connection, take the following example: A connection has an import capacity of 15kW and a PV system capable of generating 5kW of power. Suppose the firm export capacity for the connection is 2kW (example only).[49]

The variable export capacity is the difference between the firm export capacity of 2kW, and the connection export capacity of 15kW.[50] This means, at times of higher network demand, the maximum export permitted by the DOE could be up to 15kW, potentially allowing the PV system to generate at its capacity (5kW). Conversely, at times of coincidental high PV generation and low demand, the maximum export limit would remain at the firm export capacity (2kW) to maintain safe network operating limits. These limits are shown in *Table 6: Example DOE limits for a connection with a 5kW PV system*.

	High Demand	Low Demand
Static Operating Limit	5kW	5kW
DOE Export Limit	15kW	2kW

Table 6: Example DOE limits for a connection with a 5kW PV system

[47] Note that, while DOEs theoretically could be used to vary import as well as export capacity, Project Symphony will be focused on using DOEs to vary export.
[48] Open Energy Networks Project Networks Australia Position Paper, pg. 31.
[49] These figures are for example only and are not intended to represent actual future firm capacity limits.
[50] This is the typical service connection capacity limit for Single Phase connections

Identified benefits of using DOEs as a mechanism for managing DER energy generation within safe network operating limits include:

- Enabling higher levels of renewable energy generation by allowing higher export limits when there is more hosting capacity on the local distribution network.[51]
- Addressing multiple challenges currently being faced in electricity distribution networks.[52]
- Being simple to implement across a variety of different DER assets.[53]
- Ability to deploy progressively into different segments of a distribution network as required.[54]

3.3.1.2 Network Support Services

As previously described, distribution networks are designed such that network ADMD is less than the sum of individual connection point import limits, meaning it is technically possible for energy consumption/generation to exceed ADMD. This is particularly an issue during seasonal periods of peak demand and on distribution networks that have changed since original design as a result of, for example, the sub-division of housing blocks creating additional connection points with unmanaged DERs. As such, DOEs may not be sufficient for managing all network constraints. Traditionally, the solution to maintaining safe operating limits during periods of increased load has been to augment local distribution networks, resulting in significant investment to manage conditions that only occur for a small number of hours of the year.

The Project will test whether localised Network Support Services (NSS) may be delivered using available aggregated DER to alleviate network constraints, particularly during periods of peak demand. It is anticipated that the use of targeted NSS will provide a cost-effective mechanism for managing network constraints, allowing network augmentation investments to be deferred, reduced or even avoided.[55]

Under NSS, participating customers will be incentivised by the Aggregator to allow their energy consumption/generation to be restricted/managed without negative impacts to comfort. In the case of periods of peak demand, this will involve moving participating customer connections from net import towards net export by, for example, turning down/off controllable load devices and/or discharging customer owned BESS. This movement is demonstrated in *Figure 4: NSS impact on Service Connection – Reduce Import.*

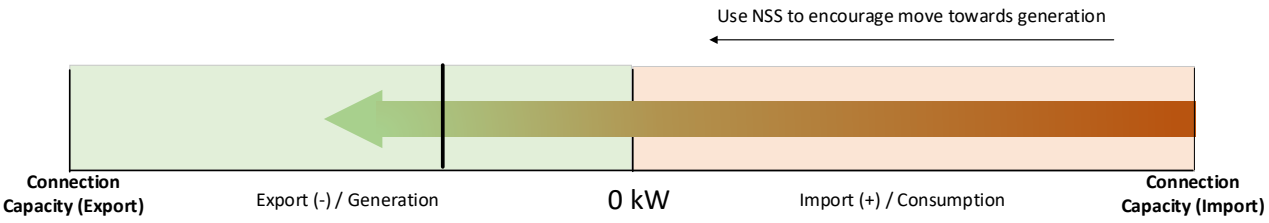


Figure 4: NSS Impact on Service Connection - Reduce Import

[51] Project Symphony Project Management Plan, pg. 27.
[52] On the Calculation and Use of Dynamic Operating Envelopes, pg. 5.
[53] Ibid, pg.5.
[54] Ibid, pg.5.
[55] Energy consumption on some areas of the SWIS may peak in the short-to-midterm before stabilising or reducing, behaviour likely driven by a combination of consumer energy consciousness and availability of energy efficient appliances. NSS may assist in supporting local networks through these expected peaks, potentially avoiding augmentation in the long-term.

NSS may also be a technically effective mechanism for managing energy generation during periods of low demand. DOEs will provide a mechanism for limiting the export of participating customer connections, but in periods where demand is low and energy generation from uncontrollable sources[56] is high, there may be a requirement to move participating NMIs towards net import to use excess energy being exported onto the network by, for example, turning on/up controllable loads and/or charging BESS. This movement is demonstrated in *Figure 5: NSS Impact on Service Connection – Reduce Export.*[57]

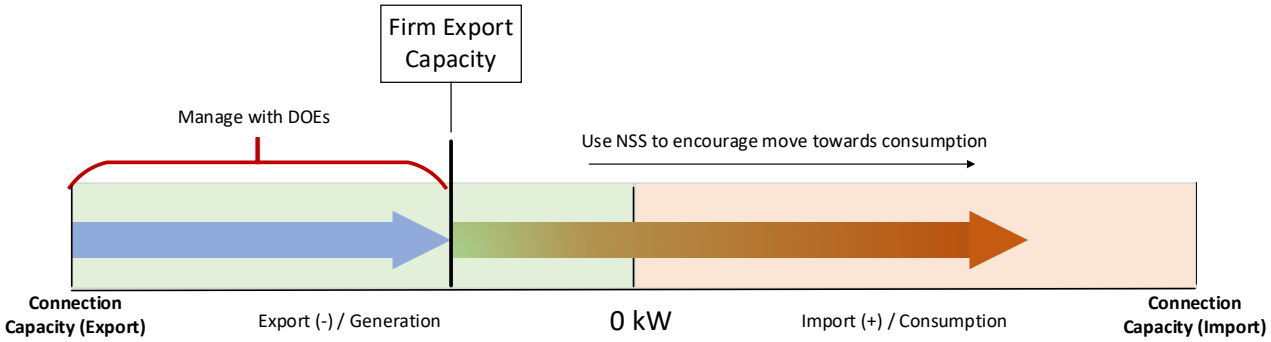


Figure 5: NSS Impact on Service Connection - Reduce Export

NSS will be provided by orchestrating changes in consumption/generation across a group of customer service connections (active NMIs). The DSO will use available network monitoring data in the DSO Platform to identify areas of the distribution network that would benefit from NSS. The DSO will then work with Aggregator(s) to identify capacity capable of delivering targeted NSS services on identified distribution network areas. This will allow the DSO and Aggregator to negotiate suitable bi-lateral commercial arrangements to provide NSS when, where, and at the capacity required. NSS will be delivered as a market service. When NSS is required, the Aggregator (via dispatch by the DMO) will orchestrate DER to produce the desired outcome, remunerating participating customers.

The DSO Platform will forecast network demand several days in advance, including conducting a load flow analysis which will identify when network loads are predicted to exceed safe operating limits, the specific components that will constrain network operations, and the area of the local distribution network impacted. This information will allow the DSO to invoke bi-lateral agreements in advance to arrange for the delivery of a targeted NSS, allowing time for the Aggregator to prepare for NSS delivery by, for example, charging/discharging BESS, appropriately orchestrating DER operations, and preparing market bids. Closer to the forecast time of need, network forecasts will confirm that the NSS is still required. The DMO will coordinate the dispatch of NSS, ensuring it is dispatched within facility capacity limits and as a priority over other market services. The DSO will then work with the Aggregator and DMO to confirm NSS dispatch and settle contracts accordingly.

As with DOEs, NSS could be available to support the network through both predictable and unpredictable circumstances. NSS could be made available to network operations to support the management of changes to the network that result from planned and unplanned outages, adverse

[56] For example, generation from passive NMIs that cannot be curtailed using mechanisms such as DOEs.
[57] While it is theoretically possible to use both DOEs and/or NSS to manage both energy generation and consumption, it is likely DOEs would be used as the primary mechanism for managing distribution network constraints arising from excess energy generation, while NSS would be the primary mechanism for managing constraints that arise from energy consumption. This is because the Network Operator is able to recover the cost of NSS or network investment through network tariffs which are primarily based upon energy consumption.

incidences, and/or temporary changes in network topology. Project Symphony will investigate the requirements for a responsive NSS that could be utilised to support the management of changes in network conditions, and the costs/benefits involved in service delivery.

3.3.1.3 Network Monitoring

The DSO's focus is the safe and reliable management of the distribution network in a manner that optimises the integration of DER.[58] To do this, the DSO Platform will include technical capabilities to forecast network power flows and allocate DOEs that optimise the renewable energy hosting capacity on the local Medium Voltage (MV) and Low Voltage (LV) network within safe operating limits and in accordance with policies and service agreements. This requires that the DSO have visibility of local MV and LV network flows.

The DSO will be responsible for implementing appropriate monitoring on the MV and LV networks in the pilot area to enable DOE calculation to support Project Symphony. *Figure 6: Scope of Project Symphony Network Monitoring* identifies the scope of network monitoring required for the Project Symphony pilot.

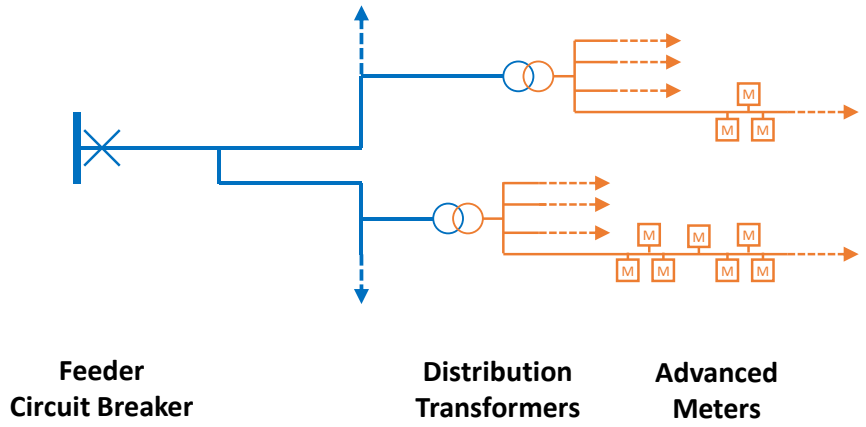


Figure 6: Scope of Project Symphony Network Monitoring

The DSO Platform will test the receiving and processing of MV and LV network monitoring data that, when combined with network configuration, weather and solar forecast information, is sufficiently detailed and timely to support accurate network forecasting, DOE allocation and, if required, the provision of NSS to manage network constraints. The DSO Platform will initially publish DOEs and NSS requirements daily (covering 72, 48 and 24 hours in advance) allowing the Aggregator Platform to process DOEs and NSS requests and incorporate them into DER orchestration and market bid processes. This will ensure DER operations are bound by safe network operating limits. The DSO Platform will receive new network input data and incorporate them into subsequent network forecasts, DOE allocations and NSS requests, creating a cyclic relationship between DSO Platform outputs and local distribution network operations. This cycle is shown in *Figure 7: DSO Platform DOE Calculation Cycle*.

[58] Interim Report: Required Capabilities and Recommended Actions, pg. 4.

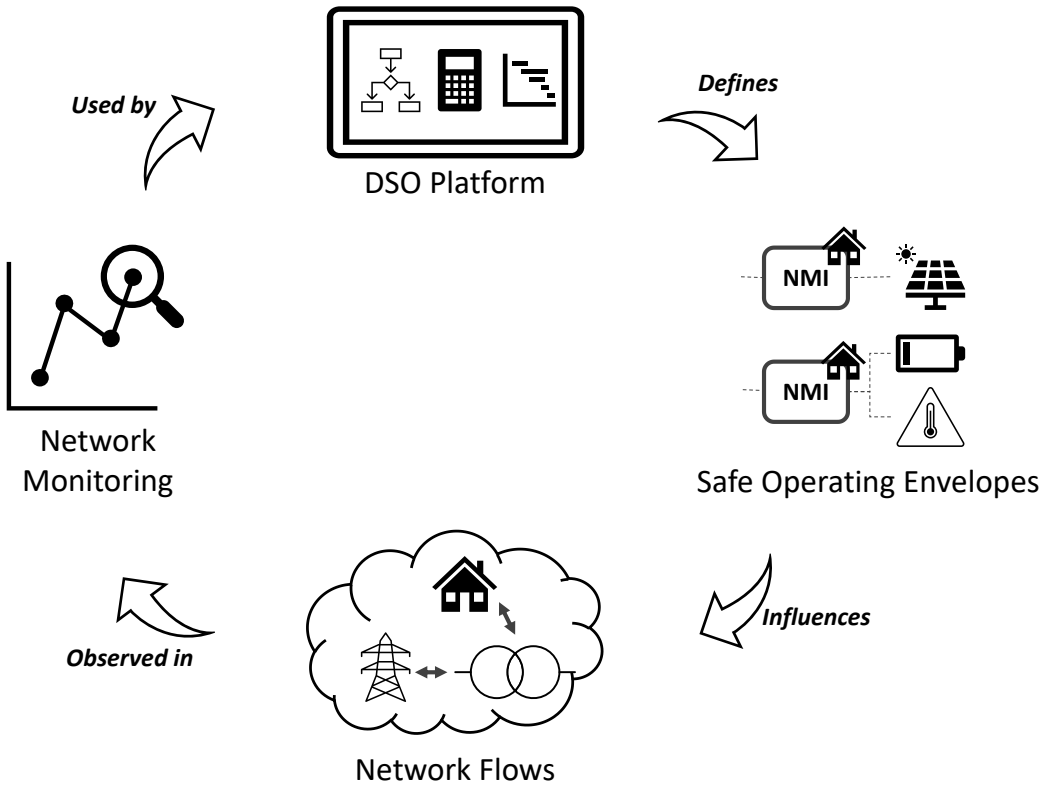


Figure 7: DSO Platform DOE Calculation Cycle

A key role of the DSO will be ensuring Aggregator adherence to relevant contracts and policies mandated to maintain safe network operating limits. This will include using network monitoring data to validate Aggregator compliance with DOEs and execution of NSS in line with relevant agreements. Project Symphony learnings will be used to inform any policy and/or regulatory change requirements for ensuring compliance with conditions and/or directions to enforce safe operating limits.

It is important to note that monitoring of the MV and LV network is vital to the optimisation of DER, particularly as changes in the mix and type of networked DER will increasingly result in less predictable network flows.[59] In addition, unlike the transmission network, the distribution network is dynamic,[60] meaning the network model will need to be maintained to support accurate and responsive DOE allocation. To manage issues as they emerge, a DSO would need to monitor the flow of power across the distribution network in real-time.[61] The Project will test the feasibility of increased monitoring of the distribution network, both from a technical and commercial perspective, including the level of monitoring, telemetry data requirements, and collection/processing frequency. As the pilot progresses, the Project will increase the frequency of end-to-end calculation and application of DSO Platform forecasts and publications to further understand network modelling and monitoring requirements for the delivery of a system that is suitably responsive to changes in hosting

[59] "The Impact of DER and renewable generation on Western Power is likely to be varied and inconsistent across geographical locations and times", DER Roadmap, pg. 31
[60] The transmission network is largely fixed, while switching, expansion and/or reconfiguration regularly results in both temporary and permanent changes to the distribution network.
[61] Open Energy Networks Project Networks Australia Position Paper, pg. 26

capacity and network conditions, and discern the impact on downstream Aggregator and DMO processes.

3.4 DSO Platform Delivery Approach

Western Power conducted an options appraisal to determine the best approach for delivering a DSO Platform to support the Project Symphony pilot. Technology solution options were identified and evaluated against a set of criteria covering the following areas:

- **Project Requirements**. How well the option would allow Western Power to meet its commitments under Project Symphony, including timeframes.
- **Pilot Test and Learn Strategy**. Whether the option would support the pilot's test and learn strategy - allowing for incremental evolution in response to pilot learnings and input from subject matter experts - and whether the option allowed for retention of any technology, learnings and/or other intellectual property.
- **Delivery of Functions.** How well the option would deliver the functions listed in *Table 1: DER Optimisation Functions,* project and business requirements outlined in section *5. Project and Business Requirements*, and align with concepts described in section *6. Design Concepts*.
- **Non-functional Requirements**. Whether the option would be capable of meeting relevant non-functional requirements, such as requirements to align with Western Power technical standards and policies that are based on industry standards and best practice.[62]
- **Longevity**. Whether the option could be reused more broadly within Western Power.

The appraisal identified four main options for delivering a pilot DSO Platform:

- **Procure an Existing Sandbox Solution**.This option proposed conducting a limited procurement process to adopt a solution already being used to deliver DER projects in regional Western Australia.
- **Go to Market for a Pilot Solution.** This option proposed procuring and implementing several functionally discrete solutions, including a pilot dynamic operating envelope calculation solution, and integrating them with components sourced from existing Western Power systems.
- **Go to Market for New Enterprise Solution**.This option proposed procuring a new enterprise solution through an open procurement process. This option was evaluated in part based on responses from a request for information.
- **Internal Build**.This option proposed Western Power develop a solution internally, either based on an existing solution or from scratch.

After considering the options, *Go to Market for a Pilot Solution* was established as the preferred option to deliver the pilot DSO Platform as this option supported the majority of evaluation criteria, including the ability to:

- Calculate dynamic operating envelopes in support of the functions described in *Table 1: DER Optimisation Functions.*

[62] This includes but is not limited to the Western Powers ICT Governance Standard (2017), Enterprise Architecture Standard (2015), and Cyber Security Program.

- Integrate with Western Power systems and provide options for integrating with DMO and Aggregator Platform solutions.
- Evolve in response to learnings as part of the Project's test and learn strategy and input from subject matter experts.
- Deliver within Project Symphony timeframes.

It is important to note that the options appraisal focused on selecting a solution that would deliver a DSO Platform specifically to conduct the Project Symphony pilot. Options that were unable to satisfy *Project Requirements* and *Pilot Test and Learn Strategy* criteria were discounted in the evaluation. Therefore, the solution described in this document may not be the best solution for delivering a DSO Platform long-term. A revised set of assessment criteria will be developed as part of project learnings to inform any future evaluation of technology to support the wider delivery of DSO functions.

3.5 DSO Platform Functional Requirements

The following sections summarise functional and non-functional requirements for the pilot DSO Platform. Detailed requirement statements are provided in *Appendix C: DSO Platform Requirements Catalogue*. Requirements have been prioritised as either Mandatory or Desirable. Mandatory requirements will need to be delivered to provide a basic DSO Platform capable of delivering the pilot. Desirable requirements provide additional functionality that would be of benefit but are not considered essential to the successful completion of the pilot and/or may be delivered outside of the DSO Platform.

Note that the requirements described and prioritised in this document are particularly focused on the delivery of a DSO Platform for the Project Symphony pilot. Additional requirements may be specified and/or a different priority assigned to requirements as part of the definition of a robust, comprehensive and long-lived DSO Platform solution.

3.5.1 Data Requirements

Table 7: DSO Platform Data Requirements lists the functional requirements that have been identified to support the collection, organisation and storage of data within the DSO Platform. Detailed requirement statements are provided in *Appendix C: DSO Platform Requirements Catalogue*.

Table 7: DSO Platform Data Requirements

REQ.	Requirements Area	Requirement Name	Priority
1	Network Model	Network Components	Mandatory
2	Network Model	Network Connections	Mandatory
3	Network Model	Network Component Constraints	Mandatory
4	Network Model	Service Connections	Mandatory
5	Network Model	Network Model Management	Mandatory
6	Network Model	Network Model Changes	Mandatory
7	Network Model	Network Outage Information	Desirable
8	Network Model	Future Planned Outage	Desirable
9	Network Monitoring – Historical Data	Feeder Data - History	Mandatory
10	Network Monitoring – Historical Data	DSTR Data - History	Mandatory
11	Network Monitoring – Historical Data	Service Connection (NMI) Data - History	Mandatory

REQ.	Requirements Area	Requirement Name	Priority
12	Network Monitoring – Historical Data	Network Model History	Desirable
13	Network Monitoring – Availability and Granularity	Feeder Data - Granularity	Mandatory
14	Network Monitoring – Availability and Granularity	DSTR Data - Granularity	Mandatory
15	Network Monitoring – Availability and Granularity	Service Connection Data - Granularity	Mandatory
16	Network Monitoring – Availability and Granularity	GRID Connected BESS - Granularity	Mandatory
17	Network Monitoring – Availability and Granularity	Telemetry Data - Availability	Mandatory
18	Weather Data	Weather Data – History	Mandatory
19	Weather Data	Weather Observation Data – Granularity	Mandatory
20	Weather Data	Weather Observation Data – Availability	Mandatory
21	Weather Data	Weather Forecast Data – Forecast	Mandatory
22	Weather Data	Weather Forecast Data – Granularity	Mandatory
23	Weather Data	Weather Forecast Data – Availability	Mandatory
24	External Data	Facility Registration Data	Desirable
25	External Data	Service Connection Participation	Mandatory
26	External Data	DER Registration Data	Mandatory
27	External Data	Facility Registration – Change History	Desirable
28	External Data	Service Connection Participation – Change History	Mandatory
29	External Data	DER Registration – Change History	Mandatory
30	Service Provision Data	Market Service Information	Mandatory
31	Service Provision Data	Network Support Service Requests	Mandatory
32	Service Provision Data	Network Support Service Trigger	Mandatory
33	Service Provision Data	ESS and NSS Provision	Mandatory

3.5.2 Dynamic Operating Envelope Calculation Requirements

The DSO Platform will take network monitoring data as an input and use it to forecast loads and allocate DOEs, as well as identify network constraints which may need to be managed using NSS. *Table 8: DSO Platform DOE Calculation Requirements* list the functional requirements the DSO Platform will need to satisfy to support the accurate forecast and allocation of DOEs. Detailed Requirement statements are provided in *Appendix C: DSO Platform Requirements Catalogue*.

Table 8: DSO Platform DOE Calculation Requirements

REQ.	Requirements Area	Requirement Name	Priority
34	Forecast Network Load	Forecast Against Available Data	Mandatory
35	Forecast Network Load	Network Load Forecast Length	Mandatory
36	Forecast Network Load	Load Flow Analysis	Mandatory
37	DOE Allocation Algorithm	DOE Allocation Granularity	Mandatory
38	DOE Allocation Algorithm	DOE Allocation to Alleviate Constraints	Mandatory
39	DOE Allocation Algorithm	DOE Allocation for Participating Service Connections	Mandatory
40	DOE Allocation Algorithm	Equal Allocation	Mandatory
41	DOE Allocation Algorithm	Proportional Allocation	Mandatory
42	DOE Allocation Algorithm	Optimal Allocation	Mandatory
43	DOE Allocation Algorithm	Firm Capacity	Mandatory
44	DOE Allocation Algorithm	Grid Connected BESS	Mandatory
45	DOE Allocation Algorithm	Transformer Level DOE Allocation	Desirable

46	DOE Allocation Algorithm	Default DOEs	Mandatory
47	DOE Allocation Algorithm	Service Dispatch Information	Desirable
48	DOE Calculator Outputs	Load Flow Analysis - Output	Mandatory
49	DOE Calculator Outputs	Identified Constraints - Output	Mandatory
50	DOE Calculator Outputs	Identified NSS Constraints - Output	Mandatory
51	DOE Calculator Outputs	DOE Allocations – Output	Mandatory
52	DOE Calculator Outputs	Default DOEs – Output	Mandatory
53	DOE Calculator Configurability	Manually Triggered DOE Calculation	Mandatory
54	DOE Calculator Configurability	Automated DOE Calculation	Mandatory
55	DOE Calculator Configurability	Configurable Items	Desirable
56	DOE Calculator Configurability	Default DOEs	Desirable
57	DOE Calculator Configurability	DOE Calculation in Response to Incidents and Outages	Desirable
58	DOE Calculator Configurability	Failsafe Override	Mandatory
59	DOE Calculator Notification	DOE Calculator Notification Configuration	Desirable
60	DOE Calculator Notification	DOE Calculator Notification Channel	Desirable
61	DOE Calculator Notification	DOE Calculator Notification Preferences	Desirable
62	DOE Calculator Notification	DOE Calculator Notification History	Desirable

3.5.3 Data Exchange and Messaging Services

Table 9: Data Exchange and Messaging Requirements lists DSO Platform messaging and notification requirements. These requirements will be integral for supporting automation and integration with partner platforms. Detailed requirement statements are provided in *Appendix C: DSO Platform Requirements Catalogue*.

Table 9: Data Exchange and Messaging Requirements

REQ.	Requirements Area	Requirement Name	Priority
63	Data Exchange	DOE Publication	Mandatory
64	Data Exchange	DER Registration Data	Mandatory
65	Data Exchange	Facility Registration Data	Mandatory
66	Data Exchange	Receive Additional Files	Desirable
67	Data Exchange	Publish Additional Files	Desirable
68	Messaging	DSO Platform Messages	Desirable
69	Messaging	DMO Platform Messages	Mandatory
70	Messaging	Aggregator Platform Messages	Mandatory

3.5.4 Grid Connected BESS Requirements

Table 10: Grid Connected BESS Requirements lists the requirements the DSO Platform will need to satisfy to integrate with a grid connected BESS and enable it to be leased by a third party (the Aggregator). Detailed requirement statements are provided in *Appendix C: DSO Platform Requirements Catalogue*.

Table 10: Grid Connected BESS Requirements

REQ.	Requirements Area	Requirement Name	Priority
71	Grid Connected BESS	Identification of Grid Connected BESS	Mandatory
72	Grid Connected BESS	Aggregator Control	Mandatory
73	Grid Connected BESS	Aggregator Visibility	Mandatory
74	Grid Connected BESS	DSO Control	Mandatory
75	Grid Connected BESS	Prioritisation of Control	Mandatory
76	Grid Connected BESS	End-of-Lease Disconnection	Desirable

3.5.5 Network Analysis and Reporting Requirements

Requirements to support the analysis of and reporting on DSO Platform data are listed in *Table 11: Network Analysis and Reporting Requirements*. Detailed requirement statements are provided in *Appendix C: DSO Platform Requirements Catalogue*.

Table 11: Network Analysis and Reporting Requirements

REQ.	Requirements Area	Requirement Name	Priority
77	Network Monitoring	DOE Compliance	Mandatory
78	Network Monitoring	NSS Validation	Mandatory
79	Network Monitoring	DOE Calculator Performance Verification	Mandatory
80	Network Monitoring	Network Analysis	Desirable
81	Report Management and Publication	Report Creation	Mandatory
82	Report Management and Publication	Report Management	Mandatory
83	Report Management and Publication	Schedule Report Publication	Mandatory
84	Report Management and Publication	Data Visualization	Mandatory
85	Report Management and Publication	Standard Derivations and Measures	Mandatory
86	Report Management and Publication	Data Quality Reports	Desirable
87	Data Analysis	Ad-hoc Data Analysis	Mandatory
88	Data Analysis	Ad-hoc Data Visualisation	Desirable
89	Data Analysis	Additional Data	Desirable
90	Data Analysis	Logical Separation of Activities	Desirable

3.6 DSO Platform Non-Functional Requirements

DSO Platform non-functional requirements, including presentation, security, interoperability, and service management requirements, are listed in *Table 12: DSO Platform Non-Functional Requirements*. Detailed requirement statements are provided in *Appendix C: DSO Platform Requirements Catalogue*.

Table 12: DSO Platform Non-Functional Requirements

REQ.	Requirements Area	Requirement Name	Priority
91	Presentation	Useability	Desirable
92	Presentation	Branding	Desirable
93	Presentation	Consistent Error Messages	Desirable
94	Presentation	WWW Access	Desirable
95	Presentation	Single Portal	Desirable
96	Security	Single Sign-on	Desirable
97	Security	Role Based Access Control	Mandatory
98	Security	User Management	Mandatory
99	Security	Compliance with Australian Privacy Principles	Mandatory
100	Security	Cloud Risk Assessment	Mandatory
101	Security	Virus and Malware Detection	Mandatory
102	Security	SSDLC	Mandatory
103	Environment Management	Environment Provisioning	Mandatory
104	Environment Management	Test Environment Equivalence	Mandatory
105	Environment Management	Simulated Data	Mandatory
106	Environment Management	Software Version Control	Desirable
107	Extensibility and Scalability	Storage of DOE Calculator Inputs and Outputs	Desirable
108	Extensibility and Scalability	Network Coverage	Desirable
109	Extensibility and Scalability	DOE Calculation Frequency	Desirable
110	Extensibility and Scalability	Multiple Aggregators	Desirable
111	Extensibility and Scalability	Increased DER – Volume	Desirable
112	Extensibility and Scalability	Increased DER – Scope	Desirable
113	Extensibility and Scalability	Software Licensing	Desirable
114	Modular Design	Modular Design	Desirable
115	Audit and Data Retention	Audit Trail	Desirable
116	Audit and Data Retention	Audit Retrieval	Desirable
117	Audit and Data Retention	Data Retention	Mandatory
118	Audit and Data Retention	Data Provenance	Mandatory
119	Performance	Response Times	Desirable
120	Interoperability	Open Standards	Desirable
121	Service Management	Support and Maintenance	Desirable
122	Service Management	Service Request Process	Desirable
123	Service Management	Problem and Incident Management Process	Desirable
124	Service Management	Change Request Process	Desirable
125	Service Management	Release Management Process	Desirable
126	Service Management	Availability	Desirable
127	Service Management	Downtime	Desirable
128	Service Management	SLA Reporting	Desirable
129	Service Management	Business Continuity and Disaster Recovery	Desirable

3.7 DSO Platform Solution Architecture

3.7.1 DSO Platform Solution Overview

The pilot DSO Platform will be created by sourcing components from existing Western Power systems and integrating them with functionally discrete solutions, including a dynamic operating envelope calculator solution. The resulting solution will deliver the necessary capabilities required to undertake the DSO role for the duration of the Project Symphony pilot, with scope to reuse solution components.

In general, the pilot DSO Platform solution can be conceptually described as six integrated modules:

- **Network and Environment Monitoring**. A module that receives and processes network monitoring and environmental monitoring information from the local distribution network in support of DSO Platform functions. Network monitoring will comprise several discrete solutions to support the collection of telemetry data from different network components. This area will also collect weather and solar irradiance forecasts and observation data from third parties. Collected data will be forwarded on to the DSO Data Store where it will be organised, stored and managed.
- **DSO Data Store**. Contains components that organise, store, and manage the pilot DSO Platform data. This includes: all network monitoring data collected from local distribution network monitoring components within the pilot area; the network model that describes network components and how they relate to each other on the local distribution network component operating constraints; and configuration information required to support network load flow analysis and DOE calculations. The DSO Data Store will make this information available to other DSO Platform components, including the DOE Calculator and Analysis and Reporting modules. The DSO Data Store will also hold a record of any DSO Platform inputs and outputs, including DOE publications and data received from partner platforms around the dispatch of services.
- **DOE Calculator.** Contains components to support the calculation and allocation of DOEs, including capabilities to forecast network loads, using load forecasts to analyse network flows and identify network constraints, and using the DCOA to effectively allocate DOEs to active NMIs that optimise the use of renewable energy while ensuring safe network operations. The DOE Calculator will also support the identification of network constraints that cannot be managed using DOEs, requiring the deployment of NSS. As such, the DOE Calculator will be fundamental in identifying NSS requirements and triggering DMO and Aggregator processes that facilitate the provisioning and dispatch of NSS.
- **Analysis and Reporting.** Contains components to support reporting and analysis activities, such as verifying the accuracy of DOE Calculator forecasts, validating compliance with DOEs, validating NSS delivery for settlement, verifying DOEs and/or NSS have had the desired impact on the network, and providing ad-hoc analysis capabilities for validating hypotheses as part of Project Symphony's test and learn strategy.
- **Data Exchange Service.** This area will contain components that support the secure exchange of information between the DSO Platform and Aggregator and DMO Platforms. Consequently, this area is critical to DSO Platform integration with partner platforms in

support of a holistic system that delivers the functions outlined in *Table 1: DER Optimisation Functions*.

- **Battery Service**. Provides a gateway to control the grid connected BESS. The gateway will allow the Aggregator to control grid connected BESS in support of VPP operations within the bounds of safe operating parameters defined by the DSO. Detailed solution Requirements for this component will be developed in conjunction with the Aggregator to support the execution of the battery under a lease agreement.

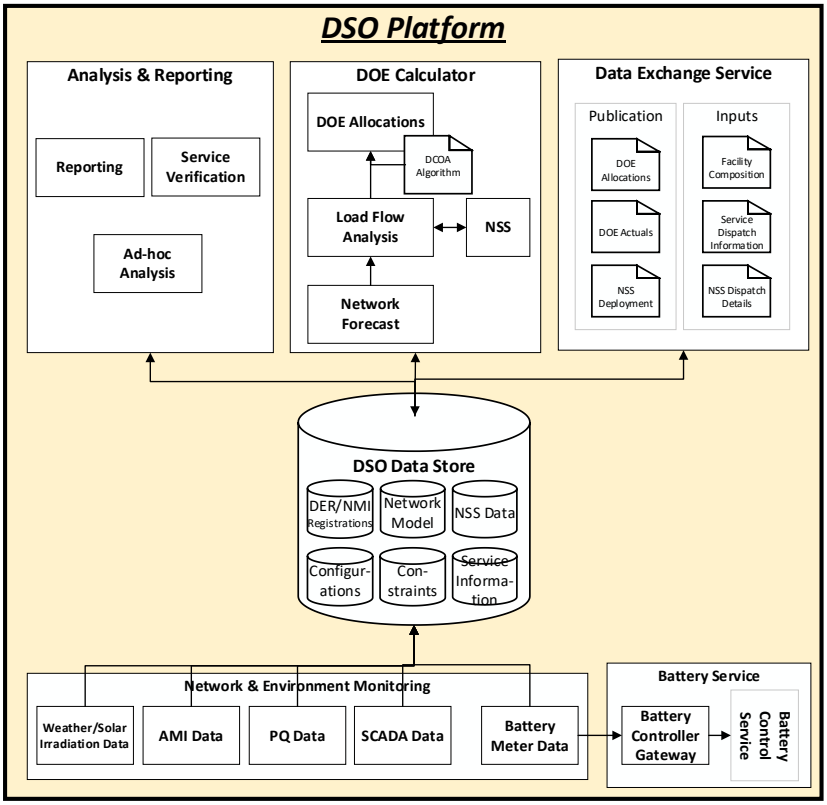


Figure 8: DSO Platform Conceptual Architecture

A more detailed representation of the DSO Platform and how it relates to external entities, such as the local distribution network, Aggregator Platform, and DMO Platform, is provided in *Appendix D: DSO Platform Conceptual Model*.

3.7.2 DSO Platform Conceptual Data Model

One of the key capabilities of the DSO Platform will be to describe, monitor and organise data associated with entities that represent actual objects and meaningful concepts. The data will be used in the execution of DSO functions, including the forecast of network loads and calculation of DOEs. Common understanding of data entities is essential to the successful integration between the DSO Platform, the Aggregator and DMO Platforms, as well as existing Western Power and supplier systems.

Fifteen key entities have been identified as essential to DSO Platform functions. These entities are categorised as follows:

- **Infrastructure Assets**. Entities that describe physical components and assets that comprise the local distribution network.
- **Network Management**. Information to support the management of the local distribution network.
- **Market Integration**. Concepts that allow the local distribution network to be controlled and managed in the context of the market.

Table 13: DSO Platform Conceptual Data Entities describes each of the identified entities.

Table 13: DSO Platform Conceptual Data Entities

Concept	Type	Description
Feeder	Infrastructure Asset	Identifies and describes the physical feeder that forms part of the pilot area local distribution network (SNR540), including describing how energy flows through the feeder, and the downstream components that are connected to the feeder.
DSTR	Infrastructure Asset	Identifies and describes physical distribution transformers that form part of the pilot area local distribution network, including describing how energy flows through each transformer, and the downstream components that are connected to each transformer.
NMI	Infrastructure Asset	Identifies and describes physical service connections located on the local distribution network that are used to monitor energy consumption and generation at connection points.
DER Asset	Infrastructure Asset	Identifies and describes physical DER Assets that are connected to the local distribution network, including their location on the network and their capacity.
Grid Connected BESS	Infrastructure Asset	Identifies and describes any grid connected BESS that are connected to the local distribution network, including their capacity, and data to describe their operations.
DOE	Network Management	A calculation performed at a specified time that describes the timebound consumption and generation limits for a specific NMI.
Outage	Network Management	A period where all or part of the local distribution network was impacted by an outage. Outages may be planned or unplanned. Outage data will describe the time and area of the network that was/will be impacted by an outage.
Service Dispatch	Network Management	Describes the dispatch of services, including NSS, ESS and constrain to zero services. Includes information such as when service was dispatch, the capacity, the location/area of the network, and the time period over which the service was delivered.
Aggregator	Market Integration	Data that describes the Aggregator, including contact information.
Facility	Market Integration	An Aggregator will be able to combine the capacity of DER into one or more facilities in order to provide market services. The DSO will need to know the number and capacity of facilities operating on a local distribution network.
Market Service	Market Integration	Describes the market services that may be offer to the local distribution network. This entity will be used to identify the services provided by Aggregators via facilities.

Concept	Type	Description
NSS Contract	Market Integration	Information about a particular bi-lateral agreement the DSO has in place for the provision of NSS. This entity will describe contract start and end date, and any associated business rules.
NSS Request	Market Integration	Information about a request for an NSS to be provided by an Aggregator as per a NSS contract. Services will be provisioned according to contractual terms, giving Aggregator time to prepare for service dispatch.
NSS Settlement	Market Integration	Information on the settlement of any NSS requests, including validation that the service was provided, and payment information.

Appendix E: DSO Platform Concepts contains an entity relationship diagram and descriptions of the relationships between the key concepts. Physical data models and processes contained within the DSO Platform will need to maintain these conceptual relationships.

3.7.3 Solution Architecture Principles

The DSO Platform will be built according to the principles outlined in this section, which will heavily influence the technical design and internal operation of the resulting solution.

3.7.3.1 Containerised Application Architecture

The DSO Platform applications architecture will be modular in design to facilitate future re-use and/or decommissioning of platform components. A containerised applications architecture will be used to package software and its dependencies into isolated units (or containers) which run consistently in any environment, making them portable.

Individual DSO Platform components will be developed and deployed within their own container, allowing DSO Platform components to be built, deployed, and tested in isolation. There are several benefits to this approach:

- **Reuse of Components**. The DSO Platform will be able to make use of containerised applications from other Western Power solutions, while Western Power solutions would be able to reuse DSO Platform components where they meet requirements.
- **Monitoring and Management**. The DSO Platform will be making use of several discrete solutions from different vendors to meet specific requirements. A containerised architecture supports the separate monitoring and management of these solutions.
- **Disposable**. At the end of the Project, components that are no longer deemed to be of value can be decoupled from the solution and decommissioned without impacting any other systems and/or DSO Platform component.
- **Strategic Alignment.** Aligns with Western Power Enterprise Architecture Standard.[63]

[63] Enterprise Architecture Standard, Western Power, 2015 principle "(iii) Reuse existing systems before buying commercial off the shelf systems, before building our own."

3.7.3.2 Open Standard Integration

Where practical, the DSO Platform will support integration via Application Programming Interfaces (APIs) that make use of open standards. Open standards are specifications for communication protocols that are created, maintained, and distributed by a reputable source and commonly agreed upon by the relevant development communities. The benefits of using open standards include:

- **Interoperability**. DSO Platform components that use open standards are more likely to support integration with other systems without the need for a translation layer.
- **Security**. As open standards are in broad use, they are consistently being used and tested in a wide range of settings, such that generic security risks are quickly identified and corrected.
- **Strategic Alignment**. Adoption of open standards aligns with Western Power Enterprise Architecture Standard principles[64] and Australian Government Digital Transformation Agency Standards criteria.[65]

3.7.3.3 Security Continuously Assessed

The DSO Platform will be delivered using a Secure Software Delivery Life Cycle (SSDLC). Under this approach, security assessment and testing activities are integrated into all areas of the software development life cycle. The benefits of this approach include:

- **Continuous Assessment**. Software security is continuously assessed and tested throughout the development process, making security integral to every stage of software development.
- **Early Detection**. Security flaws are generally detected early in the development lifecycle, saving time, cost, and lowering overall risk.
- **Security Becomes Everyone's Responsibility**. Under SSDLC, security is a consideration in all software development activities, from specification, through to design, development, testing and implementation, making everyone in the development process responsible for security.
- **Reduce Risks**. Continuous security assessment and testing reduces overall intrinsic ICT security risks.

3.7.3.4 Pragmatic Data Quality Management

The DSO Platform will build on existing Western Power monitoring and network management capabilities by collecting detailed telemetry data for the MV and LV network components at scale for the first time. Network monitoring will be incrementally rolled out on a portion of the MV and LV network in the pilot area to provide the DSO Platform with data inputs. Existing Western Power

[64] Enterprise Architecture Standard, Western Power, "(ii) Adopt mainstream systems and technology…" and "(v) Adopt simplification, [s]tandardisation, consolidation…"
[65] Digital Transformation Agency Digital Service Standards criteria "7. Use open standards and common platforms". *Last accessed 15/12/2021.*

network modelling and management data will be combined with this additional data as part of Project Symphony.

Due to limitations in existing MV and LV data management systems, the Project expects to identify gaps where existing Western Power network management data collection processes are not responsive and/or accurate enough to support Project Symphony requirements. However, it is not the role of the Project to correct these processes. As such, when issues arise, the Project will log them as part of project learnings and attempt to resolve them in one of two ways:

1) Make modifications to the data inputs used by downstream DSO Platform applications/processes so that they can continue to function as intended, or
2) Manually modify Project Symphony source data. In these cases, Project Symphony will flag records to show that they deviate from the 'master' records held by Western Power.

3.8 DSO Next Steps

The pilot DSO Platform will be built based on the detailed design informed by the functional and non-functional requirements provided in *Appendix C: DSO Platform Requirements Catalogue*. Once built, the pilot DSO Platform will be integrated with the Aggregator and DMO Platforms to test and simulate the capability of aggregated DER resources to participate in market and network services while maintaining safe distribution network operations.

Following delivery of the pilot DSO Platform, Western Power will detail the technical specification of the platform (in Work Package 5.1 DSO Platform (as built) Report), including documenting the level of conformance with the requirements and designs outlined in this report, provide testing and performance results, and record key learnings. The build report will also inform how Western Power can scale technically for a wider SWIS-wide enablement of DER orchestration to provide network and market services.

4 Distribution Market Operator (DMO) Executive Summary

In the following section Project Symphony will outline the approach, requirements, and conceptual design for a Distribution Market Operator (DMO) Platform to deliver functions and capabilities required by AEMO, acting as the DMO, in performing the market operations role within Project Symphony. AEMO undertook a three stage approach to define the conceptual platform design, the platform specifications and the tender and procurement process for the Market Platform.

The platform architecture design to integrate Distributed Energy Resources (DER) into a Market Platform was based on an assessment of existing Market Platform solutions, business requirements and project scope and objectives. As part of developing the specifications four 'must have' on-market and off-market services or scenarios were selected by the project participants. These scenarios enable facilities made up of aggregated DER to participate in the following services: submitting bids and offers in a bi-directional energy market; provision of network support services to help manage localised network contraints; constraining DER to zero export or output at the NMI conenction point to help manage low system load events; and enablement to respond to system frequency deviations in case of contingency frequency events.

The tender and procurement process concluded that a single Market Platform solution could not meet the requirements with an acceptable level of risk. Accordingly, AEMO separately sourced individual components of the Market Platform Solution to meet its identified business requirements and platform specifications.

The functional and non-functional Market Platform requirements were developed to not only deliver the capability to integrate with the Aggregator and the Distribution System Operator (DSO) participant platforms to deliver the end-to-end solution, but to also enhance the learnings from Project Symphony by including additional interfaces, reporting and assessment capability and integrations between the platforms.

4.1 DMO Approach

The AEMO's vision for DER integration and orchestration is to build a future where DER competitively participates to provide services to the WEM while maintaining the security and reliability of the SWIS to support a highly distributed energy future. In achieving this, DER will become an integrated part of the SWIS and WEM, and DER devices and equipment will provide the technical capability to allow Western Australia to continue increasing use of these resources as a foundational component of the energy mix.

In early 2020, AEMO instigated the DER Program, assembling project teams to deliver the systems and processes to support DER implementation into the SWIS and participation in the WEM as outlined in the WA DER Roadmap. The Project was conceptualised in 2020 and announced in early 2021. During this stage, AEMO's DER program teams developed and initiated a three-stage process to create the conceptual design, assess the available solutions, specify the requirements, and procure the build of a Market Platform in preparation for the start of the Project, which was scheduled for late 2021.

The process was coordinated with AEMO's delivery of Project EDGE[66], which will test a DER Marketplace for DER services with Aggregator and DSO project participants operating in the NEM. As the two projects share common objectives and outcomes, it was agreed that a single foundational

[66] At https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/project-edge

platform should be designed and built for both, with the capability to branch for delivery of different requirements for each project.

This section outlines the approach AEMO undertook to integrate DER into a Market Platform, defined as a DER Integration Platform (DERIP), the development of the conceptual design and platform specifications, and the tender and procurement process for AEMO's DMO Platform for Project Symphony.

4.1.1 Three Stage Approach

- Stage 1: Development of the Conceptual DER Integration Platform Design.
- Stage 2: Specification Development.
- Stage 3: Tender and Procurement Process.

4.1.2 Stage 1: Development of the Conceptual DER Integration Platform Design

In alignment with the WA DER Roadmap principles, and AEMO's vision for DER integration and orchestration, the AEMO project team conducted business reviews with technical teams and domains. The intent of the reviews was to develop a conceptual DER Integration Platform design and to formulate platform requirements and specifications. The reviews focused on the following key areas; Market and technical assessments of DER market solutions, risk assessments, detailed project concept, and feasibility and options analysis.

The following sections summarise the steps taken to develop the conceptual DER Integration Platform design.

4.1.3 Market Review & Assessment

4.1.3.1 Design Criteria

The conceptual DER Integration Platform design was based on the principles and design criteria listed below to ensure conformity with project-specific objectives and AEMO business alignment.

The DER Integration Platform is required to:

a) Meet the Pilot requirements at a minimum.
b) Have the potential to scale to meet additional participants (Aggregators).
c) Be simple for additional participants to join and utilise.
d) Be able to manage high frequency telemetry data.
e) Preferably be a SaaS solution, and at a minimum be hosted on a Cloud based Platform.
f) Have the ability to be easily modified to align to market rules once they are defined.
g) Have the ability to integrate with market systems in the future.
h) Align to the AEMO security principles and governance.
i) Operate in an off-market environment for the duration of the Pilot.

Internal AEMO business alignment required:

a) Alignment with AEMO's Digital Strategy – Proposed solution or system changes are in line with objectives and principles laid out in the Digital Strategy. Where there are deviations; architectural exceptions are agreed and documented.
b) Integration – Enable functionalities using modern data exchange protocols and formats.
c) Enable external interfaces via internet.

d) Non-functional changes – Provide a solution meeting the documented non- functional and operational requirements System changes must reside in cloud (or) be cloud ready. Where there are deviations, exceptions are to be obtained.
e) Other technology areas – Solution covering the areas of networks, security, information (data) and enterprise scheduling, logging, monitoring and alerting.

4.1.3.2 Market Review

A market review on DER Integration Platform solutions, including academic research and learnings from relevant projects, was conducted internationally to develop an understanding of existing capabilities and solutions, and the challenges in aligning these with the project's objectives and integrating a solution into AEMO's infrastructure.

The review process culminated with AEMO defining three main criteria for assessing a DER Integration Platform, with subcategories, as listed below:

1. Experience and Innovation.
    a. Smart Contracts.
    b. DSO Services.
    c. Access / Channels.
    d. Bids & Offers.
    e. Interoperability.
    f. Market Platform Support.
    g. Analytics.
2. Composition and Orchestration.
    a. Registration.
    b. DER Grouping.
    c. Operating Envelopes.
    d. Constraint Optimisation.
    e. Dispatch.
    f. Transactions.
3. Technology Platform and Infrastructure.
    a. Automation.
    b. Network & Access.
    c. Storage.
    d. Compute.
    e. Availability.
    f. Security.
    g. Artificial Intelligence and Machine Learning.

4.1.3.3 Assessment

A market assessment was conducted, with each solution ranked according to strength and capability for the given criteria, based on commercial readiness and technical capability.

At the time of the assessment, the results revealed that DER Integration Platform capability was spread across four companies, with two companies leading in both the 'composition and orchestration', and 'technology platform and infrastructure' categories respectively. However, capability was spread across a wide range of companies in the 'experience and innovation' subcategories. The assessment showed that no single company or solution had capability across all

sub-categories for the specified criteria, indicating that the solutions are focused on specific functionality particular to the company's background and experience. This finding is an indicator of the complexity and early stage of market development of DER Integration Platforms.

4.1.3.4 Risk Review

AEMO conducted a review to identify risks and mitigations for the design, development, and implementation of a Market Platform for the Project. The review was based on the following core principles:

- **Minimal functionality** – This is an off-market system intended to support a Pilot with the intent of defining future requirements in the evolving DER landscape of Australia.
- **Simplicity of Integration** – This system should leverage existing interfaces and workflows where possible to minimise the impact to development cost and staff training.
- **Auditability** – This system is designed to provide data for post analysis.

These principles were guided by the primary objective of the Pilot, to enable an off-market technical demonstration of the Hybrid Model, to understand how existing rules, procedures and technologies support, or do not support, this type of program. AEMO aims to maximise the learnings from the Project utilising the flexibility of a Pilot environment, whilst also being mindful of minimising technical debt through utilisation of functionality for future integration into existing platforms.

Risk Description	Mitigation
Protracted implementation of external links due to technical complexity and working with multiple external parties.	• Clearly define the data needed for the Pilot • Explore ways to implement the minimum interface to support the Pilot demo
Data access and usability in AEMO causes scope extension and increases project time.	• Verify data formats from internal systems and others to determine detailed implementation plans and usage of data early in the project. Consider operational requirements from AEMO-generated data and how modelling changes, or how maintenance activities are impacted
System complexity increases the probability of missed design requirements.	• Engage with market and system operation experts to ensure use cases are thorough • Develop step by step guides based on use cases to ensure the right data / tools are accessible • Engage with system architects in design reviews to implement standardisation of interface requirements with the purpose of supporting future development without wholesale changes to seemingly unaffected components • Engage with system architects to ensure infrastructure components are migratable for the future or are leveraging technologies already defined as standard for AEMO
Future changes to AEMO's WEM market and system operations	• Modularity in design to reduce future changes to core design

Risk Description	Mitigation
	• Engage experts to review the functional design and identify components that have a higher risk of refactoring
Potential regression issues depending on implementation option chosen	• Changes to the Digital Strategy, depending on the implementation option chosen, can introduce regression issues that needs to be fixed and tested. It also has the potential to affect existing market processes and outcomes • Pre-plan development efforts to minimize discontinuous development efforts • Identify affinity of work to consolidate effort and increase the probability of surfacing comprehensive design requirements
End design does not meet the functional needs of the use cases	• Leverage experts and testers to develop scripted test cases in parallel with development. The goal will be to work hand-in-hand with the developers to increase functional alignment

Table 14. Platform Risk Analysis

4.1.3.5 Conceptual DER Integration Platform Design

High-level business objectives were then defined to inform the platform functionality and conceptual design. The objectives were based on the WA DER Roadmap actions 22 and 23, the roles and responsibilities outlined in the Hybrid Model, the project objectives agreed with project participants, and completion of the market and technical assessments and internal reviews as described.

4.1.3.6 Project Symphony Business Objectives

- Demonstrate roles for the DMO, DSO and Aggregator.
- Build and Pilot integration components between actors and simulated market systems, including demonstrating dispatch of DER.
- Demonstrate capability of DER to participate in WEM markets (post WEM Reform), in parallel with providing network support services (NSS).
- Provide key learnings and definition of the DER orchestration model and market participation model implemented in the WEM from July 2023.
- Develop stakeholder understanding of expectations for DER orchestration in the WEM and SWIS.

Discrete functionality were defined and platform architectural requirements developed. The architectural impacts associated with each requirement were assessed. The functionality listed in Table 15 informed the conceptual platform design.

Function	Description
Register Participant	• The ability of an Aggregator to nominate to participate in the DER energy market • The ability of the Aggregator to successfully register a facility with AEMO

Function	Description
Process Facility and Constraint Data	• The ability for AEMO to assess the behaviour of aggregated groups or DER assets (facilities) • The ability for AEMO to understand any constraints applied to DER facilities by Aggregators and DSO
Manage Bids and Offers	• The ability of for AEMO to receive and manage market bids and offers by Aggregators
User Modifiable Test Variables	• To facilitate testing, market and operational variable data needs to be able to be modified pre-test and during the test as part of test set up and execution
Manage Dispatch Instructions and Control Signals	• The ability for AEMO to send dispatch instructions or control signals to the Aggregator to supply services and receive a commitment
Reporting and Performance Assessment	• The ability for AEMO to assess and validate if the aggregated DER facility deliver the level of energy and impact to price and cost to operate the market

Table 15. Platform Functionality

The conceptual design approach was based on the fundamental principle that data exchange and business interactions, relating to market and network requirements as agreed between the project participants, could be managed and facilitated through the DER Integration Platform as a central hub. This minimised the need for individual platforms to integrate directly with each other.
A simple conceptual DER Integration Platform diagram, integrated with project participant platforms and existing AEMO existing market and system management systems, is illustrated in Figure 9 below.

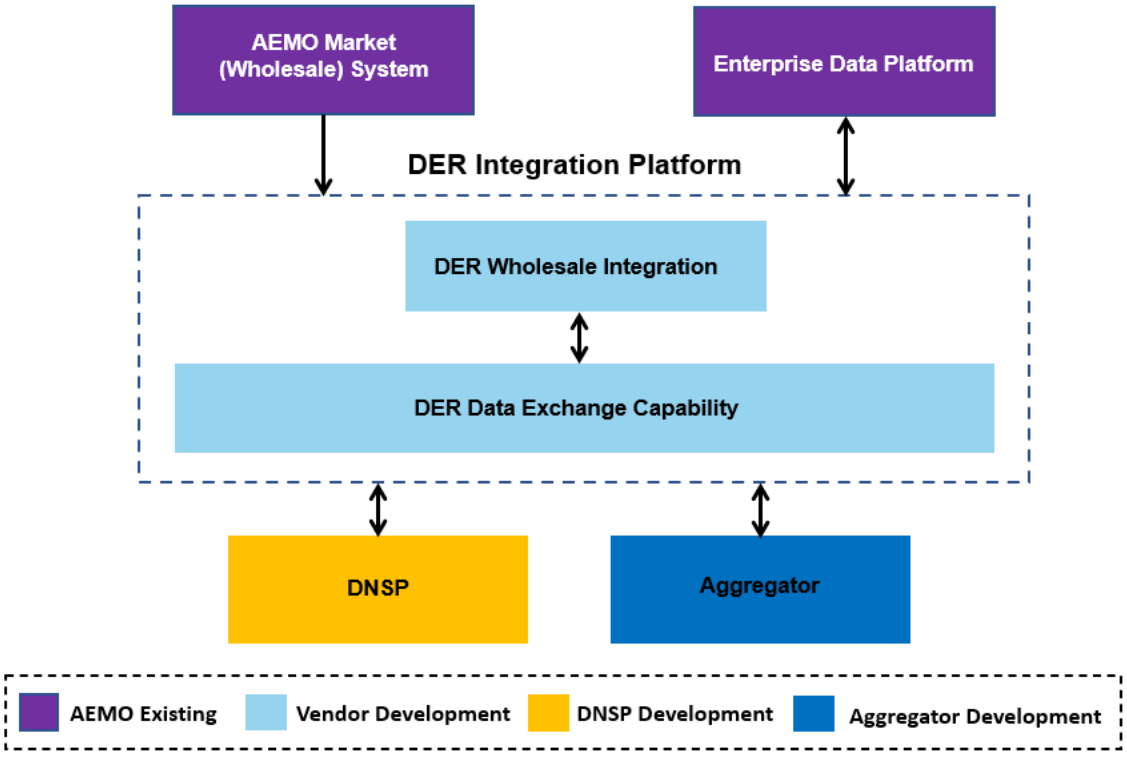


Figure 9. Simple Conceptual DER Integration Platform

The functional conceptual Market Platform was then developed for the Project based on the functionality and architectural requirements identified. The platform consisted of two layers, an intelligence layer and data exchange layer and is illustrated in Figure 10.

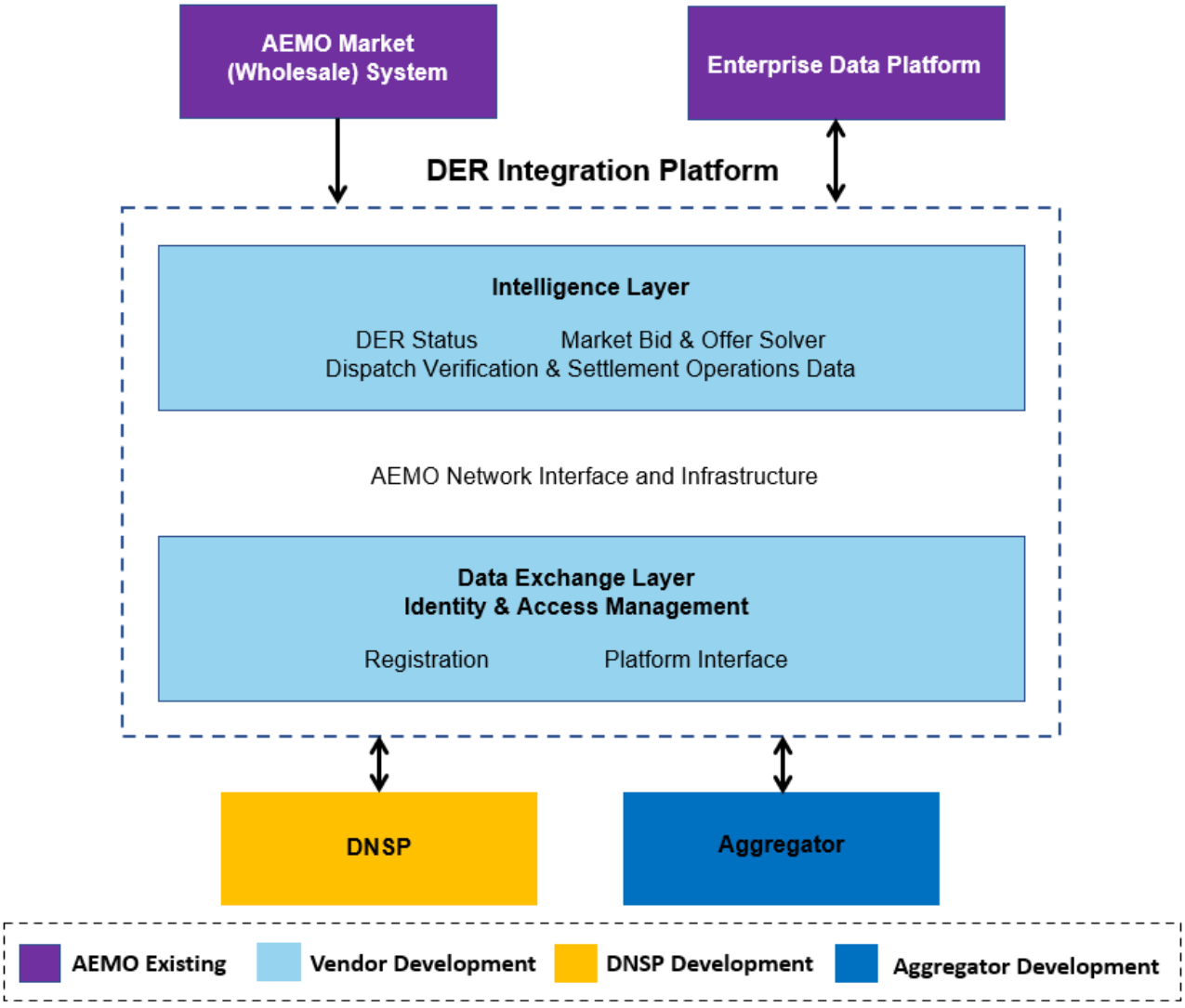


Figure 10. Simple Conceptual DER Integration Platform for Project Symphony

The data exchange layer provides identity and access management via a platform interface enabling market participants to register, submit and access data and receive instructions.

The intelligence layer is the market engine and database, bids and offers are solved, dispatch instructions are generated, and validation and settlement of market services occurs.

4.1.4 Stage 2: Specification Development

The specification development stage focused on identifying the on- and off- market scenarios that would inform the development of the Market Platform business requirements, functionality, and integrations.

4.1.4.1 Project Scenarios Identified

A scenario or use case describes the end-to-end (E2E) capability required of each platform to operate a DER Market for the WEM. A total of 18 market scenarios were initially identified and documented by the project participants for the Project. The full list of scenarios initially considered is listed in Appendix F. An action was undertaken to reduce these to define the project scope.

4.1.4.2 Must have Scenarios Defined

Following deliberation between Western Power, Synergy and AEMO and in consultation with EPWA, the four “must have” scenarios were identified and endorsed as in scope for the Project. These were selected based on ratings on the following criteria:

- Does the scenario involve all Project participants within the framework of a hybrid operating model?
- Does the scenario demonstrate the potential economic and/or commercial value of DER in the SWIS?
- Does the scenario address the system security risks associated with a high DER future (at both the transmission and distribution levels) forecast in the SWIS?
- What is the complexity and effort of delivering the scenario?

4.1.4.3 Four “must have” Scenarios Selected

1. **Energy Services – Bi-directional Energy - Balancing Market Offer (BMO).** The balancing market is a mandatory ‘gross pool’ market for dispatch and ‘net pool’ for settlement that determines the most economically efficient dispatch of generation to meet system electricity demand at a given time.
2. **Network Support Services.** A contracted service provided by a generator, retailer or DER Aggregator to the Network Operator/DSO (Western Power) to help manage or solve localised network constraints. AEMO will have visibility of the contracted operational requirements and provide the pre-dispatch instruction to the Aggregator on receiving the operation request from the DSO.
3. **‘Constrain to Zero’.** To demonstrate the ability of the AEMO Market Platform to instruct the Aggregator Platform to constrain energy output from DER to zero export (net) or zero output (gross). This could be offered as a market service, in the context of reducing the number of minimum operational demand events requiring intervention by the DSO, or incorporated into normal dispatch arrangements if customers are remunerated appropriately.
4. **Essential System Service (ESS) - Contingency Raise.** Market provided response to a locally detected frequency deviation, to help restore frequency to an acceptable level in the case of a 'contingency event' such as the sudden loss of a large generator or load.

4.1.4.4 Energy Services – Bi-directional Energy - Balancing Market

Scenario Definition	The Project will develop an end to end (E2E) solution that will test an energy generation and load scenario. The findings from this will inform a working product/capability definition of a market offer and provisioning for energy within the boundaries of a hybrid operating model. It demonstrates the potential economic and commercial value of DER via an Aggregator in the SWIS by allowing access to the WEM (Market service).
Hypothesis Statement	Our hypothesis is that AEMO will perform the role of the Market Operator (within the scope of the Hybrid Model) in a way that will result in a market outcome that is better than the outcome (price and effectiveness) experienced currently where customers are not able to access a two-sided marketplace. VPP's will enable the bi-directional energy of DER to be valued in the energy market by market participants.
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System Functionality (bids/offers received by AEMO from Aggregator, DI sent to Aggregator, Acknowledgement received from Aggregator). • System response time. • Scalability of the dispatch functionality. • Provision of energy (response time of the devices) to the network by the Aggregator. • Impact to system security. • Impact to market clearing price.
Exclusions	• Ancillary Services/ESS. • NSS (potentially could be considered during bid validation).
Assumptions	• Dynamic Operating Envelopes are refreshed prior to the start of each trading interval.
Constraints	• Policy: This is a current market offering and must adhere to existing policies and recommended changes to the future post-SCED market as stipulated by EPWA. • Process: None. • Technology: None.
Acceptance Criteria	• An Aggregator's facility can be registered with AEMO (as required) • The Aggregator (supported by the DSO's DOE) is able to determine the capacity of the operational facility per trading interval prior to the start of the trading interval • AEMO is able to receive and offer and dispatch the Aggregator • The aggregator is able to dispatch energy to the market as per the dispatch instruction provided by AEMO • The DSO is able to monitor the network operation

Table 16. Energy Services – Bi-directional Energy - Balancing Market Scenario

4.1.4.5 Network Support Services (NSS)

Scenario Definition	The Project will develop an E2E solution that will test a NSS scenario. The NSS is a bilateral contract between the DSO and Aggregator. The findings will inform a working product/capability definition of a market offer and provisioning of a network support

	service, within the boundaries of a hybrid operating model where AEMO will coordinate and optimise the activities with the DSO and market participants
Hypothesis Statement	Our hypothesis is that AEMO will efficiently and effectively perform the role of conveying deployment instructions, within AEMO's dispatch instructions, to the Aggregator (on behalf of the DSO) to enable the Aggregator to provide NSS as specified in the bilateral contract, and to provide AEMO with visibility of NSS execution such that market operations can be conducted efficiently
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System Functionality (contracted operational requirements and request for service received from the DSO, bids/offers allowing for NSS capacity, received by AEMO from Aggregator, DI sent to Aggregator, Acknowledgement received from Aggregator). • System response time. • Scalability of the deployment and dispatch functionality. • Provision of the service by the Aggregator. • Impact to system security. • Impact to market clearing price.
Exclusions	• Ancillary Services/ESS • Energy Bid/Offers
Assumptions	• NSS demand can be determined by the DSO and the DSO and Aggregators can agree on technical and commercial requirements for NSS via a bilateral contract
Constraints	• Policy: This is a current market offering and is modelled on existing policy. • Process: None. • Technology: None.
Acceptance Criteria	• An NSS product can be defined • A bilateral contract service between the DSO and Aggregator can be recorded with AEMO • The NSS deployment request and dispatch can be orchestrated successfully • The performance of the provision of the NSS service can be assessed by the DSO

Table 17. Network Support Services Scenario

4.1.4.6 Constrain to Zero

Scenario Definition	The Project will develop an E2E solution that will test the ability of the Aggregator to provide a new constrain to zero export service, whereby instructions can be sent by AEMO to the Aggregator and executed to: • Zero Net Flow: Limit energy export at the NMI (apply zero export or lower). The ability to keep DER devices online behind the meter (BTM) and restrict export to zero as a paid service. • Zero Gross Flow: Turn off devices to achieve zero export. The ability to turn off devices as a paid service. The findings from this will inform procedures, processes, and supporting system functionality that would be required in a live market. This scenario is modelled within the boundaries of a hybrid operating model where AEMO will coordinate the activities with the DSO and market participants
Hypothesis Statement	Our hypothesis is that AEMO and Synergy are able to manage a solution that will provide capability to constrain net and gross output as required
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System functionality (instructions sent between Aggregator, DSO and AEMO) • System response time (the ability of the three platforms to respond to a constrain to zero event) • Scalability
Exclusions	• Distributed solar PV Management (DPVM) - compulsory curtailment of solar PV when system security is threatened. Will apply to all eligible DER not already being curtailed under paid measures such as the Constrain to Zero scenario.
Assumptions	• Symphony will not consider DPV processes • Symphony will only determine if the capability to constrain output can be implemented and operated. The determination of value to the market will not be done in Symphony
Constraints	• Policy: None. • Process: None. • Technology: None.
Acceptance Criteria	• Instructions can be sent by AEMO to the Aggregator and executed by the Aggregator to constrain energy output to zero • Instructions can be sent by AEMO to the Aggregator and executed by the Aggregator to constrain energy output to zero and turn off the inverter • The DSO can monitor the network operation

Table 18 Constrain To Zero Scenario

4.1.4.7 Essential System Service (ESS) - Contingency Raise

Scenario Definition	The Project will develop an end to end solution that will test the provision of the ancillary service Contingency Raise. The findings from this will inform a working product/capability definition of a market offer and provisioning for energy within the boundaries of the hybrid operating model
Hypothesis Statement	Our hypothesis is that AEMO will perform the role of the Market Operator (within the scope of the hybrid operating model) in a way that will result in a market outcome that is better than the outcome (price and effectiveness) experienced currently where customers are not able to access a two-sided marketplace. Our hypothesis is that the Aggregator's DER assets can rapidly respond to a locally detected frequency drop outside the normal operating frequency band 50.00HZ +/-0.2 and help restore the frequency to an acceptable level.
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System Functionality (bids/offers received by AEMO from Aggregator, DI sent to Aggregator, Acknowledgement received from Aggregator). • System response time. • Scalability of the dispatch functionality. • Provision of the service (response time of the devices) to the network by the Aggregator. • Impact to system security. • Impact to market clearing price.
Exclusions	• Energy Services • NSS
Assumptions	• There are no bilateral contracts between parties for this service. • The Aggregator will make offers into the market for all services and time trading intervals that they wish to supply
Constraints	• Policy: None. • Process: None. • Technology: None.
Acceptance Criteria	3. An Aggregator's facility can be registered with AEMO to provide the service (as required) 4. The Aggregator (supported by the DSO's DOE) is able to determine the capacity of the operational facility per trading interval prior to the start of the trading interval 5. AEMO can receive the offer 6. The Aggregator can provide the service 7. AEMO to be able to monitor the provision of the service

Table 19. Essential Support Services Scenario

Once the four scenarios were selected, Western Power, Synergy and AEMO were tasked with determining the capability of each of their respective platforms to deliver the functionality required to meet the scope and objectives of the Project.

4.1.4.8 Business Requirements and Platform Specifications Defined

AEMO undertook a requirements determination exercise of the processes and system behaviours required to support the operations and assessment of a DER energy market. These requirements based on the four 'must have scenarios' were then grouped into the six categories as defined below in Table 20.

Category	Description
Facility Registration	To receive and store NMI and aggregated DER facility level registration information from the Aggregator
Process Facility and Constraint Data	Must receive, then process and store, the following data from the Aggregator and DSO: • Constraint information. • NSS Contracts Commitments. • Aggregated facility capacity. • DER facility status.
Manage Bids & Offers	1. Energy Balancing Market: Test ability of the aggregated DER facility to submit bids/offers for energy and be dispatched by the Market Platform to deliver that energy. 2. ESS: a) Contingency Raise (like Spinning Reserve & Load Rejection), Test ability of the aggregated DER facility to offer CR services to the market.
Manage Dispatch Instructions / Control Signals	1. Must send and manage a series of dispatch instructions to the Aggregator for the provision of energy services 2. Must send and manage a series of control signals to the Aggregator for the provision of CR and CL services 3. Must receive and process a deployment signal from the DSO platform for NSS. Must send and manage the dispatch of instructions for NSS to the Aggregator 4. Must send and manage an instruction to an Aggregator to constrain their energy generation output to zero 5. Must collect and store data related to dispatch instructions and control signals to facilitate post-test assessment by Market and System operations analysts 6. Must receive, process and visualise telemetry data (facility) related to the dispatch instructions/control signals to allow the control room operator to manage and monitor the Aggregator's response to a dispatch instructions or signals
Reporting and Performance Assessment	To support: 1. System Operations to assess the aggregated DER facility's ability to deliver the level of energy requested. 2. Market Operations analyst to assess the value that aggregated DER facility can provide. 3. Must allow analysts to retrieve and extract the test related data in a format that can be imported into an analysis platform.

Category	Description
	4. An analyst to perform an assessment of the performance of the system.
User Modified Test Variables	Must allow at time prior or during a test event, the ability to: • Construct and input a dispatch schedule. • Construct and input a control signal. • Modify the testing parameters including dispatch time interval, gate closure cut off time and price ceiling/floor and price/quantity tranches. • Simulate frequency increase or frequency decrease scenario. • Simulate a constrain to zero scenario.

Table 20. Platform Business Requirements

The finalisation of the business requirements and platform specifications enabled AEMO's Market Platform solution to be scoped and defined. AEMO then undertook a tender and procurement process to identify a suitable technology solution for the DMO or Market Platform.

4.1.5 Stage 3: Tender and Procurement Process

AEMO undertook a procurement process to identify a suitable technology solution for the DMO or Market Platform. The procurement process commenced with a targeted request for proposal (RFP) to identified vendors, and included the identified business requirements and platform specifications described above.

After considering each response in the context of AEMO's strategic technology requirements, the complexity of the business requirements and platform specifications, and associated risks with the successful development and delivery of the project, AEMO was unable to identify a single respondent that met its requirements with an acceptable level of risk. Accordingly, AEMO terminated the RFP and separately sourced individual components of the Market Platform Solution to meet its requirements.

4.2 Market Platform Functional Requirements

The functional requirements of AEMO's Market Platform were established on six core functions, specific to the business requirements and specifications, to integrate with the Aggregator and DSO Platforms and enable end-to-end transactions for the four market and off-market scenarios. The six core functions are:

- Register Participant.
- Process Facility and Constraint Data.
- Manage Bids/Offers.
- Manage Dispatch Instructions/Control Signals.
- Reporting and Performance Assessment.
- User Modifiable Test Variables.

Figure 11 illustrates the high-level process flow of the six core functions of the Market Platform and how it interfaces with the Aggregator and DSO Platforms.

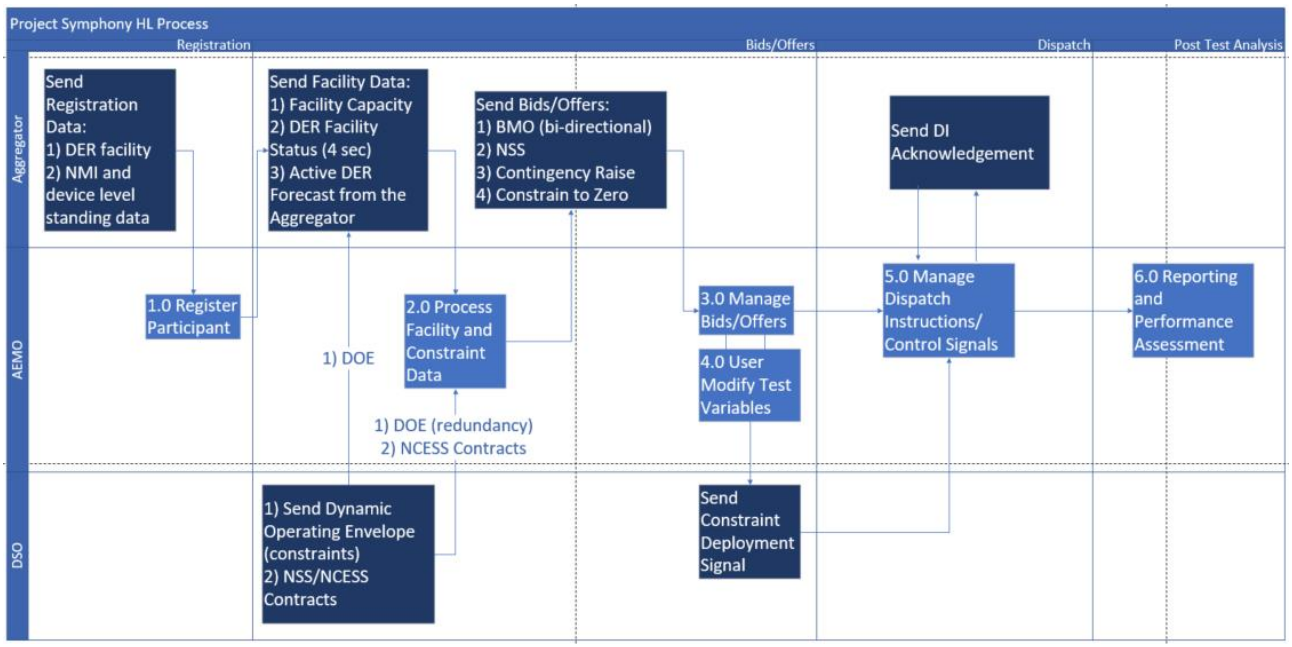


Figure 11. Project Symphony High Level Process Flow

4.2.1 Register Participant

The process flow starts with the Aggregator registering facilities via the Market Platform. This involves entering the required device standing data and facility operation data, and validation tests. Once these are complete the facility is registered by AEMO and is ready for market operations.

4.2.2 Process Facility and Constraint Data

Pre-market market operations include activities such as;

- DER capacity forecast
- Submittal of contractual requirements and request for NSS from the DSO for network services
- Submittal, validation of bids/offers for BMO and ancillary services
- Submittal of dynamic operating envelopes

4.2.3 Manage Bids and Offers – Real-time market transaction process

Real-time DER market operations include:

- Market clearing of submitted energy and ancillary services whereby the Aggregator submits bids/offers utilising the Real Time Market Submission (RTMS),
- Mitigation of transaction capacity to be within dynamic operating envelopes before publishing market awards, and
- Mitigating dispatch orders if network conditions and/or significant dynamic operating envelopes have been changed prior to sending out dispatch instructions.

The bids and offers are analysed, validated, and awarded according to market rules, and dispatched based on the latest system conditions. The real-time market transaction window is marked by the market gate closure for wholesale bids/offers and the execution of dispatch instruction is sent to the Aggregators.

4.2.4 Manage Dispatch instructions: Post awards and dispatch operations

After dispatch instructions are sent to an Aggregator, an acknowledgement will be required to confirm the execution. After the market service has been fulfilled by the Aggregator, telemetry data with a predefined data resolution will be submitted to AEMO for post-dispatch compliance verification and settlement.

In addition to facilitating bi-directional bids in the wholesale market, the Market Platform will also enable the operation of ESS, NSS and Constrain to Zero services.

The following sections summarises the functional requirements including ID, Short Description and Priority as outlined in Table 21 below.

Priority	Description
Mandatory	Non-negotiable and must be present for the final product
Desirable	Important but not vital. Will add significant value if present
Could Have	Nice to have, will have little negative impact if left out
Will Not Have	Not a priority at this time. Can be added to later iterations without impact

Table 21. Priority Descriptions

4.2.5 Register Participant

Capability for the:

- AEMO administrator to coordinate with the applicant to setup the technical and financial requirements in a multi-step process to complete the registration as a market participant. A registered user will be assigned a role, username and logon password to access the user interface.
- AEMO Market Platform to receive and store NMI and aggregated DER facility level registration information from the Aggregator Platform to monitor the capability of the aggregated DER facility that can offer/bid and provide energy, ancillary and network services.

ID	Short Description	Priority
REG1	Receive registration data from the Aggregator for registered services	Mandatory
REG3	Store the registration data from the Aggregator	Mandatory
REG4	Record that the service requirements can be met by the Aggregator	Mandatory

Table 22. Register Participant

4.2.6 Process Facility and Constraint Data

Capability for the AEMO Market Platform to:

- receive, process and store data required to operate the market.
- construct and send data required to operate the market.
- receive, process and store data required to assess the performance of the DER market.

ID	Short Description	Priority
PFC1	Receive facility constraint information from the DSO	Desirable
PFC2	Receive aggregated facility capacity from the Aggregator	Mandatory
PFC3	Receive DER facility status from the Aggregator	Mandatory
PFC4	Receive AGC interface points from the Aggregator	Mandatory
PFC5	Receive Active DER Forecast from the Aggregator	Mandatory
PFC6	Receive Telemetry Data (facility) - 4s resolution and frequency	Mandatory
PFC8	Store facility constraint information from the DSO	Desirable
PFC9	Store aggregated facility capacity from the Aggregator	Mandatory
PFC10	Store DER facility status from the Aggregator	Mandatory
PFC11	Store AGC interface points from the Aggregator	Mandatory
PFC12	Store Active DER Forecast from the Aggregator	Mandatory
PFC13	Store Telemetry Data (facility) - 4s resolution and frequency	Mandatory
PFC17	Receive NSS Contract Information	Mandatory
PFC18	Store NSS Contract Information	Mandatory

Table 23. Process facility and Constraint Data

4.2.7 Manage Bids/Offers

Capability for AEMO's Market Platform to:

- Receive bids and offers from the Aggregator to provide energy services to the DER market.
- Receive bids and offers from the Aggregator to provide ancillary services to the DER market.

ID	Short Description	Priority
MBO1	Must receive and process offers for BMO	Mandatory
MBO3	Must receive and process offers for Frequency Regulation Up/Down	Desirable
MBO6	Must define and communicate Contingency Reserve Raise requirements to the market	Mandatory
MBO7	Must receive and process offers for Contingency Reserve Raise	Mandatory
MBO11	Must receive and process deployment signal from the DSO platform for NSS	Mandatory
MBO13	Must receive and process offers for a bi-directional bid	Mandatory
MBO15	Must receive and process a dispatch acknowledgement from the Aggregator for any DI or control signal sent by AEMO	Mandatory
MBO16	Must send a NSS DI acknowledgement to the DSO	Mandatory

Table 24. Manage Bids/Offers

4.2.8 Manage Dispatch Instructions/Control Signals

Capability for the AEMO Market Platform to:

- Construct and send instructions to the Aggregator to provide energy services during specified time intervals.

- Construct and send instructions to the Aggregator to enable provision of Ancillary Services during specified time intervals and in response to observed network events.

ID	Short Description	Priority
MDICS1	Send and manage a series of dispatch instructions to the Aggregator for BMO	Mandatory
MDICS2	Send and manage a series of dispatch instructions to the Aggregator for BMO (marginal unit)	Mandatory
MDICS3	Send and manage a series of control signals to the Aggregator for ESS Regulation.	Desirable
MDICS4	Send and manage a series of dispatch signals to the Aggregator for ESS Frequency Regulation Raise and Lower.	Desirable
MDICS7	Send a control signal to the Aggregator for Contingency Raise	Mandatory
MDICS9	Send a NSS DI to the Aggregator for NSS	Mandatory
MDICS10	Send an instruction of constrain export to 0 MW	Mandatory
MDICS12	Send and manage a series of dispatch instructions to the aggregator for a bi-directional offer/bid	Mandatory

Table 25. Manage Dispatch Instructions / Control Signals

4.2.9 Reporting and Performance Assessment

Provide capability for:

- The AEMO Market Platform to retrieve and configure the data required to assess the performance of the DER market.
- AEMO to present this information to both internal and external Project stakeholders.

ID	Short Description	Priority
REP1	Send registration data to the DSO	Mandatory
REP2	Send bid/offer data to the DSO	Mandatory
REP3	Receive and store operational forecast data from the Aggregator to allow AEMO to monitor the energy balance in the grid	Mandatory
REP4	Receive and store DER high-speed recorder data from a Pilot scenario.	Mandatory
REP5	Receive and store distribution network constraints during test period from the DSO	Mandatory
REP6	Receive and store network outage information during test period from the DSO	Mandatory
REP7	Receive and store Real-time Load Levels during test period from the DSO	Could Have
REP8	Receive and store Voltage / Frequency (telemetry - 4s freq) information during test period from the DSO	Could Have
REP9	Receive and store operating limits include thermal limits for network equipment from the DSO	Could Have
REP10	Allow analysts to retrieve and extract the test related data from the storage capability in a format that can be imported into an analysis platform	Mandatory
REP11	Allow for an analyst to perform an assessment of the performance of the system and participants during the tests and overall Pilot	Mandatory
REP12	Must record the energy dispatch, ESS & NSS of the aggregated DER facility in real time and display to control room user to monitor	Mandatory

Table 26. Reporting and Assessment Performance

4.2.10 User Modifiable Test Variables

Provide capability to:

- Configure system variables related to market timing, market price and network events.
- Allow set up of testing market and operational scenarios through the configuration of variable data pre-test and during the test execution.

ID	Short Description	Priority
UM1	Must allow at time prior or during a test event, the ability to construct and input a dispatch schedule	Mandatory
UM2	Must allow at time prior or during a test event, the ability to construct and input a set of control signals	Mandatory
UM3	Must allow the analyst to modify the dispatch time interval testing parameters	Mandatory
UM4	Must allow the analyst to modify the gate closure cut off time testing parameters	Mandatory
UM5	Must allow the analyst to modify the price ceiling/floor testing parameters	Mandatory
UM6	Must allow the analyst to modify the price/quantity tranche that will be settled testing parameters	Mandatory
UM7	Must allow the analyst to simulate a frequency increase scenario	Mandatory
UM8	Must allow the analyst to simulate a frequency decrease scenario	Mandatory
UM9	Must allow the analyst to simulate a constrain to zero scenario	Mandatory

Table 27. User Modifiable Test Variables

4.3 Market Platform Non-Functional Requirements

Non-functional requirements are specifications that describe the system's operational capabilities and constraints that enhance its functionality.

Non-functional requirements:

- Ensure the software system follows legal and compliance rules,
- Ensure the reliability, availability, and performance of the software system,
- Ensure a good user experience and ease of operating the software, and
- Supports the formulation of security policy.

The Market Platform capability will be chosen and deployed in a manner that supports the needs of the Pilot. It is expected that the solution will be used in bursts while running the Pilot, and as it is not integrated with operational market systems, is expected to require minimal support in the Service Level Agreement (SLA).

The key non- functional requirements are listed in table 28 and further defined in the following sections.

ID	Short Description	Priority
SEC01	Security of platform	Mandatory
PER01	Platform performance measured by response time	Mandatory
SCA01	Ability to scale up or out	Mandatory
SCA02	Capability of platform to add additional users without any noticeable impact to services	Mandatory
AVA01	Capability of platform to run without a failure for a given period of time	Mandatory
MAN01	Periodic maintenance window	Mandatory
REC01	System restoration objectives and ability to recover	Mandatory
REC02	Data backup and retention objectives	Mandatory
DAT01	Backup daily	Mandatory
INT01	Handle multiple versions of schema	Mandatory
AUD01	Audit record of user actions	Mandatory
SUP01	Technical and non-technical support required for the system. Solution must be supportable	Mandatory

Table 28. Non-Functional requirements

4.3.1 Security

This non-functional requirement category ensures all data inside the system or its part will be protected against malware attacks or unauthorised access.

Data will need to be protected and not accessible to the public and be available only through authorised credentials.

The data will be housed in data centres within Australia and the solution will comply with AEMO's security framework and patterns.

4.3.2 Performance

This non-functional requirement category defines how fast a software system responds to user or system actions under certain workload.

As the Market Platform is operating as an off-market Pilot (non-business critical), the performance requirements for the Pilot are low due compared to a platfrom operating in a live market. The system will be required to process Bids and Offers in under 4 seconds, and Dispatch Instructions in under four seconds.

It is expected that the large majority of the transactions – e.g. Enrolment of Participants, Registration of Facility and upload of some telemetry – do not require a high performance.

4.3.3 Scalability

This non-functional requirement category assesses the highest workloads under which the system will still meet the performance requirements.

The solution will scale up/scale out (as required) for up to 10 concurrent users if additional participants are added in the Pilot,and/or data flows (number of messages processed within a given unit of time) increase, without any noticeable impact to services.

4.3.4 Availability

This non-functional requirement category specifies how likely the system, or its elements, would be to run (be available) without a failure for a given period (time) under predefined conditions.

As the Market Platform is operating as an off-market Pilot, the solution will be available and fully operational for 99% of time for the period which the scenarios are run.

The Maximum Tolerable Downtime per Incident is one day.

4.3.5 Maintenance

This non-functional requirement category defines the time required for a solution or its component to be fixed, changed to increase performance or other qualities, or adapted to a changing environment.

Due to the nature of the Pilot, the solution is expected to have many scheduled maintenance windows to implement technical fixes and platform upgrades/patches as required.

4.3.6 Recoverability

This non-functional requirement category defines the system restoration objectives and measures of the system to recover following a major incident or disaster event.

Due to the nature of the Pilot, and the lower criticality of the data and transactions, the following requirements are set.

4.3.6.1 Recovery Point Objective (RPO)

RPO describes the interval of time that might pass during a disruption before the quantity of data lost during that period exceeds the Business Continuity Plan's maximum allowable threshold or tolerance.

The RPO is set at 48 hours.

4.3.6.2 Recovery Time Objectives (RTO)

RTO measure the amount of time from the occurrence of a disruptive event to when the affected resources must be fully operational and ready to support the organisation's objectives.

The platfrom has been developed to meet the following requirements:

- The RTO is set at 48 hours.
  This is based on the classification of the AEMO Market Platform as an off-market system (non-business critical) for the Pilot.
- The solution will be backed up nightly as a minimum.
- The solution will have the ability to be restored from backup as required.

4.3.7 Data Retention

This non-functional requirement category defines the data backup and retention objectives for the system.

All system data must be backed up daily and retained for seven days. System messages and logs will be archived and retained for the length of the Pilot.

4.3.8 Interoperability

This non-functional requirement category defines how easily a system can share information and exchange data with other systems and external hardware.

The solution should cater for multiple versions of API schema, i.e. provide message interoperability between versions such that participants can operate independently of each other.

Additionally, the solution will aim to have mechanism in place that will enable a participant (Aggregator or DSO) to transition over from a file-based transfer to a API approach.

4.3.9 Auditability

This non-functional requirement category defines the degree to which transactions can be traced, from originator to approver to final disposition, through a system by an auditor.

The solution shall provide non-repudiation (i.e. assure recipient validity of sender and transaction) through secure transfer of messages (ensure messages are not compromised, tampered, modified, or manipulated with when exchanged via a shared platform).

The solution should also maintain an audit record of any user action (e.g. manual data modification) and should allow all Business To Business (B2B) and Business to Market (B2M) communications be auditable based on capture time and completeness.

4.3.10 Support

This non-functional requirement category defines the technical and non-technical support required for the system.

All system errors / failures must report back relevant error messages for troubleshooting, i.e. provide appropriate business responses pertaining to exceptions. The solution must have technical support during business hours (AWST).

All system errors must be logged and accessible for support staff (i.e. the solution should allow for IT support staff to manage and view data including logs and system performance). The solution should also allow for business support staff to manage and view test data being processed or configured.

4.4 Market Platform Architecture Solution

AEMO's Market Platform will support the Pilot by creating a test environment for a working energy market in an off-market environment. The intent of this capability is to allow AEMO to test and subsequently help define future requirements for the evolving DER landscape and energy market.

The architectural solution comprises of a number of key components that have been brought together to fulfil the functional and non-functional requirements defined in Section 14 and Section 15. It primarily comprises of five key components:

1. A component that resides on the Aggregator and DSO environment that acts as a Distributed Service Bus (DSB) that enables the external party to send synchronous and asynchronous messages to the Market Platform.
2. A Market Platform that receives and send messages from\to multiple Aggregators and DSO (s).
3. An intelligence layer that processes transactions, stores data and performs business logic based on market rules.
4. An intelligence reporting layer that enables real time insight into monitoring and market conditions.
5. A reporting platform to perform analytics and visualisation of different scenarios.

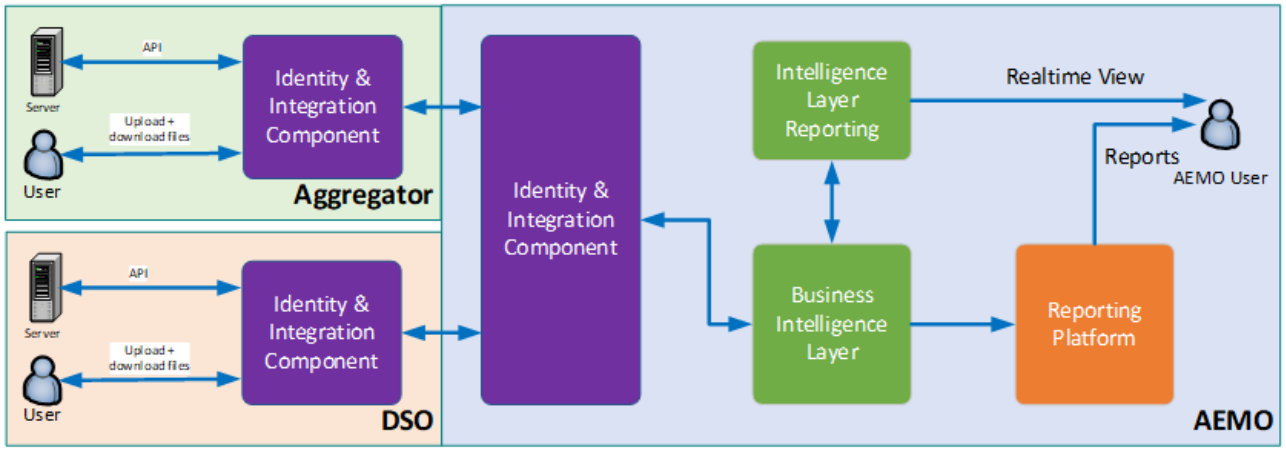


Figure 12. Market Platform Architecture Solution

The solution was developed on several principles as outlined in Section 13.1. In addition, consideration was also given to the following additional technical capabilities:

- Enable participants to submit non-real time data via file uploads.
- Enable participants to swap from a file upload and use API's if they chose to and/or have the means to do so.
- Make the process of integrating to AEMO as easy as possible (via self registration) and use of open source software.

Based on the functional requirements identified in Section 13.2 and defined in Section 14, additional capability such as automation, the retrieval, storage and extraction of data, reporting and assessment of the system performance was defined.

In addition, to enable high performance and potentially large data volumes, the Market Platfrom architecture solution has been developed to:

- Utilises a distributed service bus architecture to enable high transaction throughput in an asynchronous manner.
- High speed monitoring data is stored in a Historian to achieve real time viewing of the state of the network for monitoring purpose.
- Analytical data is extracted from the core system into a reporting platform.
- A market dispatch engine is utilised to mimic the market rules to perform calculations, determine the merit order and send dispatch instructions.
- A decentralised self-service identity store is utilised for additional participants to start interacting with the Market Platform.
- Market transactions between a participant system and the Market Platform are signed and transmitted securely to ensure the integrity of the message.
- The integration components on the Market Platform are horizontally scalable (i.e. easy to add new resources) to facilitate and increase in volume and/or performance need).
- The transaction has a flexible version control mechanism to enable new versions of transactions to be added without impacting existing formats.

4.5 DMO Next Steps

The Market Platform will be built based on the final detailed design informed by the platform functional and non-functional requirements and Market Platform architecture solution outlined in this document.

Once built, the three platforms will be integrated via the platform data exchange layer and platform interfaces to ensure seamless communication between the DSO, DMO and Aggregator platforms to test and simulate the capability of aggregated DER resources to participate in both the market and network services.

Subsequent reports will provide further detail on the design, integration methods, data sharing requirements and operation of the Market Platform, provide testing and performance results, and record key learnings of the functional and non-functional requirements of the Market Platform solution used in the Project.

5 Aggregator Executive Summary

In the following section Project Symphony will describe the approach, requirements, and conceptual design for the Aggregator platform delivered by Synergy.

Synergy undertook a multi-stage approach for this deliverable encompassing the definition of conceptual platform design, the definition of platform specifications and the conducting of a tender and procurement process.

The platform architectural design to enable an Aggregator to orchestrate residential and commercial DER resources was based on an assessment of existing Market Platform solutions, business requirements and project scope and objectives. As part of developing the specifications four “must have” on-market and off-market services or scenarios were selected by the project participants. These scenarios will enable facilities made up of aggregated DER to participate in the following services: submitting bids and offers in a bi-directional energy market; provision of network support services to help manage localised network contraints; constraining DER to zero export or output at the NMI connection point to help manage low system load events; and enablement to respond to system frequency deviations in case of contingency frequency events.

The tender and procurement process concluded that a single platform solution could not meet the requirements with an acceptable level of risk. Accordingly, Synergy sourced two individual commercial platform components and is developing a third platform layer to meet its identified business requirements and platform specifications.

The functional and non-functional Aggregator platform requirements were developed to not only deliver the capability to control DER assets to meet simulated WEM market requirements, but also to integrate with the Distribution Market Operator (DMO) and the Distribution System Operator (DSO) platforms to deliver the end-to-end solution. This solution is also expected to enhance the learnings from Project Symphony by including additional capabilities, reporting and integrations between the platforms.

5.1 Aggregator Approach

This section outlines the three stage approach Synergy undertook to integrate DER into an Aggregator Platform. These stages were:

- Stage 1: Development of the conceptual architecture design;
- Stage 2: Global request for information (RFI) and evaluation; and
- Stage 3: Specification development, RFP tender process.

An additional stage was added to the plan, at a later stage, when the selected vendor contract negotiation was unexpectedly terminated.

- Plan B: Vendor pivot and additional procurement process.

5.1.1 Stage 1: Development of the Conceptual Architecture Design

The enterprise architecture design is detailed in section 5 of this document. The following sections are included within this section due to the direct link to the request for information (RFI) requirements.

The development of the conceptual architecture design required the identification of the scenarios that would inform the development of the Aggregator Platform business requirements, functionality, and integrations. The following sections outline the process followed to determine these scenarios.

5.1.1.1 Project Scenarios Identified

A total of 18 market scenarios were initially identified and documented by the project participants for the Project. The full list of scenarios initially considered is listed in Appendix F. An action was undertaken to reduce these to define the project scope.

5.1.1.2 Must Have Scenarios Defined

Following deliberation between Western Power, Synergy and AEMO and in consultation with EPWA, four “must have” scenarios were identified and endorsed as in scope for the Project. These were identified in advance of the RFI going to market and were selected based on ratings against the following criteria:

- Does the scenario involve all Project participants within the framework of a hybrid operating model?
- Does the scenario demonstrate the potential economic and/or commercial value of DER in the SWIS?
- Does the scenario address the system security risks associated with a high DER future (at both the transmission and distribution levels) forecast in the SWIS?
- What is the complexity and effort of delivering the scenario?

5.1.1.3 Four “must have” Scenarios Selected

1. **Energy Services – Bi-directional Energy - Balancing Market Offer (BMO).** The balancing market is a mandatory ‘gross pool’ market for dispatch and ‘net pool’ for settlement that determines the most economically efficient dispatch of generation to meet system electricity demand at a given time.
2. **Network Support Services.** A contracted service provided by a generator, retailer or DER Aggregator to the Network Operator/DSO (Western Power) to help manage or solve localised network constraints. The DMO will have visibility of the contracted operational requirements

and provide the pre-dispatch instruction to the Aggregator on receiving the operation request from the DSO.

3. **'Constrain to Zero'.** To demonstrate the ability of the DMO Platform to instruct the Aggregator Platform to constrain energy output from DER to zero export (net) or zero output (gross). This could be offered as a market service, in the context of reducing the number of minimum operational demand events requiring intervention by the DSO, or incorporated into normal dispatch arrangements if customers are remunerated appropriately.
4. **Essential System Service (ESS) - Contingency Raise.** Market provided response to a locally detected frequency deviation, to help restore frequency to an acceptable level in the case of a 'contingency event' such as the sudden loss of a large generator or load.

The four "must have" scenarios selected are defined in more detail in the tables below. Note that in all scenarios it is assumed that Synergy is the Aggregator within Project Symphony.

5.1.1.4 Energy Services – Bi-directional Energy - Balancing Market

Table 29 - Energy Services – Bi-directional Energy - Balancing Market Scenario

Scenario Definition	The Project will develop an end to end (E2E) solution that will test an energy generation and load scenario. The findings from this will inform a working product/capability definition of a market offer and provisioning for energy within the boundaries of a hybrid operating model. It demonstrates the potential economic and commercial value of DER via an Aggregator in the SWIS by allowing access to the WEM (Market service).
Hypothesis Statement	Our hypothesis is that the Aggregator will safely aggregate customer DER assets and offer more flexiblity in provision of energy services into the market in a way that will result in a market outcome that is better than the outcome (price and effectiveness) experienced currently where customers are not able to access a two-sided marketplace. VPPs will enable the bi-directional energy of DER to be valued in the energy market by market participants.
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System Functionality (bids/offers provided to the DMO from the Aggregator, dispatch instruction received from the DMO, acknowledgement provided by the Aggregator). • System response time. • Scalability of the dispatch functionality. • Provision of energy (response time of the devices) to the network by the Aggregator. • Impact to system security. • Impact to market clearing price.
Exclusions	• Essential System Services
Assumptions	• Dynamic Operating Envelopes are refreshed daily and contain envelope constraints for the following 3 days. The frequency of DOE refresh will be tested up to gate closure, to understand the impacts of DOE within an aggregated VPP environment.
Constraints	• Policy: This is a current market offering and must adhere to existing policies and recommended changes to the future post-SCED market as stipulated by EPWA.

	• Process: None. • Technology: Limitations of the Aggregator Platform capability to deliver aggregated DER at the required latency of the total system, will be tested within the project.
Acceptance Criteria	• The Aggregator's facility can be registered with the DMO (as required). • The Aggregator (supported by the DSO's DOE) is able to determine the capacity of the operational facility per trading interval prior to the start of the trading interval. • The DMO is able to receive the Aggregator's offers and issue dispatch instructions. • The Aggregator is able to dispatch energy to the market as per the dispatch instruction provided by DMO. • The DSO is able to monitor the distribution network operation.

5.1.1.5 Network Support Services (NSS)

Table 30 - Network Support Services Scenario

Scenario Definition	The Project will develop an E2E solution that will test a NSS scenario. The NSS is a bilateral contract between the DSO and the Aggregator. The findings will inform a working product/capability definition of a market offer and provisioning of a network support service, within the boundaries of a hybrid operating model where the DMO will coordinate and optimise the activities with the DSO and market participants.
Hypothesis Statement	Our hypothesis is that the Aggregator will efficiently and effectively be able to provide a NSS as specified in the contract, and will be able to provide the DMO and DSO with visibility of NSS execution such that regular market operations can be conducted efficiently.
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System Functionality (contracted operational requirements and request for service received from the DSO, bids/offers allowing for NSS capacity, received by DMO from the Aggregator, dispatch instruction sent to the Aggregator, acknowledgement received from Aggregator). • System response time. • Scalability of the deployment and dispatch functionality. • Provision of the service by the Aggregator. • Impact to system security. • Impact to market clearing price.
Exclusions	• Essential System Services. • Energy Bid/Offers (it should be noted that the NSS service energy will form part of the Real Time Market Submission (RTMS) provided by the Aggregator to the DMO).
Assumptions	• NSS demand can be determined by the DSO, and tendered with the Aggregator to agree on technical and commercial requirements for NSS via a bilateral contract.

Constraints	• Policy: This is a current market offering and is modelled on existing policy. • Process: None. • Technology: None (once BMO scenario is deployed).
Acceptance Criteria	• An NSS product can be defined. • A bilateral contract service between the DSO and the Aggregator can be recorded with the DMO. • The NSS deployment request and dispatch instruction can be orchestrated successfully. • The performance of the provision of the NSS service can be assessed by the DSO for purposed of contract settlement.

5.1.1.6 Constrain to Zero

Table 31 - Constrain to Zero Scenario

Scenario Definition	The Project will develop an E2E solution that will test the ability of the Aggregator to provide a new constrain to zero export service, whereby instructions can be sent by the DMO to the Aggregator and executed to: • Zero Net Flow: Limit energy export at the NMI (apply zero export or lower). The ability to keep DER devices online behind the meter (BTM) and restrict export to zero as a potential new wholesale market service. • Zero Gross Flow: Turn off PV generation devices to achieve zero export (or lower). The ability to turn off generation devices as a wholesale market service. The findings from this will inform procedures, processes, and supporting system functionality that would be required in a live market. This scenario is modelled within the boundaries of a hybrid operating model where the DMO will coordinate the activities with the DSO and the Aggregator.
Hypothesis Statement	Our hypothesis is that the Aggregator will be able to manage a solution that will provide capability to constrain net and gross output as required.
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System functionality (instructions sent between the Aggregator, DSO and DMO). • System response time (the ability of the three platforms to respond to a constrain to zero event). • Scalability.
Exclusions	• Distributed solar PV Management (DPVM), also known as Emergency Solar Management - compulsory curtailment of solar PV when system security is threatened. Will apply to all eligible DER not already being curtailed under paid measures such as the Constrain to Zero scenario.
Assumptions	• The project will not consider DPVM processes. • The project will only determine if the capability to constrain output can be implemented and operated, meaning any potential market service constructs will not be tested.

Constraints	• Policy: None. • Process: None. • Technology: None.
Acceptance Criteria	8. Instructions can be sent by the DMO to the Aggregator and executed by the Aggregator to control the NMI at either a gross or net level. Note that for control at the net level the intent is to control energy output to zero as measured at the connection point; this may result in an importing load at the connection point. 9. The DSO can monitor the network operation.

5.1.1.7 Essential System Service (ESS) - Contingency Raise

Table 32 - Essential Support Services Scenario

Scenario Definition	The Project will develop an end to end solution that will test the provision of the ancillary service contingency raise. The findings from this will inform a working product/capability definition of a market offer and provisioning for energy within the boundaries of the hybrid operating model.
Hypothesis Statement	Our hypothesis is that the Aggregator can rapidly respond to a locally detected frequency drop outside the normal operating frequency band 50.00HZ +/-0.2 and help restore the frequency to an acceptable level.
Measures	Our measure of improvement for our business/customer is based on the following measurable criteria/data indicators: • System Functionality (bids/offers received by the DMO from the Aggregator, dispatch instruction sent to Aggregator, acknowledgement received from the Aggregator). • System response time. • Scalability of the dispatch functionality. • Provision of the service (response time of the devices) to the network by the Aggregator. • Impact to system security. • Impact to market clearing price.
Exclusions	• Energy Services. • NSS.
Assumptions	• There are no bilateral contracts between parties for this service. • The Aggregator will make offers into the market for all services and time trading intervals that they wish to supply.
Constraints	• Policy: None. • Process: None. • Technology: None.
Acceptance Criteria	• The Aggregator's facility can be registered with the DMO to provide the service (as required).

- The Aggregator (supported by the DSO's DOE) is able to determine the capacity of the operational facility per trading interval prior to the start of the trading interval.
- DMO can receive the offer.
- The Aggregator can provide the service.
- DMO to be able to monitor the provision of the service.

5.1.1.8 RFI Capability Requirements

Once the four scenarios were selected, Western Power, Synergy and AEMO were tasked with determining the capability of each of their respective platforms to be delivered, to support the functionality required to meet the scope and objectives of the Project.

5.1.1.9 RFI Key Selection Decisions

Decision 1

A key design decision made by the project was the method of controlling DER assets from the central cloud. The available options were:

1. Local control via a gateway device installed at the premises; and
2. Control via third party asset software.

Of the 2 possible options, option 1 was selected to enable the level of certainty of control required by the agreed scenarios. The control via third party asset software (vendor cloud control) is not yet mature enough to provide the mix of DER assets control required by the Project.

Decision 2

A key decision was made that the software vendor must provide an overarching commercial accountability delivery structure. This meant the solution could only be comprised of multiple vendor offerings if there was a lead vendor with commercial accountability for the whole solution who had sub-contracted to other parties.

5.1.1.10 RFI Tender Scope of Work

The RFI tender scope of work was developed predominantly around the Synergy developed Aggregator Platform Reference Architecture model designed to provide a reference frame for vendor comparison (see section 5) and the tender document contained the following key headings:

- Part A – Project background and overview;
- Part B – Scope of requirements – key requirements;
- Part C – Vendor response requirements – how the vendors are to respond; and
- Part D – Schedule information – primarily procurement governance, costs and delivery response.

5.1.2 Stage 2: Global Request for Information (RFI) and Evaluation

The Synergy platform stream conducted early analysis of the market using key words of "DERMS" and "VPP platforms". It was soon clear that the platform vendor market was comprised of two distinct markets, the DERMS market focused on grid security and microgrid management, and the more

general VPP market that was focused primarily on large scale control and industrial asset control such as large-scale solar PV and battery installations. The unique market of residential focused DER control with the wholesale market integration was not well supported by vendor offerings.

From an initial market investigation ~35 different vendors were identified and asked to participate in a formal RFI, 21 were formally invited with 17 responses received.

Of the 17 RFI respondents, 5 were shortlisted through a comprehensive three-month evaluation process.

5.1.2.1 Key Learnings From RFI

Table 33 - RFI learnings

Topic	Learning	Implication
DER	Emerging market of residential DER Control.	The Symphony pilot will inform the question as to viability of residential focused DER aggregation and participation in various market and services.
Platform	Few software vendors had all layers required (gateway controller, monitor & control, optimisation).	Generally, vendors' software offerings are immature and will require time to mature.
Platform	Specific to Symphony requirements experience across the world is not comprehensive.	More pilots will need to be undertaken to gain market experience of specific Symphony requirements.
Platform	Some vendors were happy to tender a combined bid comprised of multiple partners to support the diversity of the solution.	Diversity of offering is not yet established, with very few vendors able to support the whole platform ecosystem, leading to little choice for Aggregators / retailers.

5.1.3 Stage 3: Specification Development, RFP Tender Process

Following the RFI, the Aggregator Platform Reference Architecture was redeveloped based on the learnings from the RFI responses. From the platform reference architecture, a set of request for price (RFP) functional requirements were developed and were prioritised based on the goals and objectives of the project.

The Symphony platform stream invited the 5 shortlisted vendors from the RFI to tender as part of the RFP, based on the RFP functional requirements developed using the following content headings:

- Part 1 – Background and overview; and
- Part 2 – Assessment criteria, consisting of the following areas;
  - Qualitative;
  - Functional;
  - Non-functional;
  - Cost;
  - License agreement;
  - Information required of respondents;
  - Delivery considerations;

- Licence period; and
- Structured demonstrations.

The RFP was planned and executed around the following key assessment activities:

- RFP tender provided to 5 shortlisted vendors;
- RFP vendors respond to tender;
- Evaluation of functional, non-functional requirements, delivery and costs;
- Vendor structured demonstrations; and
- Evaluation selection.

The RFP evaluation process concluded after 4 months with selection of the preferred vendor, at which point detailed contract negotiation started based around the proposed delivery plans and the detailed scope of the project, with a planned conclusion of 4 weeks.

After a short time into the contract negotiations, the preferred vendor felt they were unable to continue with the project and notified Synergy that they would withdraw from the tender process. Synergy and the vendor spent a further 2 weeks negotiating but were unable to reach agreement to continue with the project.

5.1.3.1 Key Learnings From RFP

Table 34 - RFP learnings

Topic	Learning	Implication
Optimisation	Forecasting available load response from DER (or 'Flex') is key to optimising the VPP.	The ability of the platform to forecast the spare energy or load response within the VPP is key to effective optimisation of the VPP's energy.
Platform	Few software vendors provided effective optimisation and runtime disaggregation.	Vendors' software offering is largely immature in the optimisation capability area.
Market Services	Trading support by aggregation platforms is not yet mature.	Vendors' software offering in trading and interaction with market services is not well supported.
Commercial	The DER aggregation software vendor market is undergoing significant change through mergers and acquisitions.	This may be a risk that constrains the establishment of commercial arrangements with some vendors.

5.1.4 Plan B: Vendor Pivot and Additional Procurement Process

During the RFP process, Synergy defined a contingency plan to mitigate the risk of either the vendor negotiations failing or the vendor not being able to deliver within the expected timeframe or to the desired quality.

Following the withdrawal of the preferred vendor from the RFP process, Synergy re-evaluated their tender approach and assessed all options to their approach to selection of the Aggregator Platform and vendor. This directly led to the decision to change a previous decision in selection of the software vendor.

5.1.4.1 Plan B Decisions

Decision 3

A decision was made to open the solution to multiple vendors without a prime. This would allow a 'best of breed' approach to the solution but would add additional risk due to overlap of capability, accountability now shared and new integration between systems required. This negated the previous project Decision 2.

5.1.4.2 Plan B Solution

From our significant evaluation of RFI and RFP vendors against the now known requirements of an Aggregator Platform, the platforms team were able to select multiple candidates capable of delivering a 2-vendor solution. An additional evaluation process, termed Plan B, was conducted to select the final candidates to supply the Aggregator Platform.

5.1.4.3 Plan B Vendor Evaluation

The RFP requirements were redeveloped into user stories and these formed the key input into the evaluation process through detailed technical workshops with each vendor to match their capability to the defined user stories. In addition to these detailed workshops, demonstrations were held to showcase each of the vendor's capabilities.

Following the technical workshops, an evaluation process was conducted to select the best vendor offering.

In all, the plan B vendor evaluation took a further 2 months and 2 vendors were selected. Contract negotiation was concluded quickly with both vendors.

5.1.5 Key Learnings From Plan B Evaluation

Table 35 - RFP Plan B learnings

Topic	Learning	Implication
Platform	User story mapping to vendor capability is an effective evaluation process.	Evaluation of vendors software to defined detailed scope enabled a rapid selection result.
Platform	A 'Best of Breed' strategy involving multiple vendors is required when the vendor offerings are not yet mature.	Due to the evolving Residential DER aggregation space, a single vendor solution may not yield enough capability to fulfill all capabilities required at the current time.
Platform	Vendors are willing to collaborate with other vendors.	Selection of multi-vendor solutions are possible given motivated vendors.

5.2 Aggregator Platform Architecture Design

Synergy's Aggregator Platform architecture design defined the following artefacts:

- A partner boundaries model;
- Synergy key success measures;
- Conceptual architecture;
- Logical Aggregator Platform Reference Architecture;
- Future state logical architecture model; and
- Technical design considerations.

These are outlined in more detail in the following sections.

5.2.1 Partner Boundaries Model

Synergy's architecture team began architectural design by conducting analysis of the DER Roadmap, all business drivers and known dependencies/criteria of the proposed solution. This included conducting architectural workshops with the Symphony partners, with a focus on further definition of outcomes required from each of the respective partner roles. Following this initial work it was clear each of the partners needed to agree on scope/boundaries from each other. An Architectural Working Group defined an outline of project boundaries of each of the partners as described in the following model.

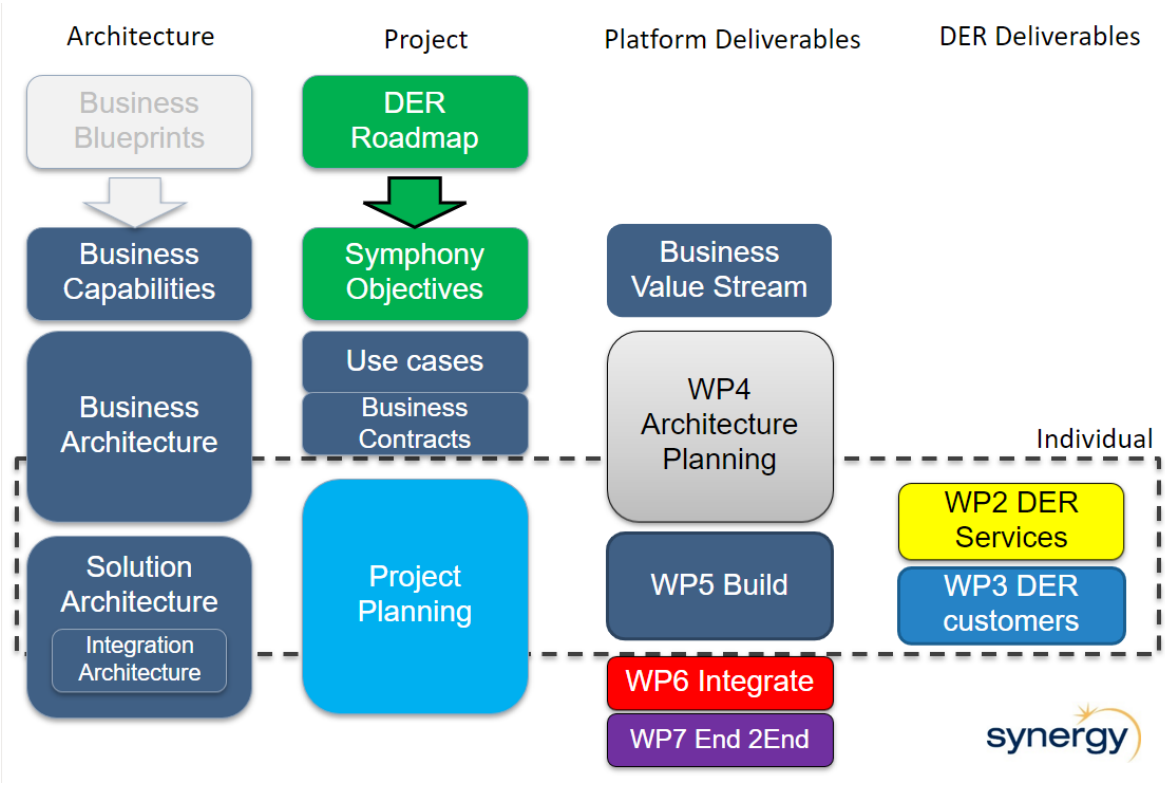


Figure 13 – Partner boundaries model

It can be seen in the partner boundaries model where each of the partners are responsible for individual architecture, project delivery and deliverables. The model also indicates the high-level deliverables that were required to be developed through partner collaboration.

5.2.2 Synergy Key Success Measures

In parallel with the partner boundaries model Synergy also defined three Project Symphony 'success measures' that informed the architecture design. The Aggregator Platform is mostly aligned to fulfill measure B and support the understanding of measure C.

Figure 14 – Synergy success measures

5.2.3 Conceptual Architecture

Synergy then developed a conceptual architecture model showing how the business capabilities would be handled by each pilot participant. This model was used to define project work streams and guide project scope.

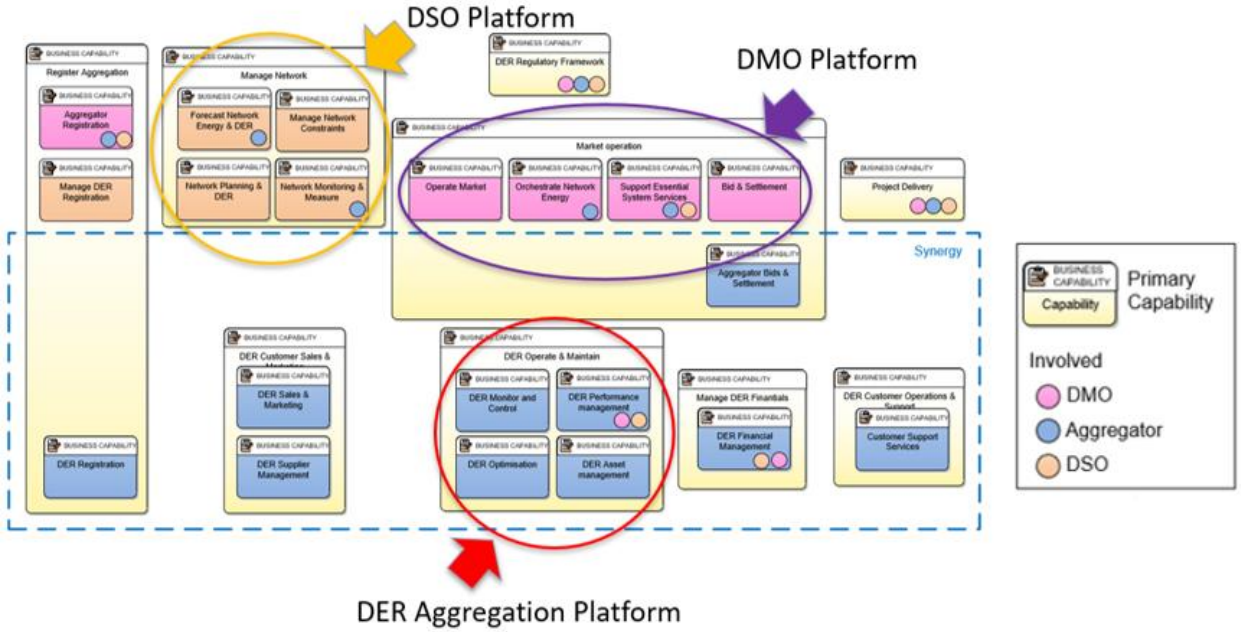


Figure 15 – Conceptual architecture model

5.2.4 Logical Aggregator Platform Reference Architecture

In order to define the logical architecture of the business services, applications and data services, and technology required for the Aggregator role, the Synergy team developed an Aggregator Platform logical reference architecture, based on the conceptual architecture, principles, reference models and knowledge of Industrial Internet of Things (IIoT), blended with a known IoT reference architecture model.

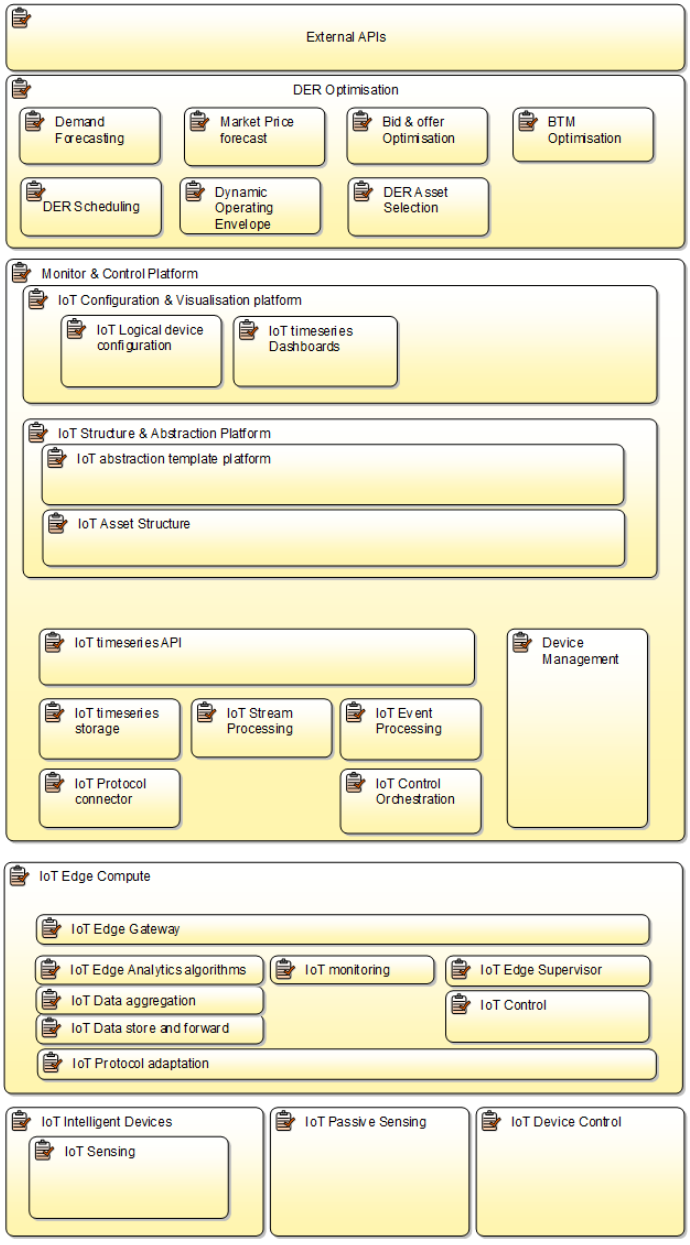


Figure 16 - Aggregator Platform Reference Architecture

The Synergy Aggregator Platform Reference Architecture Model was the core foundation of the functional requirements for the platform RFI selection process tender.

5.2.5 Future State Logical Architecture Model

A future state logical architecture model was also developed to explain the layered platform architecture. These layers are described in the following sections.

5.2.5.1 Partner Layer

- ***AEMO*** as the Distribution Market Operator (DMO).
- ***Western Power*** as the Distribution System Operator (DSO).

5.2.5.2 Synergy Energy Management System

- ***External partner APIs***: an integration layer providing communication between the DMO, DSO and the other layers of the Aggregator Platform.
- ***Synergy Trading platform, DER Trading Platform***: The existing Synergy portfolio trading platform and the new DER trading platform that supports the development and lifecycle of bids and offers.

5.2.5.3 Cloud Platforms

- ***DER Optimisation***: the optimisation layer responsible for determining 'what' and 'how much' each of the assets within the VPP will contribute to providing the energy or network service. Provides the VPP energy forecasts as a virtual facility and provides dis-aggregation of a dispatch instruction into the discrete setpoints for each of the DER assets.
- ***Monitor & Control Platform***: the monitor and control layer responsible for near real-time monitoring of the assets operation and determining the control setpoints for each device to be executed through the local gateway controller.

5.2.5.4 On-site

- ***Gateway Controller:*** the gateway controller is responsible for communication of near real-time monitoring of the assets' operation. Also responsible for distributed (local) control of the DER assets as determined in the monitor and control layer of the cloud platforms.
- ***DER Assets:*** the DER controllable assets including solar PV inverters, battery inverters, Air conditioning units, Hot water system heat pumps and optionally pool pumps. The core focus group for Symphony is residential customers' assets, although a small number of commercial and FoM assets will be also controlled.

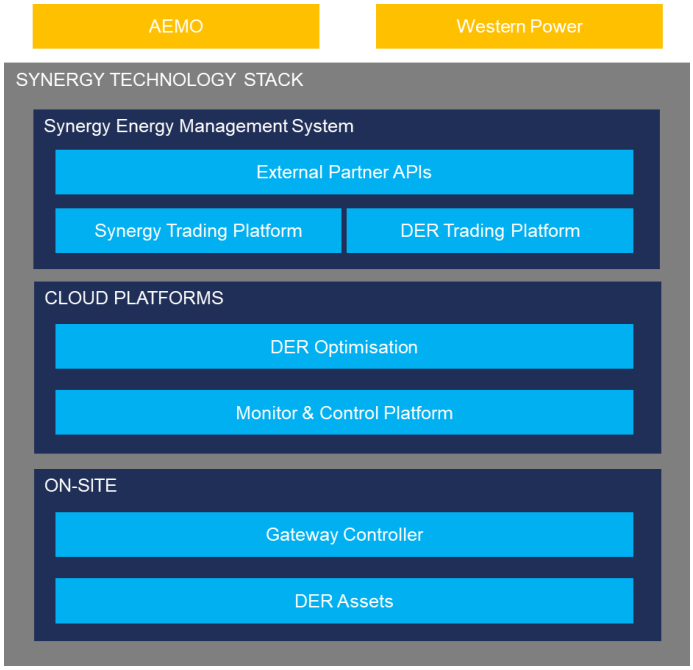


Figure 17 - Future state logical architecture

5.2.6 Technical Design Considerations

The following technical design considerations were also defined:

- A key project Symphony goal is to test and learn based on a real-world pilot that can inform and contribute to a scalable solution. Therefore, the core technology should be designed with extensibility in mind but should also be tempered based on the budget limitations and the value it can bring to the project objectives;
- The solution will secure all associated information and be resilient to cyber intrusions;
- DER orchestration in a residential context is a new capability and as such, much in project Symphony will be developed for the first time. Therefore, an agile, iterative approach in the design and scope management is required to support the level of learning required;
- The solution should represent a smaller scale solution of a much larger real world scale requirement. The design should understand the implications of scale especially on DER performance; and
- Project Symphony aims to test and understand the impacts of DER orchestration in resolving system stability issues caused by DER penetration while maintaining overall Network security.

5.3 Aggregator Platform Functional Requirements

Requirements for the four 'must have' scenarios are outlined in the following sections.

5.3.1 Scenario 1 - Bi-Directional Energy Services

5.3.1.1 Customer and DER Asset Onboarding

As the electricity retailer, Synergy is responsible for recruiting and enrolling Southern River residential and commercial customers from their existing customer base into the Symphony pilot. Synergy will also be sourcing existing controllable assets from customers and procuring and installing new assets at customer sites. Once pilot enrolment is complete customer sites and DER assets will be available in the Aggregator Platform to be monitored, managed and included in DER facility definitions.

Table 36 - Functional requirements: Customer Recruitment

ID	Short Description	Priority
REC1	Store customer site information.	Mandatory
REC2	Store network model information.	Mandatory
REC3	Store DER asset information, including asset operating constraints.	Mandatory
REC4	Store IOT gateway information.	Mandatory
REC5	Support automated and manual DER asset and IOT gateway commissioning information.	Mandatory
REC6	Store commissioning results.	Mandatory

5.3.1.2 Structure Facility and Register with DMO

As the Aggregator, Synergy is responsible for defining DER facility structures and registering these facilities with the DMO to be able to participate in Symphony off market simulations.

Table 37 - Functional requirements: Structure Facility

ID	Short Description	Priority
FAC1	Define a DER facility as a logical grouping of NMI connection points.	Mandatory
FAC2	Capture and store DER facility information required for registration and orchestration.	Mandatory
FAC3	Update of registered facility standing information, including NMIs contained.	Mandatory
FAC4	Extract of new structured facility information into a file format as required by the DMO.	Mandatory
FAC5	Structure of any facility registered with DMO will ensure 1 NMI will be part of only 1 registered facility.	Mandatory
FAC6	Ability to optimise NMIs into discrete facilities.	Desirable

5.3.1.3 Determine Facility Operating Capacity

In order to know what DER capacity is available for offering into the market, Synergy will determine the current operating capacity of each registered DER facility on a high frequency basis. The available operating capacity will take into account constraints required by the DSO (such as

operating envelopes), service provision commitments (such as ESS and NSS) and technical operating constraints of the DER assets contained within the facility.

Table 38 - Functional requirements: Determine Facility Capacity

ID	Short Description	Priority
CAP1	Ingestion of Dynamic Operating Envelope data received from the DSO.	Mandatory
CAP2	Application of Dynamic Operating Envelope to the required NMI for operational control of the assets attached to the NMI.	Mandatory
CAP3	Calculation of the available flexible energy capacity for a facility, incorporating Dynamic Operating Envelope constraints for all NMIs within the facility and the DER asset operating or opt-out constraints.	Mandatory

5.3.1.4 DER/VPP Portfolio Dispatch Planning (including optimisation)

As the Aggregator, Synergy will undertake planning on a high frequency basis in order to:

- Determine what energy capacity is available across its DER fleet for participating in markets and provision of paid services; and
- Determine the optimal use of the energy across all markets and services given the pricing, forecasting and pre-dispatch schedule information available.

Table 39 - Functional requirements: Dispatch planning

ID	Short Description	Priority
OPT1	View current state of DER assets – availability and performance.	Mandatory
OPT2	Provision of behind-the-meter demand and generation forecasts.	Mandatory
OPT3	Provision of generation, load and flexible energy capacity forecasts.	Mandatory
OPT4	Provision of optimised control event schedule for each enrolled DER asset that will ensure fulfilment of market bids.	Mandatory

5.3.1.5 Balancing Market Submission

As the Aggregator, Synergy will submit bids and offers into the Balancing Market for energy services that take into account available capacity of DER facilities and market pricing. Bids and offers will be cleared by the DMO and the Aggregator will be dispatched for the energy cleared shortly thereafter.

Table 40 - Functional requirements: Balancing market submission

ID	Short Description	Priority
SUB1	Generation of optimised proposed bids/offer for a facility and service, considering balancing market price forecast and VPP operational costs.	Mandatory
SUB2	Ability to send optimised bids/offers for energy services to the DMO in compliance with RTMS specification using EnergyWeb.	Mandatory
SUB3	Ability to manually contruct bids and offers for energy services compliant with the DMO RTMS specification and submit them to the DMO.	Mandatory

5.3.1.6 Create Lower-Level Dispatch Instructions to DER Assets

Upon receiving dispatch instructions from the DMO at the facility level, Synergy will disaggregate the facility level energy requirement into individual control event instructions for each DER asset that will generate energy or provide load to meet the requirement. Control events will respect all known constraints and parameters, including any ramp rates received in the dispatch instruction.

Table 41 - Functional requirements: Create lower-level dispatch instructions

ID	Short Description	Priority
CON1	Ability to receive dispatch instructions from the DMO for dispatch of energy services.	Mandatory
CON2	Ability to send a dispatch instruction receipt acknowledgement to the DMO.	Mandatory
CON3	Create and send disaggregated (from facility level dispatch instructions) control instructions to DER assets for a specified or unspecified duration.	Mandatory
CON4	Ability to monitor and control the following asset types (various makes and models): • PV inverters; • Battery inverters; • Hot water systems; and • Air conditioning units.	Mandatory
CON5	Ability to monitor and control pool pump assets.	Desirable
CON6	DER asset control instructions to respect the individual asset control operating requirements/constraints as specified by the original equipment manufacturer.	Mandatory
CON7	Ability to return DER asset to default mode of operation when control event completed.	Mandatory
CON8	Ability to execute DER asset control to a specified setpoint, expressed as a % of maximum consumption/generation or kW/W value.	Desirable
CON9	Ability to execute DER asset control on/off via a relay contact.	Desirable
CON10	Ability to monitor and control grid-connected (FoM) battery.	Mandatory
CON11	Ability to execute DER asset control via demand response management (DRM) control.	Mandatory
CON12	Ability for the gateway device to operate on a configurable default operating mode in the event of a communications failure.	Mandatory

5.3.1.7 Monitoring and Maintenance

The Aggregator will monitor multiple aspects of the DER facilities, sites and DER assets during and outside of control events including:

- Asset performance metrics;
- Asset availability data;
- Aggregated site performance metrics; and
- Aggregated facility performance metrics.

Table 42 - Functional requirements: Monitoring and maintenance

ID	Short Description	Priority
MON1	Storing of high resolution telemetry timeseries data for all necessary parameters for each DER asset.	Mandatory
MON2	Ability to monitor DER asset performance metrics specific and appropriate to the asset type.	Mandatory
MON3	Ability to monitor DER asset availability and status.	Mandatory
MON4	Ability to monitor IOT gateway device availability and status.	Mandatory
MON5	Ability to monitor DER asset, site and facility performance during and post control event execution in order to validate service delivery.	Mandatory
MON6	Ability to monitor connections and communications between: • DER assets and IOT gateway device; and • IOT gateway and optimisation layer.	Mandatory
MON7	Ability to execute firmware and software maintenance remotely on IOT gateway device.	Desirable
MON8	Ability to log, action and track system issues to resolution.	Mandatory

5.3.1.8 Reporting and Information Sharing with Partners

As the Aggregator, Synergy is required to share information and datasets for test and learn analysis purposes.

Table 43 - Functional requirements: Reporting

ID	Short Description	Priority
REP1	Provision of NMI and DER asset master data once per week during customer and DER asset recruitment via file upload.	Mandatory
REP2	Provision of aggregated facility telemetry data once per day for all registered and active DER facilities.	Mandatory
REP3	Provision of facility forecast data once per day for all registered and active DER facilities.	Mandatory

5.3.1.9 Customer (DER Asset Owner)

Synergy as the customer's retailer is responsible for the fulfilment of the Symphony product offering, including any agreed payments/financial compensation in return for Synergy controlling the customer's DER assets during the pilot.

Table 44 - Functional requirements: Customer information

ID	Short Description	Priority
CUS1	Provision of data about control events executed for a customer site (NMI connection point) and customer DER assets for billing and customer communication purposes.	Mandatory
CUS2	Availability of customer facing application containing information and functionality such as: • Energy consumption and generation at site;	Desirable

	• Real time energy flows – household load, PV generation, battery charge/discharge, grid import/export; • Historical and upcoming scheduled control events; and • DER asset opt out.	

5.3.1.10 3rd Party Aggregators

The Aggregator will integrate with multiple 3rd party Aggregator Platforms to enable customers' assets of the 3rd party Aggregator to be aggregated into a VPP and utilised in market services.

Alternatively, the 3rd party Aggregator may provide detailed asset telemetry and accept control commands for each asset.

Table 45 - Functional requirements: 3rd party Aggregators

ID	Short Description	Priority
3PA1	Ability to receive dispatch instructions from Synergy for dispatch of energy services.	Mandatory
3PA2	Ability to send a dispatch instruction acknowledgement / commitment to Synergy.	Mandatory
3PA3	Ability to provide energy capacity forecasts for the VPP to Synergy.	Mandatory
3PA4	Ability to provide performance of service provision aggregated to the VPP.	Mandatory
3PA5	Ability to receive DOE constraints from Synergy and respect these constraints in both forecasts and execution of instructions to DER assets.	Mandatory
3PA6	Ability to manually provide the NMI and asset details for the VPP, including when changes occur.	Mandatory
3PA7	Ability to provide payment invoices for services provided.	Optional
3PA8	Ability to provide asset standing data and NMI details.	Optional
3PA9	Ability to provide telemetry data at high level of resolution and latency for purposes of Synergy aggregation control.	Optional
3PA10	Ability to receive asset control commands as pass through to the assets.	Optional

5.3.2 Scenario 2 - Network Support Services

The Aggregator Platform functional requirements for NSS include most of the requirements stated above for Energy Services, with some additional known requirements defined below. NSS scenario design is still being determined, therefore further functional requirements will emerge and evolve through the design process.

Table 46 - Functional requirements: Network Support Services

ID	Short Description	Priority
NSS1	Ability to structure a facility to provide network support services.	Mandatory
NSS2	Receive pre-dispatch notification of NSS requirement for a facility from the DMO.	Mandatory

ID	Short Description	Priority
NSS3	Allocate DER asset capacity within a facility to meet NSS requirement, within DOE constraints.	Mandatory
NSS4	Respect both DOE and NSS commitments of a facility and DER asset in determining operational capacity forecasts.	Mandatory
NSS5	Respect both DOE and NSS commitments of a facility in proposed bids and offers for energy services.	Mandatory
NSS6	Receive NSS operating instruction from DMO to dispatch NSS services for particular date/time intervals.	Mandatory
NSS7	Disaggregation of NSS operating instructions from DMO for a facility into individual DER asset control events.	Mandatory
NSS8	Provision of facility and/or DER asset performance data post network support service provision to enable NSS settlement.	Mandatory

5.3.3 Scenario 3 - Constrain to Zero

In this scenario, the Aggregator is required to limit grid export of energy (net) at NMI level or halt generation entirely (gross) for devices within a facility.

This scenario is still to undergo design with all partners, therefore further requirements will emerge through the detailed design phase.

Table 47 - Functional requirements: Constrain to zero

ID	Short Description	Priority
CTZ1	Receive constrain to zero dispatch instructions for a facility from the DMO for specified date/time intervals.	Mandatory
CTZ2	Disaggregation of constrain to zero dispatch instructions from the DMO for a facility into individual NMI and DER asset control events.	Mandatory
CTZ3	On conclusion of constrain to zero event, ability to control DER asset resumption of net export or gross generation to meet ramp up requirements.	Mandatory
CTZ4	Provision of facility and/or DER asset performance data post constrain to zero service provision to enable settlement.	Mandatory

5.3.4 Scenario 4 - Essential System Services – Contingency Raise

In this scenario, the Aggregator will provide a response (via market clearing and dispatch) to a locally detected frequency deviation to help restore frequency to an acceptable level in the case of a 'contingency event' such as the sudden loss of a large generator or load.

This scenario is still to undergo detailed design with all partners; however, it is expected that the requirements for ESS will closely resemble functional requirements for Energy Services.

Based on this, the table below defines ESS specific requirements (where they may differ from Energy Services Balancing Market requirements) that are anticipated ahead of detailed design.

Table 48 - Functional requirements: Essential System Services

ID	Short Description	Priority
ESS1	Ability to register a facility for the provision of essential system services, including Contingency Raise, Contingency Lower and Frequency Regulation.	Mandatory
ESS2	Respect the DOE, NSS and ESS commitments of a facility and DER assets in determining operational capacity forecasts.	Mandatory
ESS3	Generation of optimised proposed bids/offer for a facility for provision of essential system services taking into account the DOE, NSS and ESS commitments of a facility.	Mandatory
ESS4	Sending of optimised bids/offers for ESS to the DMO in compliance with RTMS specification.	Mandatory
ESS5	Ability to receive dispatch instructions from the DMO for dispatch of ESS.	Mandatory
ESS6	Create and send disaggregated (from facility level dispatch instructions) control instructions to DER assets for a specified or unspecified duration for the provision of ESS.	Mandatory
ESS7	Provision of facility and/or DER asset performance data to enable settlement of ESS service provision.	Mandatory

5.4 Aggregator Platform Non-Functional Requirements

The following tables provide a high-level categorised list of non-functional requirements defined for the Aggregator Platform across the following categories:

- Accessibility;
- Security;
- Business continuity;
- Change control;
- Maintainablity;
- Data retention;
- Scalability;
- Performance;
- Incident management; and
- Usability.

5.4.1 Accessibility

Table 49 - Non-functional requirements: Accessibility

NFR#	Area	NFR	Priority
NFR1	Accessibility	The solution shall be accessible through the most commonly used web browsers.	Mandatory
NFR2	Accessibility	The solution shall be designed to display on the most commonly used device types (smartphone, tablet, laptop).	Desirable

5.4.2 Security

Table 50 - Non-functional requirements: Security

NFR#	Area	NFR	Priority
NFR3	Security	The solution shall provide secured and controlled user access to the platform resources through authentication and secured access.	Mandatory
NFR4	Security	The solution APIs shall authenticate and provide secured access to resources. All data in transit shall be encrypted.	Mandatory
NFR5	Security	The data residing in the cloud will remain within Australia.	Mandatory
NFR6	Security	All data at rest will be securely stored.	Mandatory
NFR7	Security	All customer identifiable data will be encrypted at rest and secured access will be provisioned.	Mandatory
NFR8	Security	The cloud platform will be audited and audit records will be maintained.	Mandatory
NFR9	Security	Logs will be kept of all key transactions conducted within the platform. User access and activity shall be logged.	Mandatory
NFR10	Security	The solution shall be resilient to cyber-attacks such as distributed denial of service, viruses and malicious software.	Mandatory

NFR#	Area	NFR	Priority
NFR11	Security	The solution will be designed to support the availability of the Service Level Agreements within the contract.	Mandatory
NFR12	Security	All Synergy data shall remain the property of Synergy and not be disclosed without authorisation.	Mandatory
NFR13	Security	The solution shall secure the communications and isolate access to the distributed controller gateway.	Mandatory
NFR14	Security	The solution controller gateway shall be installed with adequate physical security access such as enclosure and tamper provisions.	Mandatory
NFR15	Security	Passwords for IoT devices will be securely stored on the device.	Mandatory

5.4.3 Business Continuity

Table 51 - Non-functional requirements: Business continuity

NFR#	Area	NFR	Priority
NFR16	Business Continuity	The solution vendor shall have provision for adequate backup and disaster recovery aligned to the contracted service levels.	Mandatory
NFR17	Business Continuity	The business continuity plans shall be periodically tested.	Mandatory
NFR18	Business Continuity	The solution vendor shall provide notice of changes to the core product that may affect business continuity for Synergy.	Mandatory
NFR19	Business Continuity	Following the conclusion of the contracted period, all Synergy data shall be available for extraction by Synergy.	Mandatory
NFR20	Business Continuity	The solution shall retain backward compatibility when new features are released.	Desirable

5.4.4 Change control

Table 52 - Non-functional requirements: Change control

NFR#	Area	NFR	Priority
NFR21	Change Control	Software updates shall follow the agreed deployment lifecycle process through, as a minimum, a non-production environment.	Mandatory
NFR22	Change Control	The solution vendor shall provide release notes for software changes ahead of the release of the software into the non-production environment.	Mandatory

5.5 Maintainability

Table 53 - Non-functional requirements: Maintainability

NFR#	Area	NFR	Priority

NFR23	Maintainability	As built technical design documentation shall be provided.	Desirable

5.6 Data retention

Table 54 - Non-functional requirements: Data retention

NFR#	Area	NFR	Priority
NFR24	Data retention	The vendor shall ensure all non-transitory data is retained for the duration of the pilot.	Mandatory

5.7 Scalability

Table 55 - Non-functional requirements: Scalability

NFR#	Area	NFR	Priority
NFR25	Scalability	The solution shall be able to scale to 900 assets being monitored, controlled and optimised.	Mandatory
NFR26	Scalability	The solution shall have the capability to scale to 10,000 assets under control.	Desirable
NFR27	Scalability	The solution shall be able to scale to 500 customers as users concurrently using the user portal.	Desirable

5.8 Performance

Table 56 - Non-functional requirements: Performance

NFR#	Area	NFR	Priority
NFR28	Performance	Availability uptime of the platform shall be 99% (excluding scheduled maintenance).	Mandatory
NFR29	Performance	Asset performance shall be captured to understand the maximum throughput of command execution for each device.	Mandatory
NFR30	Performance	Overall system response time shall be within 30 seconds from command to response (excluding any device specific reaction time).	Mandatory

5.9 Incident Management

Table 57 - Non-functional requirements: Incident management

NFR#	Area	NFR	Priority
NFR31	Incident management	The vendor shall notify Synergy of all data breaches as soon as practical.	Mandatory

NFR32	Incident management	The vendor shall notify Synergy of all unplanned outages as soon as practical.	Mandatory
NFR33	Incident management	The vendor shall comply with SLAs for response time and resolved time as detailed in the contract.	Mandatory

5.10 Usability

Table 58 - Non-functional requirements: Usability

NFR#	Area	NFR	Priority
NFR34	Usability	The solution shall meet the branding, look and feel as defined in the Synergy user interface guidelines for all customer facing user access interfaces.	Desirable
NFR35	Usability	The solution shall allow an efficient user interface to enable the user to conduct common tasks efficiently.	Desirable

5.11 Aggregator Next Steps

The Aggregator Platform will be built based on the final detailed design informed by the platform functional and non-functional requirements and Aggregator Platform architecture solution outlined in this document.

Once built, the three platforms will be integrated via the platform data exchange layer and platform interfaces to ensure seamless communication between the DSO, DMO and Aggregator Platforms to test and simulate the capability of aggregated DER resources to participate in both market and network services.

Subsequent reports will provide further detail on the integration methods, data sharing requirements and operation of the Aggregator Platform, provide testing and performance results, and record key learnings of the functional and non-functional requirements of the Aggregator Platform solution used in the Project.

Appendix A: Project Symphony Objectives[67]

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.

New 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, ancillary (essential system) service markets, 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 OpEN 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 new 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).

[67] Project Symphony Project Management Plan, pgs. 12, 13.

Appendix B: Acronyms and Glossary of Terms

Term	Definition
Active NMI	A meter identified by its unique *National Metering Identifier* that has been recruited by the *Aggregator* to participate in *Project Symphony* as part of an approved *Facility*. The import and export of power from an Active NMIs may be constrained via a *Dynamic Operating Envelope*.
Active Power	The actual power that is consumed or utilised within an AC Circuit. This is also known as real power and is measured in kilowatts (kW) or megawatts (MW).
ADMD	See *After Diversity Maximum Demand*
Advanced Metering Infrastructure	Advanced Metering 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.
AEMO	See *Australian Energy Market Operator*
After Diversity Maximum Demand	Calculation of maximum network demand used in the design of Distribution Networks. After Diversity Maximum Demand accounts for the coincidental peak load a network is likely to experience over its lifetime and as such is an overestimation of typical demand.
AGC	See *Automated Generation Controls*
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 platform that will be developed by the *Aggregator* under *Project Symphony* to support *Aggregator* operations and processes.
AMI	See *Advanced Metering Infrastructure*
ARENA	See *Australian Renewable Energy Agency*
Australian Energy Market Operator	AEMO manages Australia's electricity and gas markets including operating the systems for energy transmission, and the energy financial markets. Note: AEMO manages the WEM separately to the NEM, under different rules, funding, and governance structures. Australian Energy Market Operator will be undertaking the role of the *Distribution Market Operator* in *Project Symphony* and, as such, is responsible for development and delivery of the *DMO Platform*.
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.[68]
Automatic Generation Control	A system for adjusting the power output of multiple generators at different power plants, in response to changes in the load.
Balancing Market Offer	Offering (Sell) or bidding (Buy) energy into the balancing market.
Behind the Meter	Any technology located on the customer's side of the customer-network meter.
BESS	Battery Energy Storage System
BMO	See *Balancing Market Offer*

[68] About ARENA - Australian Renewable Energy Agency (ARENA), Australian Renewable Energy Agency website. *Last accessed 15/12/2012.*

Term	Definition
Business Requirement	High-level requirement based on a business need, the specification of which is solution agnostic. Business Requirements, once analysed and understood, can be refined into lower-level stakeholder and solution requirements.
Connection Capacity	The maximum amount of energy that can be safely consumed or generated at a Connection Point.
Connection Point	Network location which is electrically connected into the electricity system. A connection point may be metered (i.e., *Service Connection*) or unmetered (i.e., streetlight, traffic light etc.)
Constrain to Zero	A service whereby instructions can be sent by AEMO to the Aggregator and executed by the Aggregator to constrain energy output to zero.
DCOA	See *Distribution Constraints Optimisation Algorithm*
DER	See *Distributed Energy Resource*
Dispatch	Dispatch refers to the instructions from AEMO to generators delivering power to the system. Dispatch instructions are provided in the form of generation, timing, and ramp rate information. AEMO dispatches generation with consideration for the prices offered by generators, network limitations, and system requirements.
Distribution Constraints Optimisation Algorithm	The calculation of available network capacity that enables the publishing of the dynamic operating envelope in a given time interval for a given location within a segment of an electricity distribution network utilising a number of capacity allocation principles.
Distributed Energy Resource	Distributed Energy Resources or 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.[69]
Distribution Market Operator	The 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.[70] The term is interchangeable with Market Platform.
Distribution Network Service Provider	Distributed Network Service Providers 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.
Distribution System Operator	A Distribution System Operator (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.[71]
Distribution Network	The parts of the electricity network that transport electricity at lower voltages to end-use customer *Connection Points* and *Service Connections*.
Distribution Transformer	A physical asset connected to the network for the purpose of transforming voltage prior to its distribution to downstream *Connection Points*.
DMO	See *Distribution Market Operator*

[69] Issues Paper - DER Roadmap: Distributed Energy Resources Orchestration Roles and Responsibilities, pg. 39.
[70] Ibid, pg. 39.
[71] Ibid, pg.40

Term	Definition
DMO Platform	The platform that will be developed by the *Distribution Market Operator* under *Project Symphony* to support *Distribution Market Operator* operations and processes.
DNSP	See *Distribution Network Service Provider*
DOE	See *Dynamic Operating Envelope*
DOE Calculator	A component of the *DSO Platform* that will be used to forecast load and allocate DOEs for *Active NMIs* based on network load analysis and forecasted *Network Constraints*.
DSO	See *Distribution System Operator*
DSO Platform	The platform that will be developed by the *Distribution System Operator* under *Project Symphony* to support *Distribution System Operator* operations and processes. The *Requirements* in this document describe the required capabilities of the *DSO Platform* sufficient to conduct the *Project Symphony Pilot*.
DSTR	See *Distribution Transformer*
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.
Electrical System Safety Rules	The minimum electrical safety standards for personnel working on, near or in the vicinity of Western Power's electrical network and associated apparatus in Western Australia.
ENA	See *Energy Networks Australia*
Energy Networks Australia	The national industry body representing Australia's electricity transmission and distribution and gas distribution networks.
EPWA	Energy Policy WA
ESS	See *Essential System Service*
ESS Contingency Raise / Lower	Market provision of a response to a locally detected frequency deviation to help restore frequency to an acceptable level in case of a contingency event (such as the loss of a large generator or load). Will be known as the Contingency Reserve Raise and Contingency Reserve Low in the future WEM FCESS.
ESS Regulation Raise / Lower	Market provision of a response to *Automatic Generation Control* (AGC) signals to correct for small movements in frequency during a dispatch interval.
Essential System Service	A range of services designed to address or respond to deviations in system frequency.
ESSR	See *Electrical System Safety Rules*
EV	Means Electric Vehicle, cars or other vehicles with motors that are powered by electricity rather than liquid fuels.
Facility	A concept to aggregate DER for the purpose of providing *Market Services*.
Feeder	A circuit emanating from a Zone Substation that is energised at Medium Voltage.
Firm Capacity	The capacity customers are allowed to import/export at the NMI under normal operations.
Grid Connected Battery Energy Storage System	Larger batteries (typically >=1MW) that will be connected to the network. These batteries will be used to support stable electricity supply on the network, particularly during periods of generation and consumption. For the purposes of *Project Symphony*, a single 1.3MW battery will be connected to the network to service *Feeder SNR540*.

Term	Definition
Hosting Capacity	DER hosting capacity is defined as the typical amount of DER that can be connected to a *Distribution Network* without requiring network augmentation while the network remains within its technical limits.
HV	Means High Voltage. Transmission level 330kV, 220kV, 132kV and 66kV.
Hybrid Model	One of the potential technical frameworks for incorporating DER into the electricity network published by OpEN. *Project Symphony* will be testing a version of the Hybrid Model. See *OpEN Hybrid Model*.
IEEE 2030.5	Standard developed and maintained by the Institute of Electrical and Electronics Engineers (IEEE) that supports interoperability of energy technology and information technology operation with the energy system.
LV	Means Low Voltage. Distribution level 415V three-phase and 240V single-phase.
Market Participant	Refers to the people of businesses that take part in the electricity and gas markets operated by AEMO.
Market Platform	See *Distribution Market Operator*
Market Service	Services provided by a *Facility* and *Dispatched* under instruction from the DMO. Market Services include BMO electricity storage and generation, *Network Support Services* (NSS), and *Essential System Services* (ESS).
Minimum Viable Product	A version of a product with just enough features to be usable by early adopters who can then provide feedback for future product development.
MV	Means Medium Voltage. Distribution level 33kV, 22kV, 11kV and 6.6kV.
MVP	See *Minimum Viable Product*
National Electricity Market	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.
National Metering Identifier	The National Metering Identifier (NMI) is a unique 10- or 11-digit number used to identify an electricity network connection point in Australia.
NEM	See *National Electricity Market*
Network Constraint	When a section of an electricity network approaches its technical limits.
Network Model	A data representation of objects, their relationships, and any distinguishing feature. For Project Symphony, the Network Model will represent the MV and LV electricity network downstream of the *Feeder* identified as SNR540.
Network Support Service	A contracted service provided by a generator / retailer / demand side program / DER *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.
NSS	See *Network Support Service*
NMI	See *National Metering Identifier*
NMI Status	The NMI Status determines whether a NMI is participating in *Project Symphony* and, thus, may be allocated a *Dynamic Operating Envelope*, or if the NMI is a non-participant and therefore is operating within a predetermined, defined operating envelope (currently set at 5kW generation and 15kW import).
OpEN	Means Open Energy Network, a joint consultation launched by *the Australian Energy Market Operator* and Energy Networks Australia seeking stakeholder input on how best to integrate *Distributed Energy Resources* into the electricity grid.
OpEN Hybrid Model	One of four market frameworks developed through *OpEN*. In the Hybrid Model requires a technical *Distributed Systems Operator* function to manage and communicate distribution network constraints, the Distribution Market Operator manages a Market Platform that optimises all DER bids for wholesale, *Essential*

Term	Definition
	System Services, and the Aggregator sign up customers that own and aggregates their customers *Distributed Energy Resources* to deliver marketable services. The OpEN Hybrid Model is the model that will be tested by *Project Symphony.*
Open Standard	A standard that is made available to the general public and developed (or approved) and maintained via a collaborative and consensus driven process.
Operating Envelope	An Operating Envelope is the DER or Connection Point power transfer that can be accommodated before electrical limits of a Distribution Network are at risk of being breached. See also *Dynamic Operating Envelope.*
Operating Authority	The division or group responsible for a part of a network. Only one Operating Authority can be accountable for the operation of a network. This includes alarm management, real-time intervention, authorising access, and interaction with authorised personnel. The Network Operations team of *Western Power* is the Operating Authority for the electricity network encompassing the *Pilot Area*.
Outage	A network or localised issue that resulted in one or more Service Connections being unable to access the network. An Outage may either be planned or unplanned, and relate to the past, present and (in the case of planned outages) the future.
Passive NMI	A meter that is uniquely identified via a *National Metering Identifier* that is within the *Project Symphony Pilot Area* but which has not been recruited by an *Aggregator* and, thus, whose operations will not be managed using a *Dynamic Operating Envelope*. The operation of these NMIs will be as per the rules when the service was connected, which normally means a *Static Operating Envelope* with a 5kW generation and a 15kW consumption limit.
Photovoltaic	A photovoltaic (PV) cell, commonly called a solar cell, is a nonmechanical device that converts sunlight directly into electricity.
Pilot	The pilot project is an initial small-scale implementation that is used to prove the viability of a project idea. This could involve either the exploration of a novel new approach or idea or the application of a standard approach recommended by outside parties, but which is new to the organisation. The pilot study will confirm viability and scalability and enable proposed processes and procedures to be tested. It will confirm the appropriateness and safety of any tools proposed and also confirms that any working practices are safe and comply with organisational/statutory standards. It also enables the benefits to be tested and a more reliable investment appraisal to be created for the Project
Pilot Area	The area *Project Symphony* is using to conduct a *Pilot*. The area is denoted by the *Feeder* identified as *SNR540*. The distribution transformers, NMIs and DER infrastructure that is connected downstream of *SNR540* and the customers that use it are in scope of the *Pilot* for *Project Symphony*.
Engineering Power Flow Data[72]	Instantaneous measurement data collected at defined position on the network at a particular point in time that describes energy flow including the following variables: • Consumption (cumulative kWh). • Real power (kW). • Current (Amps). • Power Factor. • Voltage. This data can be used for both NMI level load forecasting as well as validating the DOEs dispatched to *Aggregators*. In the context of Project Symphony this will be referred to as PQ Data.
PQ Data	See *Engineering Power Flow Data*

[72] In the context of Project Symphony this data is a subset of Power Quality (PQ) data. PQ Data generally includes other metrics such as harmonics.

Term	Definition
(the) Project	See *Project Symphony*
Project Symphony	A project where customer *Distributed Energy Resources* will be orchestrated as a *Virtual Power Plant*.
PV	See *Photovoltaic*
Requirement(s)	Describes specific aspects, characteristics, capabilities, functions and services that may form part of a solution. Requirement statements contained in this document relate to the *DSO Platform*.
Reactive Power	The power which flows back and forth meaning it moves in both the direction in the circuit or react upon itself, is called Reactive Power. The reactive power is measured in Kilovolt Ampere Reactive (kVAR) or Megavolt Ampere Reactive MVAR.
Recovery Point Objective	Indicates the acceptable amount of data loss as a result of an outage. Indicative the amount of data (updated or created) that will be lost or need to be re-entered after an outage.
Recovery Time Objective	The duration of time within which a business process must be restored after a disaster in order to avoid unacceptable consequences associated with a break in continuity.
Request for Information	A process through which written information about the capabilities of various suppliers is directly solicited from vendors.
RPO	See *Recovery Point Objective*
RTO	See *Recovery Time Objective*
SCADA	See *Supervisory Control and Data Acquisition*
Scenario	A collection of epics and / or use cases that together define how DER could participate in a market or provide a service. The MVP has been defined at a scenario level.
Service Connection	A metered *Connection Point* that provides energy services to a customer. A *Connection Point* is uniquely identified by a *National Metering Number*.
SNR540	Refers to a specific Feeder located in the Southern River area near Perth, Western Australia. The Feeder identified as SNR540 will be used to define the boundaries of the *Pilot Area* for *Project Symphony*, with the *Distribution Transformer*, *NMI* and *DER* infrastructure that is connected downstream of SNR540 and the customers that use it with the scope of the Pilot.
South West Interconnected System	South West Interconnected System (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.
Static Operating Envelope	A Static Operating Envelope is an allocation of the available hosting capacity to individual or aggregate DER or connection points within a segment of an electricity distribution network that is applies at any time and in any conditions. As such, it differs from a *Dynamic Operating Envelope*, in that is provides upper and lower bounds on the import or export power at any time, rather than for a prescribed time interval.
Supervisory Control and Data Acquisition	The system that is used to gather and analyse real-time data to monitor and control the network.
Supply Arrangement	Approved methods to connect different classes of customer facility to Western Power's distribution network for the purpose of electricity generation (embedded) and supply. Supply arrangements are described in the Distribution customer connection requirements document.[73]
SWIS	See *South West Interconnected System*

[73] *See* Distribution Customer Connection Requirements, Western Power, May 2019. *Last accessed 15/12/2021*.

Term	Definition
Synergy	A provider of electricity and gas that supplies residential, business and industrial customers across Perth and Western Australia. Synergy will be undertaking the role of the *Aggregator* in *Project Symphony* and, as such, is responsible for the development and delivery of the *Aggregator Platform*.
Telemetry Data	The automated recording and transmission of data from remote sources into a central system in support of monitoring and analysis.
TNI	See *Transmission Node Identifier*
Transmission Network	Transmission networks allow the transport of electricity at high voltages from large generators to distribution centres.
Transmission Node Identifier	The component on the network which denotes the transmission from the transmission network to a local distribution network. It is anticipated that Facilities involve 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.
Variable Capacity	The difference between the *Firm Capacity* export limit and a NMIs potential export capacity is the capacity that may be varied using *Dynamic Operating Envelopes.*
Virtual Power Plant	A Virtual Power Plant (VPP) broadly refers to an aggregation of distributed energy resources (such as decentralised generation, storage, and controllable loads) coordinated to deliver services for power system operations and electricity markets.
VPP	See *Virtual Power Plant*
WA	Western Australia
Western Power	Western Power will be undertaking the role of the Distributed System Operator in Project Symphony and, as such, is responsible for development and delivery of the *DSO Platform*. Western Power will additionally be responsible for the installation and maintenance of a Grid Connected BESS to be used by *Project Symphony*. Western Power is also acting as the lead organisation accountable for the overall delivery of *Project Symphony*
Wholesale Electricity Market	Supplies electricity to the south-west of Western Australia via the *South West Interconnected System.*

Appendix C: DSO Platform Requirements Catalogue

This section details the functional and non-functional requirements identified for the DSO Platform being developed to support the Project Symphony Pilot. Requirements have been prioritised as either *Mandatory* or *Desirable*. Mandatory Requirements will need to be delivered to provide a basic platform capable of delivering the pilot. Desirable Requirements provide additional functionality that would be of benefit but are not considered essential to the successful completion of the Pilot and/or may be delivered outside of the DSO Platform. Terms that appear in Proper Case are defined in the Glossary contained in *Appendix B: Acronyms and Glossary of Terms*.

1. Data Requirements

1.1 Network Model

A Network Model will be used to uniquely identify, describe and classify all components that comprise the physical electricity network in the Pilot Area and how they relate to each other. This information will be used by the DOE Calculator to model and forecast the networks behaviour, allocate DOEs, and monitor network actuals, making the Network Model a critical data structure for the DSO Platform.

REQ 1. Network Components ***Mandatory***

The DSO Platform's Network Model shall include information on all assets that comprise the electricity network in the Pilot Area, including but not limited to:

- Feeder SNR540.
- All Distribution Transformers downstream of SNR540.
- All Service Connections downstream of SNR540 as identified by a NMI (metered supply).
- Unmetered Connection Points downstream of SNR540, such as streetlights, traffic lights and telecommunications.
- All known DER connected downstream of SNR540, including the Grid Connected BESS.

REQ 2. Network Connections ***Mandatory***

The DSO Platform's shall include information on the physical links between network components, including but not limited to:

- Carrier used to connect the components.
- Length of the connection.
- Operating voltage.

REQ 3. Network Component Constraints ***Mandatory***

The DSO Platform's Network Model shall include information on all operating constraints associated with components on the network, including but not limited to:

- Operating voltage information.
- Operating load limits.

REQ 4. Service Connections ***Mandatory***

The DSO Platform Network Model shall include information on all customer Service Connections in the Pilot Area. Information to include but not limited to:

- NMI that uniquely identifies the Service Connection.
- Location (longitude/latitude).
- Maximum and minimum service rating for the Service Connection (kVA).
- Any constraints/limitations associated with the customer Service Agreement under which the connection is governed.
- Project Symphony participation status (Active NMI or Passive NMI).

REQ 5. Network Model Management ***Mandatory***

The DSO Platform Network Model shall be maintained to ensure it reasonably describes the physical network and any changes that occur to it during the life of Project Symphony, including but not limited to:

- Any changes to the number and/or location of Service Connections.
- Changes in Service Connection Project Symphony participation status (Active NMI / Passive NMI).
- Changes that result from network augmentations (for example, the movement of Distribution Transformers between Feeders).
- Both permanent and temporary changes.

REQ 6. Network Model Changes ***Mandatory***

The DSO Platform Network Model shall record all changes that are made to the Distribution Network in the Pilot Area for the duration of Project Symphony.

REQ 7. Network Outage Information ***Desirable***

The DSO Platform Network Model shall include information about Distribution Network Outages that have occurred in the Pilot Area for the duration of Project Symphony.

REQ 8. Future Planned Outages ***Desirable***

The DSO Platform shall include information on all future planned Outages to occur in the Pilot Area for the duration of Project Symphony.

1.2 Network Monitoring – Historical Data

Ideally, DOE Calculations would be performed using at least 2 years-worth of historical Telemetry Data covering all components in the Pilot Area - from the Feeder level downstream to NMIs. However, AMI metering infrastructure and Distribution Transformer monitoring has only recently been deployed in the Pilot Area. As such, Project Symphony will use all available information for these components. Project Symphony will investigate the minimum amount of data required to produce reliable DOE Calculations as part of project learnings.

REQ 9. Feeder Data - History ***Mandatory***

The DSO Platform shall include a minimum of 2-years historical Telemetry Data for the Feeder SNR540.

REQ 10. DSTR Data - History ***Mandatory***

The DSO Platform shall include all available Telemetry Data from Distribution Transformer monitors located in the Pilot Area downstream of Feeder SNR540.

REQ 11. Service Connection (NMI) Data - History ***Mandatory***

The DSO Platform shall include consumption data for customer Service Connections located in the Pilot Area downstream of Feeder SNR540. The data shall include but is not limited to:

- Unique identifier for the Service Connection (NMI).
- All available Telemetry Data for AMI meters in the Pilot Area.
- Historical consumption data for basic meters (monthly or bi-monthly reading) covering a minimum of 2 -years, where this is available.

REQ 12. Network Model History ***Desirable***

The DSO Platform Network Model shall include a minimum of 2-years' historical information about changes to the Distribution Network in the Pilot Area.

1.3 Network Monitoring – Availability and Granularity

Project Symphony aims to calculate and publish DOEs for every Active NMI in the Pilot Area. It is expected DOEs will be calculated for a given Active NMI for every 5-minute interval covering a period of 3 days. Initially, Project Symphony DOEs will be calculated once a day, with an aim to increase calculation and publication frequency to 30 mins or less by the end of the Pilot. To achieve this, network monitoring data needs to be suitably granular and available to support accurate DOE calculation and allocation.

REQ 13. Feeder Data – Granularity ***Mandatory***

The DSO Platform shall include Telemetry Data for the Feeder (SNR540) in the Pilot Area. Feeder Telemetry Data to include accurate, instantaneous readings at 5 minutes intervals including but not limited to the following data points:

- Active Power.
- Reactive Power.
- Current.
- Substation bus voltage.

REQ 14. DSTR Data - Granularity ***Mandatory***

The DSO Platform shall include Telemetry Data for monitored Distribution Transformers in the Pilot Area. Distribution Transformer Telemetry data to include accurate, instantaneous readings at 5 minutes intervals including but not limited to the following data points:

- Unique identifier
- Active Power
- Reactive Power
- Current
- Voltage

REQ 15. Service Connection Data - Granularity ***Mandatory***

The DSO Platform shall include all available Telemetry Data for AMI meters located in the Pilot Area. AMI Telemetry data to include accurate, instantaneous readings at 5 minutes intervals including but not limited to the following data points:

- Unique Identifier.
- Power imported.
- Power exported.
- Active Power.
- Reactive Power.

- Current.
- Voltage.

REQ 16. Grid Connected BESS – Granularity ***Mandatory***

The DSO Platform shall *include all available Telemetry* Data for the Grid Connected BESS located in the Pilot Area. Telemetry data to include accurate, instantaneous readings at 5 minutes intervals including but not limited to the following data points:

- Battery status.
- Inverter status.
- Active power.
- Reactive power.
- Current.
- Voltage per phase.
- State of charge.
- Storage capacity.
- Energy throughput.

REQ 17. Telemetry Data – Availability ***Mandatory***

All Telemetry Data shall be available in the DSO Platform within 4 hours of reading/collection. This includes:

- Feeder bus Telemetry Data.
- Feeder Telemetry Data.
- Distribution Transformer Telemetry Data.
- Service Connection Telemetry Data.
- Grid Connected BESS Telemetry Data.

1.4 Weather Data

To accurately forecast PV output, the DOE Calculator requires data related to the weather conditions, including solar irradiance. Project Symphony have identified a weather station at Jandakot airport that collects observation data and forecasts weather conditions across the Pilot Area.

REQ 18. Weather Data - History ***Mandatory***

The DSO Platform shall include a minimum of 2-years historical weather forecast and observation data covering the entire Pilot Area.

REQ 19. Weather Observation Data - Granularity ***Mandatory***

The DSO Platform weather observation data shall include actual measurement data taken every 10 mins covering the following data points at a minimum:

- Reading location.
- Observation time.
- Temperature (degrees Celsius).
- Wind direction.
- Wind speed.
- Rainfall (mm).
- Cloud cover.
- Solar irradiance.

REQ 20. Weather Observation Data - Availability ***Mandatory***

Weather observations for the Pilot Area shall be made available in the DSO Platform within 1 hour of their publication by the Bureau of Meteorology.

Note that observations are usually published by the Bureau of Meteorology at 0900 hours daily and contains observations for the previous 24 hours.

REQ 21. Weather Forecast Data - Forecast ***Mandatory***

The DSO Platform shall include a rolling 7-days of weather forecast data.

REQ 22. Weather Forecast Data - Granularity ***Mandatory***

The DSO Platform weather forecast data shall include a forecast value for each data point at 5-minute intervals covering the following data points at minimum:

- Forecast location.
- Forecast time.
- Forecast temperature (degrees Celsius).
- Forecast wind direction.
- Forecast wind speed.
- Rain probability.
- Rainfall rate.
- Forecast cloud cover.
- Forecast solar irradiance.

REQ 23. Weather Forecast Data - Availability ***Mandatory***

Weather forecasts data shall be updated in the DSO Platform shortly after it is published by the Bureau of Meteorology.

Note that the Bureau of Meteorology usually publish a new forecast every hour.

1.5 External Data

REQ 24. Facility Registration Data ***Desirable***

The DSO Platform shall include data on registered Facilities. Facility information to include but not limited to:

- Facility unique identifier.
- Time of registration.
- Location on the network/Associated TNI.
- Market Services the facility will provide (NSS, ESS etc.).
- Dispatch capacity.
- Withdrawal capacity.
- PV generation capacity.
- Battery dispatch and withdrawal capacity.

REQ 25. Service Connection Participation ***Mandatory***

While the DSO will have access to Service Connection information, a customer Service Connection will only be considered a participant in Project Symphony when it has been registered against the DMO approved Facility. Only Active NMIs will be allocated a DOE.

The DSO Platform shall include information on all Service Connections actively participating in Project Symphony (Active NMI), including but not limited to:

- Unique identifier (NMI).
- The Facility/Facilities the NMI is registered with.

Note that all NMIs that are not participating in Project Symphony are considered Passive NMIs.

REQ 26. DER Registration Data ***Mandatory***

The DSO Platform shall include information on all DER assets that are registered in the Pilot Area. DER Asset information to include but not limited to:

- Associated Service Connection/NMI.
- Asset type.
- Dispatch capacity.
- Withdrawal capacity.

REQ 27. Facility Registration – Change History ***Desirable***

Facility registrations will change over time. The DSO Platform will need to maintain a record of changes to Facilities to support contextual analysis of historical data.

The DSO Platform shall maintain a record any changes to Facility registrations for the duration of Project Symphony.

REQ 28. Service Connection Participation – Change History ***Mandatory***

As customers will be able to op-in and out of Project Symphony throughout the life of the Project, the DSO platform will need to maintain a record of changes to a NMIs status (Active/Passive NMIs) to support contextual analysis and DOE compliance validation.

The DSO Platform shall maintain a record any changes to Service Connection participation in Project Symphony for the duration of the project.

REQ 29. DER Registration – Change History ***Mandatory***

DER registrations may change over time. The DSO Platform will need to maintain a record of changes to DER registrations to support contextual analysis of historical data.

The DSO Platform shall maintain a record of any changes to DER Registrations for the duration of Project Symphony.

1.6 Service Provision Data

A key function of the DSO Platform is to identify Network Constraints that may put the network at risk. NSS may be employed to manage Network Constraints. Information on NSS contracts, requests and Dispatches will need to be recorded in the DSO Platform to support the management and analysis of NSS.

REQ 30. Market Service Information ***Mandatory***

The DSO Platform shall record information about the services that an Aggregator may provide. Information to include but not limited to:

- The Facility that may provide the service.
- The area of the network where the service may be provided.
- The service capacity.
- Relevant conditions and/or limitations.

REQ 31. Network Support Service Requests ***Mandatory***

The DSO Platform shall record information about NSS Requests made by the DSO to the DMO. Information to include but not limited to:

- Date/Time of request.
- Date/Time the service is required.
- Duration of service provision.
- Forecast required capacity.
- Location/Network area to which the service will be applied.
- Reason for service request.
- Contractual arrangement under which the request was made.

REQ 32. Network Support Service Trigger ***Mandatory***

The DSO Platform shall record information about NSS deployment requests made by the DSO to the DMO. Information to include but not limited to:

- Date/Time of dispatch.
- Duration service is required.
- Required capacity.
- Location/Network area to which the service will be applied.
- Reason for service request.
- Link to NSS Request (REQ 31).

REQ 33. ESS and NSS Provision ***Mandatory***

Essential System and Network Support Services may be dispatched by the DMO and provided by Facilities as part of the Project Symphony Pilot. Service Dispatch information may be required to support NSS validation, as well as support analysis and forecast of network load flows as part of DOE calculation.

The DSO Platform shall record information about NSS, ESS and Constraint to Zero dispatches made by the DMO that impact the Pilot Area local Distribution Network for the duration of Project Symphony. Information to include but not limited to:

- Date/Time of service Dispatch.
- Type of service.
- Facility used to provide the service.

2 Dynamic Operating Envelope Calculation Requirements

2.1 Forecast Network Loads

REQ 34. Forecast Against Available Data ***Mandatory***

The DSO Platform shall be able to forecast network loads using data available in the DSO Platform, including:

- Network Model data (REQ. 1).
- Feeder telemetry data covering the previous 2-years (REQ. 9).
- Monthly/bi-monthly readings for basic meters covering the previous 2-years (REQ. 11).
- All available AMI Telemetry data (REQ. 11).
- All available Distribution Transformer Telemetry data (REQ. 10).
- 7-days weather forecast data (REQ. 21).
- 2-years of historical weather observations data (REQ. 18).
- 2-years of historical weather forecast data (REQ. 18).
- Services delivered to the Distribution Network (REQ. 33).

REQ 35. Network Load Forecast Length ***Mandatory***

The DSO Platform will be capable of forecasting network loads up to and including 3 days in advance.

The DSO Platform shall be able to use the available data to forecast network loads from a configurable future point in time A to another configurable point in time B, where:

- A is in the future.
- Time A is before time B.
- B is less than 3 days into the future.
- Weather forecast data is available for the period covering A through B.

REQ 36. Load Flow Analysis ***Mandatory***

The DSO Perform shall be able to produce a load flow analysis using network load forecasts (Req. 35) and the Network Model. The load flow analysis will:

- Predict how energy will flow through the Pilot Area network for the analysis period.
- Forecast the flow of energy through individual Network Components'.
- Identify components that are forecast to constrain network flow based on component constraints (REQ. 3).

2.2 DOE Allocation Algorithm

REQ 37. DOE Allocation Granularity ***Mandatory***

The DSO Platform shall be capable of allocating DOEs. DOE allocation will:

- Be for each Active NMI in the Pilot Area (REQ. 25).
- Be specified for 5-minute time intervals .
- Cover a period of up to 3 days into the future (Req. 35).

REQ 38. DOE Allocation to Alleviate Constraints ***Mandatory***

The DSO Platform shall be capable of allocating DOEs to alleviate Network Constraints (Req. 3) identified as part of a load flow analysis (REQ. 36) as far as is practicable while honouring DOE Calculator configurations (REQ. 55), including Firm Capacity limits (REQ. 43).

REQ 39. DOE Allocation for Participating Service Connections ***Mandatory***

Project Symphony will only allocate DOEs to Active NMIs, which represent customers who have signed-up to participate in Project Symphony. However, DOE calculations and allocations will have to account for forecast network load associated with Passive NMIs – NMIs associated with customers who have not agreed to participate in Project Symphony and who will operate under existing fixed operating envelopes.

DSO Platform DOE Allocations shall account for network loads associated with Passive NMIs (REQ 25, 28).

REQ 40. Equal Allocation ***Mandatory***

The DSO Platform Distributed Constraints Optimisation Algorithm (DCOA) shall be able to allocate DOEs equally (i.e., all household consumers identified by an Active NMI allocated the same DOE).

REQ 41. Proportional Allocation ***Mandatory***

The DSO Platform DCOA shall be able to be configured to allocate DOEs proportionally (i.e., household consumers identified by an Active NMI allocated DOEs proportional based on the maximum import/export capacity of their Service Connection).

REQ 42. Optimal Allocation ***Mandatory***

DSO Platform DCOA shall be able to be configured to allocate DOEs optimally taking into consideration a range of factors including but not limited to:

- DER capacity.
- Service Connection limits.
- Forecast usage.
- Network Constraints.
- Component/Service Connection position on the network.

REQ 43. Firm Capacity ***Mandatory***

The DSO Platform DCOA shall ensure DOE allocations comply with Firm Capacity limits (configured as per REQ 55), such that:

- Allocated maximum generation for a NMI is always greater or equal value to the Firm Export Capacity (i.e., consumer is able to export up to the Firm Export Capacity).
- Allocated maximum importation for a NMI is always greater or equal value to the Firm Import Capacity (i.e., consumer is able to import up to the Firm Import Capacity).

REQ 44. Grid Connected BESS ***Mandatory***

The DSO Platform DCOA shall be able to allocate DOEs for Grid Connected BESS separate to other Service Connections. (REQ. 71)

REQ 45. Transformer Level DOE Allocation ***Desirable***

DSO Platform shall be able to allocate DOEs at:

- Distribution Transformer level.
- Feeder level.

REQ 46. Default DOEs ***Mandatory***

In cases where DOEs cannot be calculated for a given Service Connection, the DOE Calculator shall allocate a default DOE. Default DOE allocation will be configured in advance and will be dependent on time of day and the phase of the connection (i.e., default DOEs for single-phase connections will be different to 3-phase connections). (REQ 56)

REQ 47. Service Dispatch Information ***Desirable***

Network Support and Essential System Services may be deployed to manage network issues or constraints. Deployment of these service may impact the network flows and need to be accounted for in the calculation and allocation of DOEs.

DOE Calculator shall consider information associated with the Dispatch and/or planned Dispatch of a service (REQ, 33) in the calculation and allocation of DOEs. Services to included but not limited to:

- Network Support Service
- Constrain to Zero.

2.3 DOE Calculator Outputs

REQ 48. Load Flow Analysis - Output ***Mandatory***

The DSO Platform shall provide an output file describing the load flow analysis. The load flow analysis output will include:

- Date of analysis.
- Forecast period the analysis covers.
- Key findings of the load flow analysis, including:
  - Predicted maximum/minimum load of each component during the forecast period.
  - Forecast time of maximum/minimum component load.
- Level of confidence in analysis.

Exact file format will be specified as part of solution requirement specification

REQ 49. Identified Constraints - Output ***Mandatory***

The DSO Platform shall provide a readable output that clearly details components that are predicted to meet operating capacity, constrain the flow of energy and/or otherwise put the network at risk during the forecast period. The output will include but is not limited to:

- Unique identifier for the component.
- Date/Time of analysis.
- Component type.
- Normal operating limits.
- Reason for identification.
- Forecast time of constrained operation.
- Likely period of constrained operation.

Exact file format will be specified as part of solution requirement specification.

REQ 50. Identified NSS Constraints - Output ***Mandatory***

The DSO Platform identified constraints output (REQ. 49) shall support easy identification of forecast constraints that are likely to require a NSS to alleviate.

REQ 51. DOE Allocations - Output ***Mandatory***

The DSO Platform shall provide a readable output that clearly details all the DOE Allocations for a given period (as defined by REQ. 35, 55).

Exact file format will be specified as part of solution requirement specification.

REQ 52. Default DOEs - Output ***Mandatory***

The DSO Platform shall be able to store and publish default DOEs in the event of a component and/or system failure. Default DOEs will be specified at the same level and in the same format as DOEs. Failure to include but not limited to:

- Error in DSO Platform ability to calculate and allocate DOEs for a specific component or group of components.
- Systemic failure of the DSO Platform affecting calculation and allocation of DOEs.
- Lack of sufficient Telemetry Data to support DOE calculation for a specific component.
- Uncertainty over a Service Connections participation status (Active/Passive NMI) caused by delay in Facility registration process (REQ. 24).

2.4 DOE Calculator Configurability

For the Project Symphony Pilot, DOEs will initially be calculated daily using defined, static parameters. This will allow calculations to be triggered manually and for outputs to be scrutinised prior to DOE publication. However, as the Pilot progresses, calculation will occur more frequently to support more responsive management of Network Constraints.

REQ 53. Manually Triggered DOE Calculation ***Mandatory***

The DSO Platform shall allow for the DOE Calculator and/or its component calculations to be triggered manually. Manual triggering of DOE calculations to include but limited to the ability to:

- Execute the DOE Calculator process end-to-end from load flow analysis through to DOE calculation.
- Manually trigger a forecast of network loads independent of other DOE calculations.
- Manually trigger a Load Flow Analysis independent of other DOE calculations.
- Manually trigger the DCOA to allocate DOEs independent of other DOE calculations.
- Manually define the inputs used in calculations and/or define the time periods the calculations cover.

REQ 54. Automated DOE Calculation ***Mandatory***

The DSO Platform shall allow for the DOE Calculator to be triggered automatically, supporting the end-to-end calculation of DOEs according but not limited to:

- A schedule.
- Availability of data.
- Receipt of a message.

REQ 55. Configurable Items ***Desirable***

The DSO Platform shall allow key variables to be configured. Configurable variables to include but are not limited to:

- Firm Import Capacity.
- Firm Export Capacity.

- DOEs forecast period.
- Default DOEs.
- Triggers for automatic calculation.
- Location of input data.
- Location for output storage/publication.

REQ 56. Default DOEs ***Desirable***

The DSO Platform shall allow for different default DOEs to be defined and used depending on:

- Connection phase.
- Time of year.
- Whether the DOE is for a Grid Connected BESS (REQ. 71).

REQ 57. DOE Calculation in Response to Incidents and Outages ***Desirable***

The DSO Platform shall be able to calculate DOEs in response to network changes that result from incidences and outages such that DOEs continue to reflect safe network operating limits as defined by network component constraints (REQ. 3).

REQ 58. Failsafe Override ***Mandatory***

There may be occasions where an incident on the network requires fast action. In these cases, the DSO Platform should allow the DSO to respond to Operating Authority instructions to override previous instructions with a failsafe state. The failsafe state will likely involve the implementation of a DOE that is safe under the majority of operating circumstances in line with the ESSR.

The DSO Platform shall support a process that allows for the fast implementation of a defined failsafe state that will be published/distributed such that they can be deployed to override all other DOE and NSS instructions.

2.5 DOE Calculator Alerts and Notifications

Identification of Network Components that are forecast to constrain or put the security of energy supply at risk is a crucial function of the DOE Calculator. Identified Network Constraints may not be manageable using DOEs either a) due to the magnitude of the energy generation and/or consumption required to alleviate the constraint, and/or b) configured limitations imposed on DOE calculation to enforce policy and/or customer Service Connection agreements. Early identification will allow for Network Support Services (NSS) to be provisioned to manage constraints.

REQ 59. DOE Calculator Notification Configuration ***Desirable***

The DSO Platform shall support the sending of notifications in response to the identification of constraints as part of load flow analysis. Notifications will explicitly state the fact that a Network Constraint has been detected, and clearly identify where more information on the can be obtained (REQ 49,50).

REQ 60. DOE Calculator Notification Channel ***Desirable***

The DSO Platform shall support the sending of notifications via email as a minimum. Other notification mechanisms that may be supported include:

- SMS.
- Send to a web service.
- Make available via a web service.
- Message displayed through a graphical interface.

REQ 61. DOE Calculator Notification Preferences	*Desirable*

The DSO Platform shall support the configuration of notifications, including email message recipient(s). Notifications may also support the following configurations:

- SMS recipients.
- Thresholds for sending notifications.
- Recipient preferences (SMS, Email, Opt-out etc.).

REQ 62. DOE Calculator Notification History	*Desirable*

The DSO Platform shall maintain a record of all notifications send, including:

- Date/Time sent.
- Communication channel.
- Recipient.
- Content of message.

3. Data Exchange and Messaging Services

The DSO Platform will need to include a service that supports the secure exchange of data with the DMO and Aggregator Platforms as part of platform integration.

3.1 Data Exchange

REQ 63. DOE Publication	*Mandatory*

The DSO Platform shall support the publication of DOE Allocation data (REQ. 51) securely such that:

- An Aggregator is only able to access the DOE allocations related to Service Connections they are managing as part of an approved Facility.
- The DSO may securely share DOE publications with other parties, such as the DMO.

Exact file format will be agreed and specified as part of solution requirement specification.

REQ 64. DER Registration Data	*Mandatory*

The DSO Platform shall be able to accept DER registration data (REQ. 26) from the Aggregator, including supporting at a minimum:

- The manual upload of DER registration data into the Data Exchange Service by a representative of the DSO or Aggregator.
- The automated transfer of DER Registration data via the Aggregator Platform.

REQ 65. Facility Registration Data	*Mandatory*

The DSO Platform shall be able to accept Facility registration data (REQ. 24) from the DMO, including supporting at a minimum:

- The manual upload of Facility registration data into the Data Exchange Service by a representative of the DSO or DMO.
- The automated transfer of Facility registration data via the DMO Platform into the Data Exchange
- Service.

REQ 66. Receive Additional Files	*Desirable*

The DSO Platform shall be able to accept additional files from the DMO Platform, Aggregator Platform and/or registered representatives of the Aggregator and/or DMO to support DSO operations. Additional files to include at a minimum:

- Information on NSS Dispatch (Req. 33).
- Information on the Dispatch of Essential System Services (Req. 33).

- Data to support system integration testing.
- Data to support ad-hoc analysis, including DER Telemetry Data.

REQ 67. Publish Additional Files ***Desirable***

The DSO Platform shall be able to publish additional files for the DMO Platform, Aggregator Platform and/or registered representatives of the Aggregator and/or DMO. Additional files to include at a minimum:

- DOE allocation compliance reports (Req. 75).
- NSS compliance reports (Req. 76).
- Other reports.
- Datasets to support partner analysis activities.

3.2 Messaging

REQ 68. DSO Platform Messages ***Desirable***

The DSO Platform Data Exchange Service shall support a messaging service. The messaging service to include but not limited to:

- The ability for registered users/system to subscribe to messages.
- The ability to send messages alerting subscribers to the publication of a new output.
- The ability to send messages acknowledging the receipt of a file.

REQ 69. DMO Platform Messages ***Mandatory***

The DSO Platform shall be able to send and receive structured messages from the DMO Platform. Messages to include by not limited to:

- Requests for services, such as NSS services.
- Information on the dispatch of services such as NSS, ESS and Constrain to Zero.
- Messages acknowledging the receipt of DSO Platform messages and/or outputs.

REQ 70. Aggregator Platform Messages ***Mandatory***

The DSO Platform shall be able to send and receive structured messages from the Aggregator Platform. Messages to include by not limited to:

- Messages acknowledging the receipt of DSO Platform messages and/or outputs.

4. Grid Connected BESS

The DSO will be installing 1.3MW of battery capacity as part of Project Symphony. The battery will be directly connected to the network and will have its own meter. The Aggregator will be afforded control of the Grid Connected BESS under a lease agreement so that it may be used to provide services to the network as part of a Facility. However, in the case of an incident or emergency, the DSO may be required to override Aggregator control to manage the battery to ensure network security.

REQ 71. Identification of Grid Connected BESS ***Mandatory***

Grid Connected BESS are technically a type of DER and will have a meter associated with them. However, they will need to be distinguishable from other types of DER.

The DSO Platform shall be able to clearly distinguish between large DER connected directly to the network, such as Grid Connected BESS, and other types of DER. This includes but is not limited to the ability to:

- Isolate, analyse and communicate Telemetry Data related to Grid Connected BESS separate from other NMIs and DER.
- Configure default DOEs for Grid Connected BESS separate from other Service Connections (Req. 56).
- Allocate DOEs using different criteria/configurations to other Service Connections/Components (REQ. 44).

REQ 72. Aggregator Control ***Mandatory***

The battery control and integration shall allow the Aggregator to control the Grid Connected BESS in real time to support the provision of services including but not limited to:

- Energy Services.
- Network Support Services.
- Essential System Services.
- Constrain System Output.

REQ 73. Aggregator Visibility ***Mandatory***

The battery control and integration shall allow the Aggregator to see how the Grid Connected BESS is functioning. Information accessible to the Aggregator to include but not limited to:

- Charge status.
- Telemetry data.

REQ 74. DSO Control ***Mandatory***

The battery control and integration shall allow the DSO to control the Grid Connected BESS in real-time. DSO control to include the ability to:

- Control active and reactive power output.
- BESS disconnection of main switch.
- BESS shutdown.
- BESS standby.
- Configure BESS either manually or remotely in the event of a communication failure.
- Configure maximum charge and discharge limits.

REQ 75. Prioritisation of Control ***Mandatory***

The battery control and integration shall support the prioritisation of control of the Grid Connected BESS such that operations performed by the DSO are prioritised over Aggregator operations.

REQ 76. End-of-Lease Disconnection ***Desirable***

The battery control and integration shall allow the DSO to take full control of the Grid Connected BESS to manage the end of a BESS lease agreement.

5 Network Analysis and Reporting Requirements

5.1 Network Monitoring

REQ 77. DOE Compliance ***Mandatory***

The DSO Platform shall include functionality to compare DOE allocations with actual network Telemetry Data.

REQ 78. NSS Validation ***Mandatory***

The DSO Platform shall include functionality to support the validation of NSS delivery by allowing NSS Dispatch requests to be compared with actual Telemetry Data.

REQ 79. DOE Calculator Performance Verification ***Mandatory***

The DSO Platform shall include functionality to allow DOE Calculator forecasts to be compared with actual network Telemetry Data.

REQ 80. Network Analysis ***Desirable***

The DSO Platform shall include functionality to support the simulation of network flows under different conditions, including but not limited to different:

- Weather conditions.
- Load.
- Network Constraints.

5.2 Report Management and Publication

REQ 81. Report Creation ***Mandatory***

The DSO Platform shall support the development, publication and dissemination of reports based on data held within the DSO Platform, including but not limited to:

- All Telemetry Data.
- Network Model data.
- Facility registration data.
- DER registration data.
- Weather data.
- DOE Calculator outputs.
- Data received via the Data Exchange Service.

REQ 82. Report Management ***Mandatory***

The DSO Platform shall allow for the definition and management of standard reports. Standard report management to include but not limited to the ability:

- To manage reports using version control.
- To publish and share reports with a wider audience.
- To restrict access to reports to specific users or user groups.
- For users to input parameters and manually run reports.

- To tag reports to allow them to be searched.

REQ 83. Schedule Report Publication ***Mandatory***

The DSO Platform shall allow for the publication of standard reports according to a defined trigger or schedule. Report publication will support at a minimum the:

- Running and publication of a reports according to a configurable schedule.
- Running of report for a pre-defined period.
- Running of reports using configurable parameters.
- Scheduled dissemination of reports via email and/or notifications.
- Ability to produce non-editable version of reports for external sharing/publication.
- Ability to securely publish reports through the Data Exchange Service (REQ. 67).

REQ 84. Data Visualisation ***Mandatory***

The DSO Platform reporting functionality shall provide functionality to produce and display data visualisations in reports and publications. Visualisations to include but not limited to:

- Tables.
- Scatter plots.
- Histograms.
- Pie charts.
- Heat maps.
- Combinations of the above.

REQ 85. Standard Derivations and Measures ***Mandatory***

The DSO Platform shall support the definition and management of standard measures, calculations, and data derivations, allowing them to be used and re-used in the creation of standard reports and ad-hoc analysis.

REQ 86. Data Quality Reports ***Desirable***

The DSO Platform shall support the creation, publication and management of reports related to the quality of the data held within the DSO Platform.

5.3 Data Analysis

REQ 87. Ad-hoc Data Analysis ***Mandatory***

The DSO Platform shall support the ad-hoc analysis of any and all data contained within the DSO Platform. Ad-hoc analysis to include but not limited to the ability to:

- Join and combine data set.
- Use existing measures, derivations, and calculations.
- Create new measures, derivations, and calculations.
- Manipulate existing data to produce new data sets.

REQ 88. Ad-hoc Data Visualisation ***Desirable***

The DSO Platform shall support the ad-hoc visualisation of any and all data contained within the DSO Platform. Visualisation functionality to include but not limited to:

- Tables.
- Scatter plots.
- Histograms.
- Pie charts.
- Heat maps.
- Combinations of the above.

REQ 89. Additional Data ***Desirable***

The DSO Platform shall support the importation of additional data for the purposes of ad-hoc analysis and visualisation.

REQ 90. Logical Separation of Activities ***Desirable***

The DSO Platform shall support the logical separation of ad-hoc analysis and reports development activities from standard report publication activities such that analysis and development activities do not impact the publication and dissemination of standard reports.

6 DSO Platform Non-Functional Requirements

6.1 Presentation

REQ 91. Usability ***Desirable***

The DSO Platform shall include consistent design elements to enhance system usability and user experience.

REQ 92. Branding ***Desirable***

The DSO Platform shall include agreed branding/colour scheme.

REQ 93. Consistent Error Messages ***Desirable***

All DSO Platform messages, pop-up windows and other user notifications shall:

- Use clear and concise language.
- Be consistent in terms of appearance.
- Be consistent in terms of the actions required of the user.
- Provide clear instructions to the user.
- Actively support the resolution of issues.

REQ 94. WWW Access ***Desirable***

The DSO Platform components shall be able to be accessed via standard internet protocols using a version of internet browser software supported by the DSO.

REQ 95. Single Portal ***Desirable***

All interfaces and features of the DSO Platform shall be available via a single portal.

6.2 Security

REQ 96. Single Sign-on ***Desirable***

The DSO Platform shall integrate with the DSO's single sign-on solution/service.

REQ 97. Role Based Access Control ***Mandatory***

The DSO Platform shall support role-based access control, allowing for access to be controlled based on:

- DSO Platform component.
- DSO Platform functionality.
- Data sensitivity.
- DSO Platform environment.
- Any combination of the above.

REQ 98. User Management ***Mandatory***

The DSO Platform shall include functionality to support user management. Available functionality to include as a minimum the ability to:

- Create and manage user groups.
- Create and/or delete users.
- Add Users to one or more user groups.
- Manage user and user group permissions to the DSO Platform, including:
  - grant and/or revoke access to DSO Platform.
  - grant and/or revoke access to DSO Platform components and functions.
  - grant and/or revoke access to DSO Platform reports.
  - grant and/or revoke access to DSO Platform environments.
- Search users and user groups to locate the details pertaining to particular individual(s).
- Identify the permissions held by a specific user.

REQ 99. Compliance with Australian Privacy Principles ***Mandatory***

The DSO Platform shall include functionality to support compliance with the Australian Privacy Principles.[74] Examples of functionality may include but are not limited to:

- Encryption of person identifiable data.
- Suppression or pseudonymisation of person identifiable data in interfaces.
- Ability to suppression small numbers when producing aggregate reports using person identifiable data.

REQ 100. Cloud Risk Assessment ***Mandatory***

In cases where a DSO Platform component is using cloud technologies to deliver functionality and/or store data, DSO Platform component shall comply with the findings of a DSO cloud risk assessment.

REQ 101. Virus and Malware Detection ***Mandatory***

The DSO Platform shall include functionality to support the detection and quarantine of malicious software. Virus and malware detection functionality to be regularly reviewed and updated in line with best practice.

REQ 102. SSDLC ***Mandatory***

[74] Australian Privacy Principles published by the Office of the Australian Information Commissioner. *Last accessed 16/11/2021.*

DSO Platform components shall be designed and developed as per Secure Software Development Lifecycle processes and principles.

5.12

6.3 Environment Management

REQ 103. Environment Provisioning ***Mandatory***

The DSO Platform shall include sufficient environments and functionality to support development and testing activities in a manner that does not impact production operations. Development and testing activities to include but not limited to:

- Unit testing.
- System testing.
- User acceptance testing.
- Integration testing.
- End-to-end testing
- Performance and load testing
- Version control.
- Controlled promotion between environments.
- Test tools.

REQ 104. Test Environment Equivalence ***Desirable***

The DSO Platform Test environment shall be sufficiently equivalent to DSO Platform production operations such that outcomes observed in testing are sufficiently replicated in production when the same or similar conditions are applied.

REQ 105. Simulated Data ***Desirable***

The DSO Platform shall include the ability to simulate Network conditions and analyse platform functionality and outputs through the creation and modification of data in a manner that does not impact production operations. Simulation to include but is not limited to:

- Simulated changes to the Network.
- Network outages.
- Changes to network component constraints.
- Changes to configurable data items, such as Firm Capacity.
- Simulated changed in weather conditions.

REQ 106. Software Version Control ***Desirable***

All DSO Platform software components shall be managed using version control. Version control to include as a minimum the ability to:

- Promote new versions of functionality.
- Revert to previous version.
- Identify which version of a component/function is operating in each environment.

6.4 Extensibility and Scalability

The Project Symphony pilot is limited to:

- A small, defined pilot area that includes largely retail customer (as opposed to industrial consumers).
- Integration with a single Aggregator system.
- A limited sample of DER which excludes large PV systems, a limited number of Load Control devices, and none/extremely limited use of EV.

While the primary aim of the DSO Platform is to deliver on the scope and aims of Project Symphony, the DSO would like to:

- explore architectures that would allow the DSO Platform to be extended and scaled to deal with increased DER, customer participation, and an increased network area, and/or
- identifying technical limitations to extending a DSO Platform to include an expanded scope.

REQ 107. Storage of DOE Calculator Inputs and Outputs ***Desirable***

The DSO Platform shall be able to store all data used in the calculation of DOEs now and into the future, including but not limited to:

- All raw data inputs used to calculate DOEs.
- All raw data outputs produced in the calculation of DOE.
- All content formatted and published for the consumption of other parties.

Where this requirement is met through the archived of data, all archived data shall be stored in an accessible form.

REQ 108. Network Coverage ***Desirable***

The DSO Platform architecture shall be scalable such that it could be used to deliver a DSO service to an expanded network area up to an including the entire SWIS.

REQ 109. DOE Calculation Frequency ***Desirable***

The DSO Platform functionality shall be extensible such that it may be used to deliver frequent DOE calculations (every 5 minutes) using (near) real-time Telemetry Data.

REQ 110. Multiple Aggregators ***Desirable***

The DSO Platform architecture shall be extensible to manage a network environment that involves multiple Aggregators.

REQ 111. Increased DER – Volume ***Desirable***

The DSO Platform architecture shall be scalable to allow for an increase in the number of DER associated with each Service Connection.

REQ 112. Increased DER – Scope ***Desirable***

The DSO Platform architecture shall be extensible to allow for a greater range of DER, including but not limited to:

- Larger PV systems.
- Different types of Controllable Load.
- Electric Vehicles.

REQ 113. Software Licencing	*Desirable*
The DSO Platform shall be designed to ensure that costs associated with software licencing are predictable and manageable. In general, exponential growth in data, user numbers, and/or transaction volumes should not automatically equate to exponential growth in software licence costs.	

6.5 Modular Design

Project Symphony is a pilot project. At the end of the project, it is intended that the DSO Platform will be retired. However, depending on the outcome of the project, Project Symphony and/or Western Power may wish to continue to use all or part of the platform, and/or salvage or otherwise reuse components of the platform for other ventures.

REQ 114. Modular Design	*Desirable*
The DSO Platform shall have a modular design to support future component reuse.	

6.6 Audit and Data Governance

REQ 115. Audit Trail	*Desirable*
The DSO Platform shall record audit data sufficient to allow for the identification of a user that has accessed the system, including but not limited to: • Time of access • The component of the system that was accessed • Outputs that were accessed • Functions that were performed	

REQ 116. Audit Retrieval	*Desirable*
Audit Trail data on the DSO Platform shall be able to be queried on demand by a user with the correct permissions (REF 107).	

REQ 117. Data Retention	*Mandatory*
The DSO Platform shall retain: • All raw data within the platform. • A record of all data inputs. • A record of all data outputs.	

REQ 118. Data Provenance	*Mandatory*
The DSO Platform shall record the data provenance for all data contained in the platform, including: • The source data system. • The date the data item was last extracted from the source data system.	

6.7 Performance

The DSO Platform will be used by a small number of users for the duration of the Project Symphony pilot. As such, users should expect the platform to be reasonably responsive.

REQ 119. Response Times ***Desirable***

The DSO Platform be responsive to user requests. Responsiveness to be defined as with 5 seconds.

6.8 Interoperability

REQ 120. Open Standards ***Desirable***

The DSO Platform shall use relevant Open Standards to support interoperability in all relevant components and/or functionality. Open Standards to include but not limited to:

- IEEE2030.5

6.9 Service Management

The DSO Platform will be used for the duration of the Project Symphony pilot. As a pilot system, many of the below requirements are aspirational and may not be met in full.

REQ 121. Support and Maintenance ***Desirable***

There shall be a clear agreement for how the DSO Platform will be supported for the duration of Project Symphony, including clear processes and service levels for:

- Level 1 support and administrative activities, such as managing user account and user requests.
- Level 2 and 3 support.
- Key service management processes.

REQ 122. Service Request Process ***Desirable***

There shall be a clear Service Request process for the DSO Platform that addresses:

- how service requests are submitted.
- how service requests are prioritised.
- how service requests are tracked.
- service level agreements.
- any templates and/or software configurations for standard documentation.

REQ 123. Problem and Incident Management Process ***Desirable***

There shall be a Problem and Incident Request process for the DSO Platform that addresses:

- how incident management processes are initiated.
- how an incident is classified.
- incident management procedures.
- problem management procedures.
- any templates for standard documentation.

REQ 124. Change Request Process ***Desirable***

There shall be a Change Request process for the DSO Platform that addresses:

- how change requests are submitted.
- how change requests are prioritised.
- how change requests are assessed.
- who makes decisions in relation to change requests.
- how change requests are allocated and tracked.
- how change requests are communicated.
- any templates and/or software configurations for standard documentation.

REQ 125. Release Management Process ***Desirable***

There shall be a Release Management Request process for the DSO Platform that addresses:

- pre-conditions before a release is scheduled.
- how releases are tested.
- how/when releases are scheduled.
- how releases are communicated.
- roll-back procedures.
- any templates and/or software configurations for standard documentation.

REQ 126. Availability ***Desirable***

The DSO Platform shall be available workdays between the hours of 6am-9pm for the duration of the Pilot with and availability of 99% (excluding scheduled downtime REQ. 127).

REQ 127. Downtime ***Desirable***

DSO Platform scheduled downtime shall:

- be arranged at least 1 month in advance.
- be communicated to users through standard channels.
- amount to no longer than 4 hours at a time.
- amount to no more than 12 hours over any given calendar year.

REQ 128. SLA Reporting ***Desirable***

Performance against agreed DSO Platform service levels shall be reported monthly.

REQ 129. Business Continuity and Disaster Recovery ***Desirable***

The DSO Platform system shall have a business continuity/disaster recovery procedure that allows the solution to be reinstated without loss of data within 1 week after the end of a major incident/disaster that impacts the system. The procedures to include:

- procedures and rule for activities likely to support business continuity in the event of an incident or disaster, such as back-up and recovery procedures.
- how a disaster is declared.
- who can declare a disaster.
- communication plan in the event of a disaster.
- when a disaster can be declared over.
- any templates and/or software configurations for standard documentation.

The procedures shall:

- support a Recovery Time Objective (RTO) of 1 week[75].
- recovery Point Objective (RPO) of zero.
- be testable.

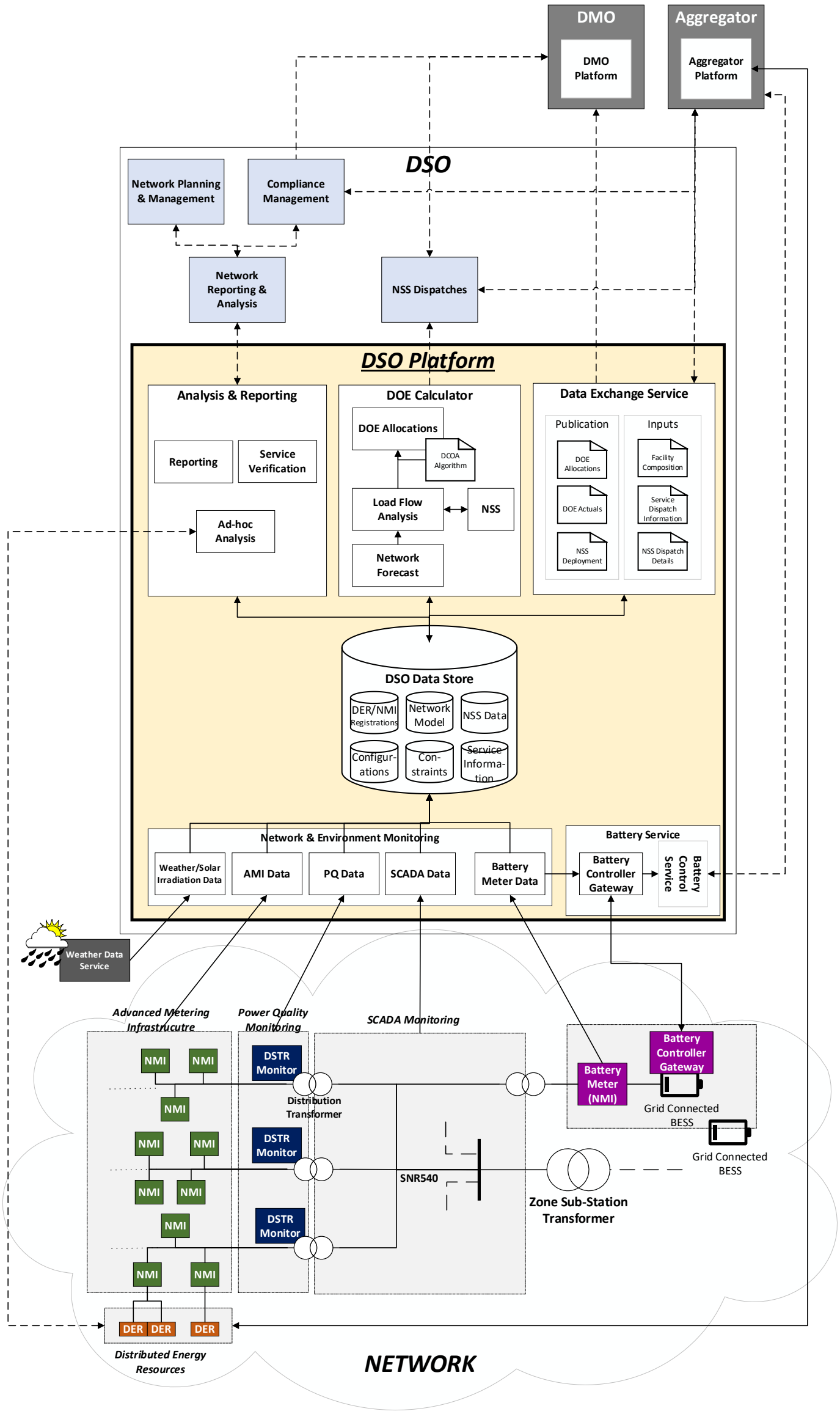
Major disaster may include but are not limited to:

- act of god, such flooding or earthquake.
- act of terrorism.
- major financial/contractual issue, such as major supplier suddenly ceasing operation.

[75] This aligns with Western Power service level expectations for a system classified as a tier 5 system.

Project Symphony
Our energy future

Appendix D: DSO Platform Conceptual Model



Appendix E: DSO Platform Concepts

1 DSO Conceptual Data Model

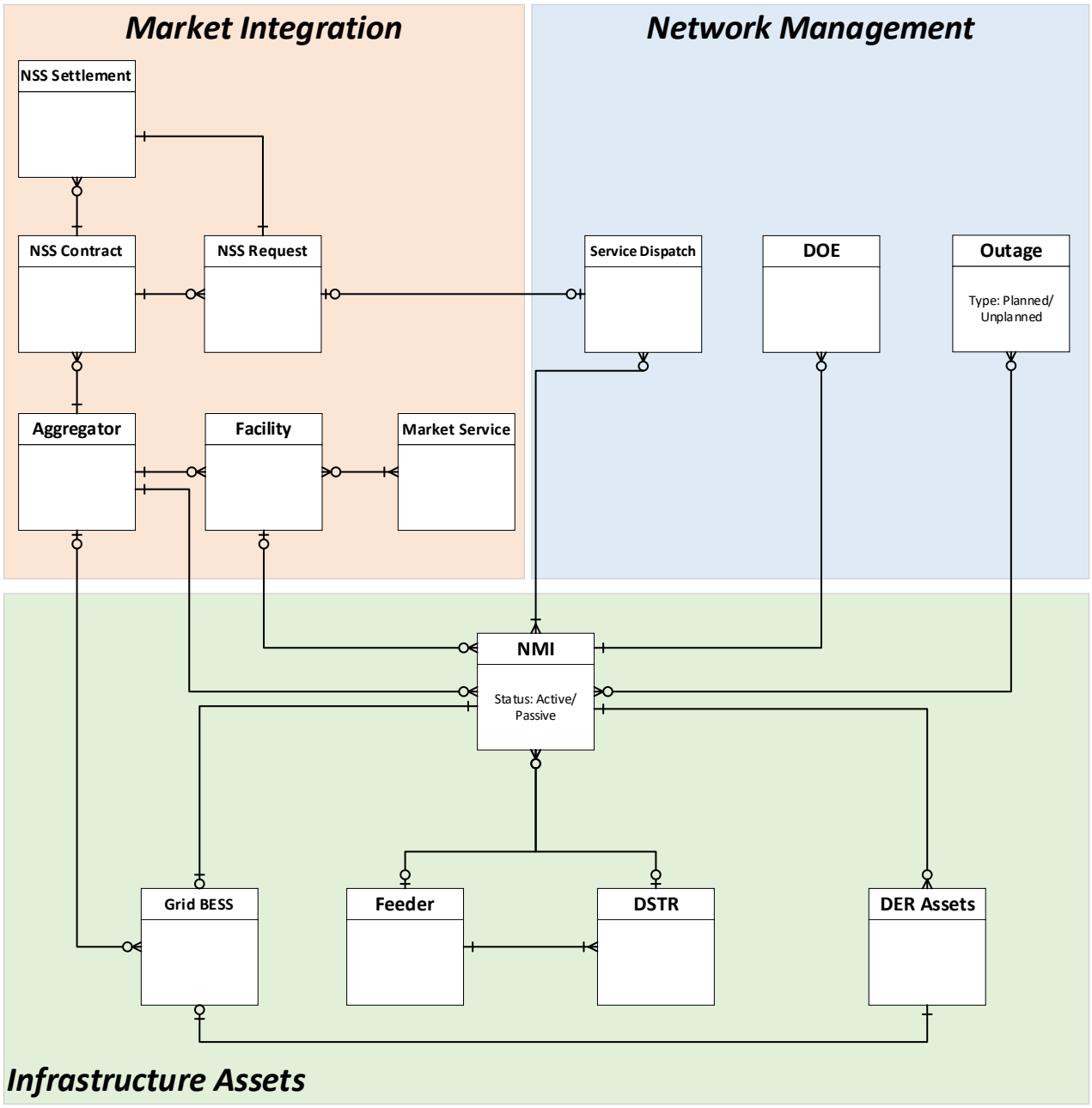


Figure 9: DSO Platform Conceptual Data Model

2 Conceptual Data Relationships

Entity 1	Relationship	Entity 2	Comment
A NMI	May be associated with	DER Assets	A NMI can be linked to multiple DERs. NMI may be active (Active NMI) or passive (Passive NMI). Active NMI's are participants in Project Symphony, meaning any attached DER is also participants.
A DER	Is associated with a	NMI	A DER is attached to 1 and only 1 NMI
A NMI	Is usually linked to a single	Distribution Transformer	A NMI is typically linked to a single Distribution Transformer. In rare cases, it may be linked to two Distribution Transformers. However, this scenario is unlikely to occur in the Pilot Area.
A Distribution Transformer	Provides electricity to multiple	NMI's	A Distribution Transformer services all the NMIs downstream of it.
A NMI	May be directly linked to	Feeder	In some cases, a meter may be located in front of a Distribution Transformer (i.e., the distribution transformer is privately owned). In these cases, the NMI is directly linked to the Feeder. There are some examples of this in the Pilot Area.
A Feeder	May be directly linked to a	NMI	To account for cases where the Distribution Transformer is privately owned and, thus, the meter is in front of the transformer.
A Distribution Transformer	Distributes electricity received via a	Feeder	A Distribution Transformer is connected to a Feeder.
A Feeder	Supports one or more	Distribution Transformers	A Feeder is typically linked to multiple Distribution Transformers. For example, Feeder SNR540 supports 56 Distribution Transformers.
A Grid Connected BESS	Has a	NMI	A meter will be used to collect import and export information for a Grid Connected BESS.
A NMI	May be linked to a	Grid Connected BESS	A Grid Connected BESS will have an associated NMI. However, very few NMIs will be connected to Grid Connected BESS.

A Grid Connected BESS	May be leased by an	Aggregator	It is anticipated that the DSO will install and maintain the Grid Connected BESS. However, the BESS will be managed and operated by an Aggregator under a lease agreement.
An Aggregator	May lease one or more	Grid Connected BESS	While there will only be a single Grid Connected BESS involved in Project Symphony, in theory, there could be more. An Aggregator can theoretically lease multiple batteries under one or more lease agreements.
A Grid Connected BESS	Is a type of	DER	A Grid Connected BESS is technically a type of DER. However, it will be owned by the DSO and has a larger capacity than a typical DER. As such, it will be managed differently to other types of DER.
A DER	May be a	Grid Connected BESS	A Grid Connected BESS is a type of DER. However, very few DER will be Grid Connected BESS
A NSS Contract	Is with an	Aggregator	NSS Contracts will be bi-lateral agreements between the DSO and the Aggregator for NSS services.
An Aggregator	May be a party in multiple	NSS Contracts	While Project Symphony only involves a single Aggregator, in theory there may be multiple Aggregators and multiple NSS Agreements covering a wide range of services for different areas of the network.
A Facility	Is controlled by an	Aggregator	A Facility is a construct that the Aggregator can use to manage their market bids and offers.
An Aggregator	May operate multiple	Facilities	An Aggregator can establish multiple Facilities. Each of which may provide different Market Services
A Facility	Comprises multiple	NMI's	A Facility is comprised of a collection of NMIs and their associated DER that, together, with be orchestrated by the Aggregator to provide Market Services.
A NMI	Is associated with a Facility	Facilities	All active NMI's will be associated with at least 1 Facility. DSO Platform may know about a NMI before it is 'Active'. A given NMI will only ever be associated with 1 Facility at any given time to support the delivery of different Market Services.

A Facility	Exists to deliver	Market Services	The Facility aggregates the generation and consumption capacity of DER together so that the result is capable of providing meaningful levels of service, allowing it to bid in the market.
A Market Service	May be delivered by multiple	Facilities	A Facility exists to deliver one or more types of market services. Example of market services include NSS and ESS.
A DOE	Is calculated for a specific	NMI	A DOE will have a creation date/time. Therefore, a DOE calculated for a specific NMI at a specific time is unique.
A NMI	May have multiple	DOEs	All NMI's with a status of Active will have DOEs calculated for them.
A NSS Contact	May lead to multiple	NSS Requests	A NSS Contract is a bilateral agreement between the DSO and an Aggregator for the provision of NSS services.
A NSS Request	Is made under a	NSS Contract	An NSS Contract may lead to the request for an NSS service. NSS services may be requested in advance based on a forecast Network Constraint. Contractual terms will dictate how far in advance NSS services need to be requested in order to ensure they are provisioned and appropriately dispatched.
A Service Dispatch	May be provided as per a	NSS Request	A NSS needs to have been requested to be dispatched as a service. However, information on the dispatch of Essential System Services will need to be recorded.
A NSS Request	May lead to a	Service Dispatch	A NSS Request may or may not lead to the dispatch of an NSS. If network conditions have changes, the NSS service may no longer be required and therefore does not require to be dispatched.
A NSS Dispatch	Involves one or more	NMI's	A NSS Dispatch will involve one or more NMIs.
A NMI	May be involved in a	NSS Dispatch	A NMI may be involved in the dispatch of multiple NSS Services over time
A NSS Request	Will lead to a	NSS Settlement	A NSS Request will be settled according to terms agreed in the NSS Contract regardless of whether the requested NSS Service was dispatched.
A NSS Settlement	Will be performed for a	NSS Request	A Settlement will relate to a specific request for an NSS Service.

A NMI	May be involved in an	Outage	A NMI may be offline for a given time period as the result of a local or network issue. Outages may be planned or unplanned.
An Outage	May involve multiple	NMIs	A network or local outage may impact multiple NMIs. An Outage may be planned or unplanned, meaning it could have happened in the past, present or future.
A NSS Contract	Will guide the completion of	NSS Settlements	A contract will guide the terms under which one or more settlements for an NSS Service are made.
A NSS Settlement	Will be conducted according to	NSS Contract	Settlements will be determined according to criteria set out in the relevant NSS Contract.

Appendix F: Full List of Scenarios Considered

Scenario (use case)	Market	Description
Energy Services - Bi-directional Energy - Balancing Market	Energy	Offering (Sell) or bidding (Buy) energy into the balancing market.
ESS Contingency Raise / Lower	ESS	Market provision of a response to a locally detected frequency deviation to help restore frequency to an acceptable level in case of a contingency event (such as the loss of a large generator or load). Will be known as the Contingency Reserve Raise and Contingency Reserve Lower in the future WEM FCESS service.
ESS Regulation Raise / Lower	ESS	Market provision of a response to Automatic Generation Control (AGC) signals to correct for small movements in frequency during a dispatch interval.
Rate of change of frequency	ESS	Market provision of a service to manage the rate of change of power system frequency.
Network Support Service	NSS	A contracted service provided by a generator / retailer / demand side program / DER Aggregator to Western Power (DSO) to help manage network limitations.
Non co-optimised essential system services	NCESS	A contracted service, not covered by other ESS categories, provided by a generator / retailer / demand side program / DER Aggregator to AEMO to help maintain power system security / reliability.
Constrain System Export	-	A service whereby instructions can be sent by AEMO to the Aggregator and executed by the Aggregator to constrain energy output to zero.
Disconnect Inverter/ PV Generation and Gradually restore after system re-start	-	A service whereby the Aggregator is able to control the Inverter, in affect constraining the PV to generation to zero. Hence the customer is a Load at the time to restore the network during system re-start The Aggregator is able to restore the Inverter into operation and follow commands to generate
Off market portfolio optimisation capacity (wholesale market participant level optimisation)	Capacity	Utilisation of DER assets to reduce a wholesale market participant's net demand during peak trading intervals, with the intent of reducing their IRCR liability.
Off market portfolio optimisation energy (wholesale market participant level optimisation)	Energy	Utilisation of DER assets to alter a wholesale market participant's balancing market exposure, rather than bidding or offering that energy into the balancing market.
Off market portfolio optimisation ESS (wholesale market participant level optimisation)	ESS	Utilisation of DER assets to alter a wholesale market participant's ESS market

Scenario (use case)	Market	Description
		exposure, rather than offering their capacity into the ESS markets.
Capacity Credits	Capacity	Certification and operation of DER for the provision of reserve capacity.
Network cost reduction (i.e. economic lens)	Network	Impact on network costs over time due to the usage of DER to defer / avoid expenditure.
Network bill reduction (i.e. commercial lens)	Network	Impact on a network user's bill due to the usage of DER (e.g. optimisation of consumption against existing network tariffs).
Self sufficiency	All	Utilisation of DER assets to allow customers to disconnect from the grid, where economic.
Back up power	All	Utilisation of DER assets to provide back up power (UPS) in the event of a power failure.
Energy management services (customer level optimisation)	All	Utilisation of DER assets to enable customers to optimise their consumption to reduce their energy costs.

Appendix G: Aggregator Key Learnings and Decisions

The key learnings and decisions contained in this document have been compiled below for ease of access.

1. Key Learnings

1.1 Key Learnings From RFI

Topic	Learning	Implication
DER	Emerging market of residential DER Control.	The Symphony pilot will inform the question as to viability of residential focused DER aggregation and participation in various market and services.
Platform	Few software vendors had all layers (gateway controller, monitor & control, Optimisation).	Generally, vendors' software offerings are immature and will require time to mature.
Platform	Specific to Symphony requirements experience across the world is not comprehensive.	More pilots will need to be undertaken to gain market experience of specific Symphony requirements.
Platform	Some vendors were happy to tender a combined bid comprised of multiple partners to support the diversity of the solution.	Diversity of offering is not yet established, with very few vendors able to support the whole platform ecosystem, leading to little choice for Aggregators / retailers.

1.2 Key Learnings From RFP

Topic	Learning	Implication
Optimisation	Forecasting available load response from DER (or "Flex") is key to optimising the VPP.	The ability of the platform to forecast the spare energy or load response within the VPP is key to effective optimisation of the VPP's energy.
Platform	Few software vendors provided effective optimisation and runtime disaggregation.	Vendors' software offering is largely immature in the optimisation capability area.
Market Services	Trading support by aggregation platforms is not yet mature.	Vendors' software offering in trading and interaction with market services is not well supported.
Commercial	The DER aggregation software vendor market is undergoing significant change through mergers and acquisitions.	This maybe a risk that constrains the establishment of commercial arrangements with some vendors.

1.3 Key Learnings From Plan B evaluation

Topic	Learning	Implication
Platform	User story mapping to vendor capability is an effective evaluation process.	Evaluation of vendors software to defined detailed scope enabled a rapid selection result.
Platform	A “Best of Breed” strategy involving multiple vendors is required when the vendor offerings are not yet mature.	Due to the evolving Residential DER aggregation space, a single vendor solution may not yield enough capability to fulfill all capabilities required at the current time.
Platform	Vendors are willing to collaborate with other vendors.	Selection of multi-vendor solutions are possible given motivated vendors.

2. Decisions

2.1 RFI - Decisions

Decision 1

A key design decision made by the project was the method of controlling DER assets from the central cloud. The available options were:

3. Local control via a gateway device installed at the premises.
4. Control via third party asset software.

Of the 2 possible options, option 1 was selected to enable the level of certainty of control required by the agreed scenarios. The control via third party asset software (vendor cloud control) is not yet mature enough to provide the mix of DER assets control required by project Symphony.

Decision 2

A key decision was made that the software vendor must provide an overarching commercial accountability delivery structure. This meant the solution could only be comprised of multiple vendor offerings if there was a designated vendor with commercial accountability to be accountable for the whole solution.

2.2 Plan B - Decisions

Decision 3

A decision was made to open the solution to multiple vendors without a prime. This would allow a ‘best of breed’ approach to the solution but would add additional risk due to overlap of capability, accountability now shared and new integration between systems required. This negated the previous project Decision 2.