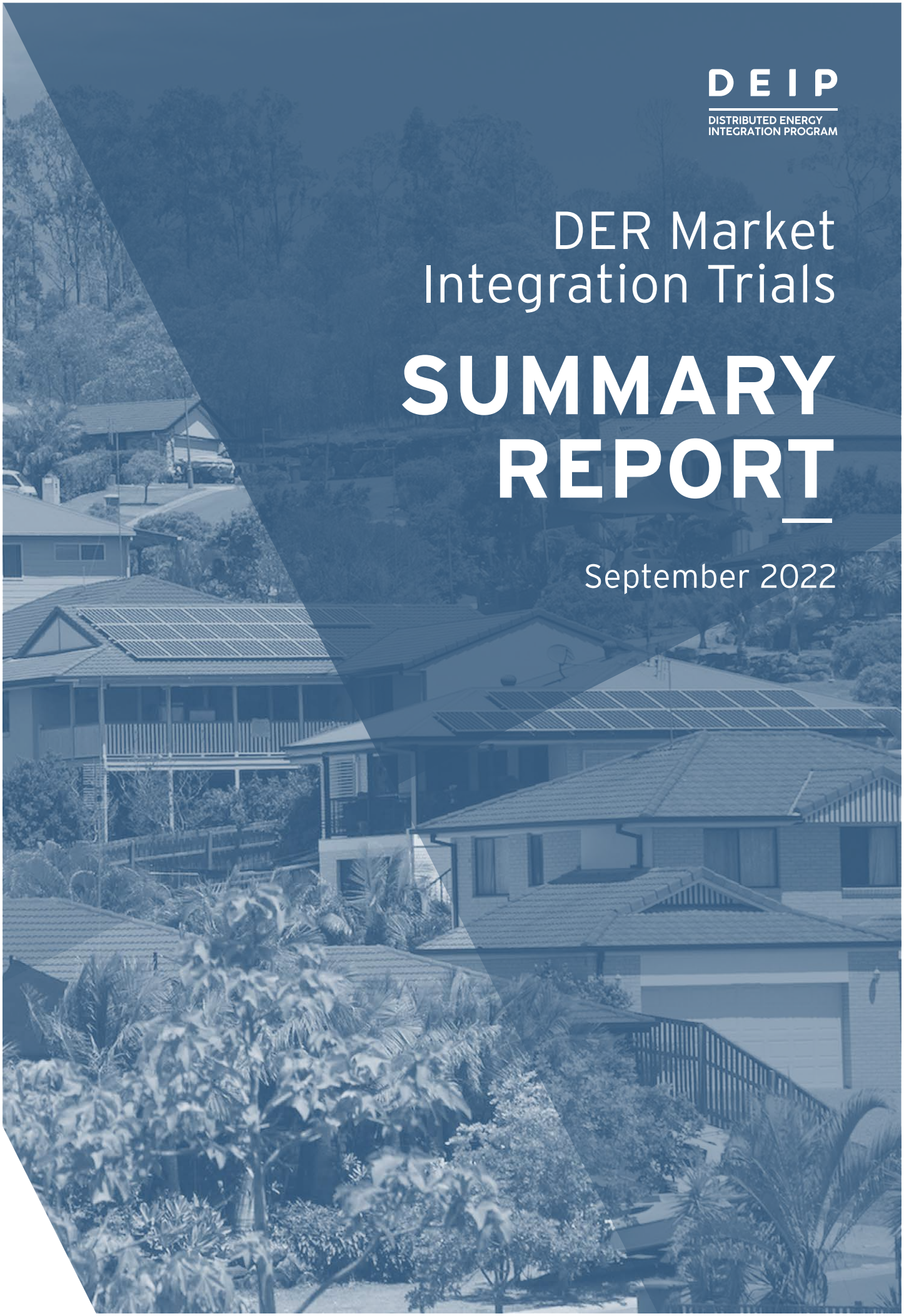

DEIP

DISTRIBUTED ENERGY INTEGRATION PROGRAM

# DER Market Integration Trials

# SUMMARY REPORT

September 2022

# ABOUT DEIP

The Distributed Energy Integration Program (DEIP) is a collaboration of government agencies, market bodies, peak industry bodies and consumer associations aimed at maximising the value of distributed energy resources (DER) for all energy users.

DEIP is not an organisation, it is a collaborative forum where organisations come together to share knowledge and work together towards a common goal. DEIP is driven by the premise that collaborating on shared issues and mutual goals will more efficiently identify knowledge gaps and priorities, as well as accelerate DER integrated in the interest of all consumers.

For more information on DEIP, visit the DEIP website.[1]

# ABOUT THIS REPORT

The DEIP DER Market Integration Trials Summary Report was commissioned by the Australian Renewable Energy Agency (ARENA), on behalf of the Distributed Energy Integration Program (DEIP). The analysis was undertaken by Grids Energy, who prepared the report in conjunction with ARENA and through a consultative process with the DER market integration trials, the DEIP Markets Working Group, and industry stakeholders.

The DEIP Markets Working Group includes representatives from the Australian Energy Council (AEC), Australian Energy Market Commission (AEMC), Australian Energy Market Operator (AEMO), Australian Energy Regulator (AER), Australian Renewable Energy Agency (ARENA), Clean Energy Council (CEC), Energy Consumers Australia (ECA), and Energy Networks Australia (ENA).

The DER market integration trials include Project EDGE (led by AEMO), Project Symphony (led by Western Power), Project Edith (led by Ausgrid) and Project Converge (led by Evoenergy).

1 arena.gov.au/distributed-energy-integration-program

# DISCLAIMER

This report was commissioned by the Australian Renewable Energy Agency (ARENA), on behalf of the Distributed Energy Integration Program (DEIP). This report has been written by Grids Energy Pty Ltd with input from the DEIP and DER markets integration trials (AEMO Project EDGE, Ausgrid Project Edith, and Evoenergy Project Converge, and Western Power Project Symphony). The report presents the findings of Grids Energy Pty Ltd, which was prepared to provide a high-level summary of the DER market integration trials. ARENA, the DEIP and the DER markets integration trials have not endorsed the contents of this report, nor does the report necessarily represent the views or opinions of ARENA, the DEIP, or the DER market integration trials. The views expressed herein are also not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

The report is provided as is, without any guarantee, representation, condition or warranty of any kind, either express, implied or statutory. ARENA and Grids Energy Pty Ltd do not assume any liability with respect to any reliance placed on this report by third parties. If a third party relies on the report in any way, that party assumes the entire risk as to the accuracy, currency or completeness of the information contained in the report. ARENA, Grids Energy Pty Ltd, the DEIP, and the DER markets integration trials do not assume any liability with respect to any reliance placed on this report by third parties. If a third party relies on the report in any way, that party assumes the entire risk as to the accuracy, currency or completeness of the information contained in the report.

To the best of ARENA and Grids Energy Pty Ltd knowledge, no conflict of interest arose during the course of preparing this report. Grids Energy Pty Ltd has not received any grant funding from ARENA.

# EXECUTIVE SUMMARY

## Emergence of DER market integration trials

A suite of of sophisticated end-to-end market integration trials and pilots are exploring how distributed energy resources (DER) can deliver services and operate in energy markets, while adhering to the physical limits of the system and offering compelling products and services for consumers. These trials and pilots are the Australian Energy Market Operator's (AEMO) Project EDGE, Western Power's Project Symphony, Evoenergy's Project Converge and Ausgrid's Project Edith. These trials and pilots are building on the lessons of previous trials that successfully demonstrated specific aspects of DER integration or the provision of specific functionality.

## Addressing the knowledge gap

There is no one-size-fits-all approach to DER market integration and optimisation. The lessons and insights from these trials and pilots have a role in informing the future of DER market integration and reform. This report summarises the complementary and distinguishing features of four DER market integration trials and pilots for industry leaders to make informed, evidence-based decisions about the future of DER integration.

## Summary of findings

Table 1 presents an overview of the various approaches the trials and pilots are exploring, with bold features denoting a novel approach to DER integration.

Areas of commonality between trials and pilots tend to be where there has been a large amount of industry collaboration and common understanding, such as the use of dynamic operating envelopes (DOEs) for communicating local network hosting capacity, and the Common Smart Inverter Profile Australia (CSIP-AUS) as a protocol to communicate that capacity. Areas of diverging approaches occur in less explored areas, such as how network services are procured or whole-of-system data architectures.

| | AEMO PROJECT EDGE | WESTERN POWER PROJECT SYMPHONY | AUSGRID PROJECT EDITH | EVOENERGY PROJECT CONVERGE |
|---|---|---|---|---|
| METERING POINT | Connection Point or **Sub-metering** | Connection Point | Connection Point | Connection Point |
| ENERGY MARKET BIDDING | **Model consistent with scheduled BDU from IESS** | Bids into balancing and **contingency reserve raise** markets | Current bidding process for FCAS | **Bids first sent to DSO** |
| DOE ALLOCATION | Various | Various | **Subscription model** | **Bid-optimised** |
| LOCAL CONSTRAINTS | DOE | DOE | DOE | DOE |
| NETWORK SUPPORT | **Local services exchange** | **Contracted network services** | **Dynamic network price** | **Real-time RIT-D** |
| DATA TRANSFER | **Data-hub** | **Platform integrations** | **Point-to-point** | Point-to-point |
| LOCAL CONSTRAINTS COMMUNICATION PROTOCOL | CSIP-AUS (only using schema) | CSIP-AUS | **CSIP-AUS extended with pricing)** | CSIP-AUS |

Table 1. Technical settings of the market integration trials. Bold denotes a novel approach.

| | AEMO PROJECT EDGE | WESTERN POWER PROJECT SYMPHONY | AUSGRID PROJECT EDITH | EVOENERGY PROJECT CONVERGE |
|---|---|---|---|---|
| LOCATION | VIC | WA | NSW | ACT |
| SOCIAL SCIENCE RESEARCH | Yes (Deakin University) | Yes (Synergy and University of Tasmania) | Not Currently | Yes (Australian National University) |
| COST BENEFIT ANALYSIS OF SYSTEMS | Yes | Yes | Partial (Ausgrid DSO system investments) | No |
| DURATION | July 2020 – Mid 2023 | July 2021 – Mid 2023 | September 2021 – March 2023 | August 2021 – January 2024 |
| TARGET NUMBER OF CUSTOMERS | 1,000 | 500 | 300 | 1,000 |
| PILOT OR TRIAL | Trial | Pilot | Trial | Trial |

Table 2. Non-technical settings and activities of market integration trials.

## Recommendations for future DER market integration trials

As the industry matures from foundational research and the demonstration of specific DER functions to more integrated trials, it is important that the industry converges (where appropriate) on how to conduct future trials that incorporate the following considerations:

- **Stronger connection between industry needs and trial learnings.**
  As many aspects of the trials must go through regulatory pathways to be implemented it is advantageous that trials understand the feasibility of those pathways. Market bodies and other policy makers are encouraged to communicate knowledge gaps in reforms that could be resolved through trials, studies or demonstrations.
- **Develop evidence bases on implementation feasibility (where possible) before rolling out in-field trials.**
  Targeted trials can be utilised to test and demonstrate business models and technologies before full-scale rollout and entrenchment of specific designs. Where appropriate, research, including feasibility studies, should be used to inform the design of these trials to avoid costly and time-consuming activities.
- **Social science studies to play a more active role in testing options and solutions.**
  As more mature trials commence, there is an opportunity for social science research to play a more active role in testing solutions. For instance, we know that consumers need to receive clear and understandable information in virtual power plant (VPP) programs, but what information and in which form may be most effective? While this can be tested through the deployment of products in multi-year trials, there are also various social science and consumer research techniques that can provide answers in faster and more cost-effective ways.

# GLOSSARY

| | |
|---|---|
| AEMO | Australian Energy Market Operator |
| AER | Australian Energy Regulator |
| AES | Alternative energy services |
| API | Application programming interface |
| ARENA | Australian Renewable Energy Agency |
| BDU | Bidirectional unit |
| CECV | Customer export curtailment value |
| CER | Consumer energy resources |
| CIC | Customer insights collaboration |
| CSIP-AUS | Common Smart Inverter Profile Australia |
| DCOA | Distribution constraint optimisation algorithm |
| DEIP | Distributed Energy Integration Program |
| DER | Distributed energy resources |
| DMO | Distribution market operator |
| DNP | Dynamic network price |
| DOE | Dynamic operating envelope |
| DSO | Distribution system operator |
| DUID | Dispatchable Unit Identifier |
| ESOO | Electricity Statement of Opportunities |
| ESB | Energy Security Board |
| ESS | Essential system services |
| FCAS | Frequency control ancillary services |
| FTA | Flexible trading arrangements |
| IDSO | Independent system operator |
| IESS | Integrating Energy Storage Systems rule change |
| IRP | Integrated Resource Provider |
| ISC | Interoperability Steering Committee |
| ISP | Integrated System Plan |
| LSE | Local services exchange |
| MMS | Market management system |
| NECF | National Energy Customer Framework |
| NEM | National Electricity Market |
| NSS | Network support services |
| PV | Photovoltaic |
| RERT | Reserve Emergency Reliability Trader |
| RIT-D | Regulatory investment test distribution |
| SIP | Single integrated platform |
| SOE | Shaped operating envelope |
| TST | Two-step tiered |
| VaDER | Value of distribured energy resources |
| VPP | Virtual power plant |
| WEM | Wholesale Electricity Market |

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# 1. ABOUT THIS REPORT

## 1.1. INTRODUCTION

As Australia progresses through the energy transition, distributed energy resources (DER) play an increasingly important role in our energy system. AEMO's 2022 Integrated System Plan (ISP) Step Change scenario models over 50% of detached homes in the National Electricity Market (NEM) will have rooftop solar by 2032, increasing to 65% and 69 GW of capacity by 2050. AEMO's 2022 Wholesale Electricity Market (WEM) Electricity Statement of Opportunities (ESOO) forecasts that in Western Australia's southwest, distributed PV capacity may increase between 5.6% to 7.8% per annum over the next 10 years, resulting in a potential doubling of distributed PV capacity from 2888 MW in 2022-23 to 5658 MW in 2031-32 (peak demand in the WEM is around 4000 MW and expected to only grow marginally). Transitioning to electric vehicles (EV) and the electrification of households, businesses and industry will also increase demand on the system.

Poor management of the transition could lead to overbuild of infrastructure and increased costs for consumers, as well as produce negative outcomes such as inhibited penetration of renewable energy, limits on DER hosting capacity and unreliable energy supply. Managed well though, there are many benefits on offer:

- NERA Economics' *Valuing Load Flexibility in the NEM* report[2] suggests that load flexibility could save consumers $8-$18 billion in high DER uptake scenarios due to a reduced need for utility scale generation and storage.
- Baringa Partners' *Potential network benefits from more efficient DER integration* report[3] found that total network benefits of efficient DER integration could be as high as $11.3 billion based on AEMO's 2020 ESOO. This is due to avoided curtailment costs and a reduced need for distribution and transmission investment.
- AEMO's *2022 ISP Step Change*[4] *scenario* models over half of dispatchable capacity in the NEM coming from coordinated DER storage in 2050, reducing the need for utility scale dispatchable capacity.

Integrating DER to realise these benefits is challenging. There are many different actors and incentives at play and the industry is currently working through various principles, options and reforms to remove barriers and support the efficient uptake and operation of these assets.

One way to inform this progress is through demonstration trials. Previous trials have tested foundational or targeted aspects of DER functionality and have validated the ways that DER can better integrate into the energy system, such as providing market services or adhering to local constraints. Recent trials have built on these lessons and are now testing the end-to-end integration of complex, sophisticated DER participation.

2 https://arena.gov.au/knowledge-bank/valuing-load-flexibility-in-the-nem/
3 https://www.datocms-assets.com/32572/1629948077-baringaesbpublishable-reportconsolidatedfinal-reportv5-0.pdf
4 https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp

These new end-to-end trials are examining different ways of meeting four core functions of DER integration:

- **Market Services:** providing system-level market services such as participating in current wholesale energy, FCAS, or RERT markets.
- **Network Services:** providing capacity to local networks to defer or avoid the need for costly network upgrades.
- **Local Constraints:** adhering to the local network capacity available to the DER.
- **Consumer Needs & Preferences:** compelling products and offers created with appropriate value, information and protections that encourage consumer participation in the above three functions.

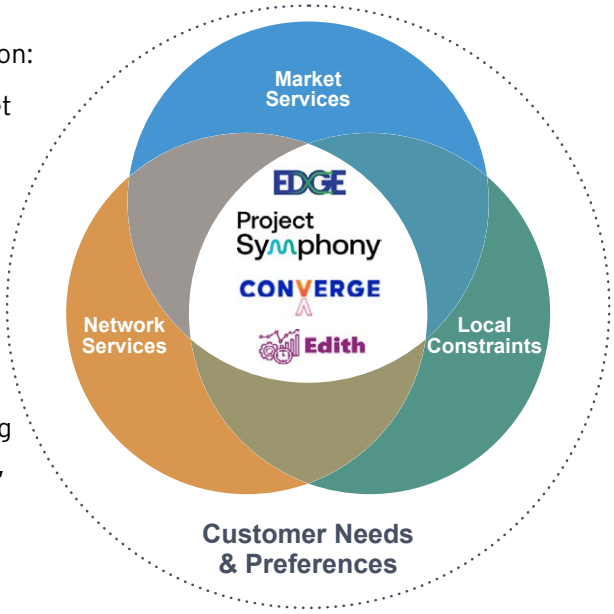



Figure 1. Core functions met in end-to-end DER market integration trials.

While these trials are examining the cutting edge of sophisticated DER capabilities under scenarios where consumers would like their DER to participate fully, this doesn't suggest that all DER should be providing these functions. Many consumers may elect for simpler products and offers, such as adhering to local constraints through static or dynamic export limits. Consumers should be appropriately informed and supported to provide local and system level services where appropriate.

The main trials examined in this report are the NEM-based Project EDGE, Project Edith, and Project Converge, and the pilot Project Symphony from the WEM in Western Australia.

## 1.2 REPORT PURPOSE

This report presents a high-level summary of the complementary and distinguishing features of AEMO's Project EDGE, Western Power's Project Symphony, Ausgrid's Project Edith and Evoenergy's Project Converge.

The purpose of this report is to describe some of challenges in DER market integration and outline the various approaches being tested to address these challenges. Uplifting industry awareness and knowledge of the trials and pilots will promote a shared understanding of the challenges and options being explored in DER market integration.

Stakeholders who may find benefit from this report include:

- Policy makers, who can better understand challenges to DER market integration and how insights from these or future trials can inform policies and reforms.
- Industry stakeholders, who can better identify challenges or areas in which they can contribute.
- Future trial operators, who by better understanding historical context, current approaches and gaps can efficiently design trials targeting future areas of need.

The intention of this report is not to evaluate the relative merits of different approaches, but to synthesise existing information to create a single place where readers can quickly come up to speed on all four of the trials at a point in time (September 2022).

## 1.3 REPORT STRUCTURE

The main body of this report explores the different approaches to the four core functions that the DER market integration trials are testing. The report contains eight sections: the first three sections look at the individual technical components, the next three sections look at the interactions between those components, and the final two sections examine the holistic end-to-end integration of all four core functions.

Each section covers:

- **Knowledge learnt from previous trials or studies**, which provides context on earlier work that the current trials are building upon.
- **Approaches from the current market integration trials**, which outlines the various approaches being trialled.
- **Current reforms**, which provides details of relevant reforms and how these trials may inform the reforms.

This report also identifies systematic gaps that may emerge as industry learns from trials testing foundational or targeted aspects of DER functionality to exploring the end-to-end integration of complex, sophisticated DER participation. Finally, a short overview of each trial is presented in the appendices.

### Language

The term 'consumer energy resources' (CER)[5] has recently emerged in reference to consumer-owned assets connected to the energy system (such as rooftop PV, batteries, electric vehicles and other assets that can be operated flexibly). This term helps industry focus on how to approach assets that are consumer owned. This report uses the term DER as it covers all assets on the distribution network, both consumer and non-consumer owned; yet it is acknowledged that most of these assets will be consumer owned. Both CER and energy products from non-CER assets (such as a consumer energy product using a third-party owned neighbourhood battery) require careful consideration of protections, transparency and fairness, which are examined in Section 2.8 *Consumer Needs and Preferences*.

5 https://energyconsumersaustralia.com.au/news/death-to-der-why-we-need-to-change-the-language-we-use-for-the-energy-transition

# 2. FUNCTIONAL ANALYSIS OF TRIALS

## 2.1 MARKET SERVICES


Small amounts of DER capacity are actively participating in existing NEM markets such as wholesale energy (as unscheduled loads), contingency Frequency Control Ancillary Services (FCAS), and Reserve Emergency Reliability Trader (RERT). Commercial and industrial providers currently supply the majority of DER capacity to these markets, however, growing DER installations at the residential level are supporting greater household participation, particularly through batteries in virtual power plant (VPP) programs.

As more DER is installed and technical capability matures, the way these assets deliver services to markets may have to change, and the types of services they provide will be expanded. This includes greater visibility and dispatchability to the market operator, and ensuring new markets and mechanisms consider efficient DER participation where appropriate.

Challenges of integrating higher amounts of DER in market services includes:

- **Sub-Metering:** Many commercial and residential settings host both active DER that can reliably respond to market signals, as well as passive loads. This means that energy flows at the connection point are a combination of both active DER and passive loads, making it difficult to reliably deliver an accurate response at the connection point. Alternative options are being explored, such as the Flexible Trading Arrangements (FTA) rule change[6], that would allow active DER to be measured separately from uncontrollable loads, thereby allowing DER to participate in markets more easily.
- **Aggregation:** While there are ways to represent a group of sites in ancillary service markets such as contingency frequency services, it currently can't be done in scheduled energy markets such as the wholesale spot market or wholesale demand response mechanism. Additionally, as aggregations of market-participating DER gets larger, the market operator will need to better understand the distribution of that capacity across entire electricity regions.
- **Reliability of Meeting Performance Standards:** As DER provides increasing capacity that must be relied on in markets, it becomes increasingly important that DER can demonstrate ongoing compliance and the ability to meet performance standards.

### Knowledge Sharing from Previous Trials or Studies

The **ARENA-AEMO Reliability and Emergency Reserve Trader (RERT) Trials**[7] tested participation in the RERT demand response market from residential, commercial and industrial (C&I) consumers. The trial successfully demonstrated aggregated demand response can work for RERT but identified some barriers:

- Residential participation was skewed towards behavioural demand response program designs, as residential consumers demonstrated a preference for retaining complete control over their energy use and participation. In contrast, C&I consumers preferred automated load control due to ease of operation (where applicable).
- Market participants reported issues with some control technologies, leading to higher costs and poorer quality of control. Keys to resolving these barriers are increased standardisation and maturity of DER monitoring and control technology.

6 https://www.aemc.gov.au/rule-changes/flexible-trading-arrangements-consumer-energy-resources
7 https://arena.gov.au/knowledge-bank/demand-response-short-notice-trial-rert-trial-year-3-report/

- The baselines used to measure changes in demand were not suitable for sites with variable demand or generation, such as day-to-day operational variation, solar output or temperature sensitive loads[8].

One of the positive outcomes of the ARENA-AEMO RERT Trials was that some consumers, particularly in the C&I sector, have expanded their participation in demand response activities after the completion of the RERT trial. RERT is a relatively simple and potentially lucrative service that can provide an entry point for energy users to gain experience providing demand response, with the option to transition into more sophisticated services like spot exposure, FCAS, or the wholesale demand response mechanism over time.

The **AEMO VPP Demonstrations**[9] tested the ability for DER to provide a market service (contingency FCAS) through a trial specification, while responding to other energy market price signals. The trial found that small battery VPPs "have proven to be highly effective at providing contingency FCAS" under the trial specification but identified future issues or improvements that could be made as the size of DER portfolios increase, including:

- Developing processes and guidelines for firmware upgrades. Without robust testing, device performance degradation caused by software errors introduced during firmware upgrades can go unnoticed.
- Streamlining processes to register and update participant portfolios with AEMO, due to the dynamic nature of DER portfolios changing over time.
- Increasing AEMO's operational and planning visibility of price responsive DER in cost effective and standardised ways.

## Approaches from Current Market Integration Trials

**Project EDGE** is testing wholesale bidding models aligned with the Trader role considered under AEMO's Flexible Trading Arrangements (FTA) and Schedule Lite reforms, and a bidding format aligned to a scheduled BDU under the Integrating Energy Storage (IESS) rule change. This includes testing options in the trial such as:

- Allowing aggregators to bid load and generation in a single portfolio (or DUID) with up to 20 price bands, reflecting the IESS design.
- Testing three different types of dispatch methods that may inform Scheduled Lite models:
  1. **Visibility,** where an aggregator bids capacity at different price levels, and is sent a dispatch target, but is not required to respond to the target.
  2. **Self-Dispatch**, where an aggregator self-nominates a dispatch target and must meet that dispatch target regardless of price.
  3. **Scheduled**, where an aggregator bids capacity at different price levels, and is sent a dispatch target that it must meet.
- The trial is testing aggregated bids of capacity measured at either the connection point or at a measurement point behind the meter that represents all controllable DER at site, called 'flex'. The 'flex' option is similar to approaches being developed in the Flexible Trading Arrangements rule change.

**Project Symphony** is testing DER participating in three system-level market services:

1. **Energy Services – Bi-directional:** participation in the balancing market which determines economic (most economically efficient) dispatch of generation to meet system demand as managed by AEMO.
2. **Constrain to Zero:** the AEMO platform instructs the aggregator platform to constrain energy output from DER to zero export or zero output. This could be offered as a market or retailer service.
3. **Essential System Services (ESS) Contingency Raise:** DER responds to help restore a deviation in frequency to normal levels (due to loss of a large generator or load).

8 https://arena.gov.au/assets/2019/09/baselining-arena-aemo-demand-response-rert-trial.pdf
9 https://arena.gov.au/projects/aemo-virtual-power-plant-demonstrations/

**Project Converge and Project Edith,** being network run trials, have a lower focus on how market services are provided but do consider how other factors impact market service delivery such as local network pricing and dynamic operating envelopes (explored in later sections), while ensuring that their models are compatible with market reforms like IESS.

## Current Reforms

**Scheduled Lite**[10] forms part of the Energy Security Board's (ESB) DER Implementation Plan. It is a potential mechanism being developed by AEMO to integrate currently unscheduled loads and generators into the scheduling process. As the amount of price responsive loads and generators increase, so does the need for the market operator to gain knowledge of the intentions of these assets beforehand so they can securely and efficiently operate the system.

The scheduling and visibility mechanisms already in place are currently expensive and complex, such as setting up SCADA connections, and therefore only suitable for large generators or loads. Scheduled Lite aims to scale these processes down to be suitable and cost effective for DER to participate. Two Scheduled Lite models are being developed for participants to opt into: a visibility model to enable the provision of information relating to forecast behaviour and actual consumption and generation, and a dispatchability model to integrate price responsive load and generation into the NEM dispatch and scheduling processes. Project EDGE is informing the detailed design of Scheduled Lite by demonstrating the level of visibility required that balances efficiency with optimised value to enable AEMO to improve the accuracy of operational forecasts and its ability to efficiently manage the supply demand balance. Other initiatives, such as Project Symphony are also informing the Scheduled Lite design.[11]

**Flexible Trading Arrangements** is a reform proposed by AEMO forming part of the ESB's DER Implementation Plan. It aims to create a framework where controllable resources, such as household batteries or electric vehicles, can be metered through an additional electricity meter at the house, allowing controllable and uncontrollable resources to be metered separately. This can allow a consumer to choose one retailer for their general electricity usage and another to operate their controllable resources. Project EDGE is testing the Trader arrangement considered under the FTA model by allowing market bids to either be the entire site or only flexible loads.

AEMO have recently submitted a rule change for one of the FTA models[12] with the intention of a quick implementation, if possible, to align with the IESS implementation.

The **Integrating Energy Storage Systems**[13] (IESS) rule change was completed in 2021 to establish the Integrated Resource Provider (IRP) market participant and better integrate sites with bi-directional flows. Currently the NEM can only register a site as a generator or a load. This creates unnecessary barriers for bi-directional loads like batteries and creates market distortions such as exporting solar from a load connection point being exempt from charges that would be applied if it were instead exporting from a generation connection point.

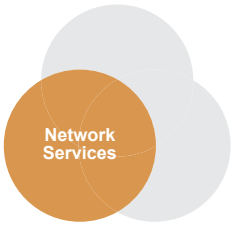
The IESS adapts the market to be more fit-for-purpose for bi-directional energy flows through changes to registration, bidding, and cost-recovery mechanisms. Project EDGE is testing how DER can participate through the new bidding structure, allowing bids to include both export and import offers with 20 price bands (10 export, 10 import).

10 https://aemo.com.au/initiatives/trials-and-initiatives/scheduled-lite
11 https://aemo.com.au/-/media/files/initiatives/scheduled-lite/appendix-1---related-projects.pdf?la=en
12 https://www.aemc.gov.au/rule-changes/flexible-trading-arrangements-consumer-energy-resources
13 https://www.aemc.gov.au/rule-changes/integrating-energy-storage-systems-nem

Western Australia's **Energy Transformation Strategy**[14] includes the Whole of System Plan[15] which considers investment and planning pathways to holistically consider all types of load and generation. The findings highlight the large extent to which rooftop PV will replace coal and large-scale solar generation over time, and that new Essential System Services (ESS) and capacity mechanisms will provide more diverse revenue streams to generation, including renewables and storage.

The transformation strategy also includes a Distributed Energy Resources Roadmap[16] which is a suite of reforms to better integrate DER into the WEM. This includes requirements for enabling DER to actively participate in the power system, contribute to enhancing system security and ensuring consumers are protected and provided with clear information. Many of the actions in the DER Roadmap are being executed or informed through the Project Symphony pilot.

## 2.2 NETWORK SERVICES




As the density of DER increases, so too does the potential effectiveness of using DER to defer or avoid spending to upgrade that part of the network. This can be achieved by DER generating or consuming energy in a specific location at specific times. This behaviour can be incentivised by directly procuring network services from DER (sometimes called 'non-network solutions'), using price signals such as critical peak pricing or dynamic network tariffs, or through mandated standards such as AS4777 volt-var and volt-watt settings.

Additionally, as distribution networks must gain a greater and more granular understanding of power flows on their network to create DOEs, this information is also useful for identifying constraints that may be cost-effective to solve with DER.

### Knowledge Sharing from Previous Trials or Studies

The **CONSORT Bruny Island Battery Trial**[17] tested novel approaches to households providing network support from their battery and PV system. The trial focused on orchestration algorithms for network support from household systems, pricing considerations, and household responses to the new technology.

During this trial, some key learnings were:

- The importance of good load forecasting. Poor load forecasts can lead to over or under dispatching DER when network support is needed.
- While the rewards structure methodology (finding the Shapely value[18]) creates fair and efficient procurement of network support, the complexity of calculating it made it unsuitable to generating spot prices or even close to real-time prices (e.g. day-ahead prices) without estimations.
- Consumers must be included in orchestration and algorithm design. How consumers' DER is operated must be made suitable for them, both in terms of information given and how these assets are operated.

**Networks Renewed**[19] was an early trial with New South Wales and Victorian distribution networks that tested how solar and batteries could support network voltage. This trial demonstrated that solar and batteries can provide viable non-network solutions when needing to manage voltage and investigated the network value of voltage support provided by consumers.

14 https://www.wa.gov.au/system/files/2021-07/Energy-Transformation-Strategy-Stage2-July2021.pdf
15 https://www.brighterenergyfuture.wa.gov.au/whole-of-system-plan/
16 https://www.brighterenergyfuture.wa.gov.au/distributed-energy-resources/
17 https://arena.gov.au/projects/consumer-energy-systems-providing-cost-effective-grid-support-consort/
18 https://en.wikipedia.org/wiki/Shapley_value
19 https://arena.gov.au/projects/networks-renewed/

As of December 2021, there are over 750 households with batteries from three aggregators participating in the **Ausgrid VPP Trial**[20]. Ausgrid can dispatch batteries in this fleet to provide network support, and then make payments to those consumers. During the first three years of the trial Ausgrid have demonstrated that with sufficient size, VPPs have the potential to address network constraints. Lessons learnt about the operation of the VPPs include that some batteries must charge before a network event and if that charging happens too close to an event it can contribute to peak demand. Another lesson is that "value stacking", in which DER participates in multiple markets, can impact the availability of VPPs during peak demand days as they may be committed to providing services in other markets.

## Approaches from Current Market Integration Trials

The current DER market integration trials follow the same philosophy in how they envision future network services: that low-cost digital systems can identify the need for network support, communicate that need through incentives and agreements, and then validate the delivery of the service. This allows networks to consider non-network solutions for a larger amount of constraints on their network (such as smaller constraints which would have previously not been cost effective to pursue non-network solutions), while removing barriers to aggregators participating in these services. This can potentially reduce the total costs to consumers for using the network and increasing the reward for consumers who elect to use their DER flexibly.

**Project EDGE** is testing a network support market called the local services exchange (LSE). Through the LSE, networks would publish network service requirements, select aggregators, and dispatch the procured local service. A digital marketplace allows services to be procured more flexibly, transparently and competitively than current processes.

In Project EDGE, the LSE will be used to procure two local services: demand increase/reduction, and voltage management. For these services there are three level of firmness: high, medium, and low. High firmness services can be used for network planning and CAPEX deferral, whereas low firmness can be used more opportunistically, such as a spontaneous market event that may create the short-term need for a local service.

**Project Symphony** is testing network support services (NSS) by requiring the distributed system operator (DSO), in this case Western Power, to forecast network capacity shortfalls or degraded power quality that could be resolved through NSS. The DSO then enters into bilateral contracts with aggregators for that service. When the service is required, the DSO instructs AEMO to send that request for service as part of the market dispatch process. Project Symphony will also assess the costs and benefits of NSS on their network.

**Project Converge** is exploring a 'real-time RIT-D' process that may more cost-effectively procure non-network solutions for smaller constraints than current processes. The current regulatory investment test for distribution networks (RIT-D)[21] is a process where networks are required to consider non-network solutions where there are augmentations or network constraints that would cost more than $6 million to resolve. The current process can be costly and slow, leading to limited interest from asset owners, as well as the inability to apply the current process to smaller and more transient constraints. Project Converge is testing a new platform which may result in more cost-effective non-network capacity procurement, by improving processes such as:

- Identifying and communicating constrained parts of the network, and opportunities for DER to provide NSS within a reduced timeframe.
- Streamlining commercial engagement processes such as establishing commercial, technical, and operational arrangements from traders on a fixed basis, as opposed to having to engage with traders on a case-by-case basis per project.
- Improving operations of constraint management mechanisms with more automation and greater use of industry-standard protocols.

20 https://www.ausgrid.com.au/Industry/Demand-Management/Power2U-Progam/Battery-VPP-Trial
21 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/rit-t-and-rit-d-application-guidelines-2018

**Project Edith** has an alternative approach to the other trials by testing the effectiveness of new, sophisticated price signals in managing network hosting capacity. These price signals, called dynamic network prices (DNPs), are cost-reflective network charges that reflect the level of congestion at different locations in the network. For example, on a sunny, mild day the network costs for importing energy in the middle of the day is likely to be very cheap, or even negative. On a cloudy, hot day though, the price for importing is likely to be more expensive as there's less locally generated energy and more locally consumed energy due to increased air conditioning usage. Traders and retailers with price-responsive DER could elect to be exposed to these DNPs instead of typical network charges, giving consumers the opportunity to be further rewarded for their flexibility and making better use of our electricity infrastructure.

Pricing that reflects real-time power flows and local network constraints are in some ways simpler to implement than procured NSS. Another advantage is that DNPs can shift load and generation curves to increase utilisation of the network before constraints bind, as opposed to procured NSS which are only utilised after a constraint is forecast. A downside of using DNPs to manage network capacity is the low firmness and visibility of response from traders or aggregators, therefore procured NSS where traders or aggregators have contractual obligations may be necessary for scenarios where a high level of firmness and reliability of response is required.

## Current Reforms

The *Access, pricing and incentive arrangements for DER*[22] rule change from 2021 set new rules and obligations for DNSPs to support DER on their networks, including:

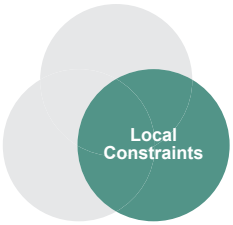
- Clarifying that export service hosting is a core service to be provided by the distribution network. This means that networks must offer export hosting capacity to consumers, and the planning and provisioning of export services should be included in regulatory proposals.
- Enabling networks to offer a range of options to consumers in the amount of capacity they can access to export excess electricity to the network. This includes trade-offs between reliability of that access and cost.
- Strengthening consumer protections with the AER having oversight of how export services are implemented by DNSPs.
- An increase in the amount of cumulative revenue that a network can earn from tariff trials from 1% of revenue to 5%. This allows networks to test a wider range of tariffs with a larger group of consumers.

Over the past few years, the AER has published many studies and guidance notes on how networks can better integrate and support DER. Studies such as the *Customer export curtailment value methodology (CECV)*[23] *and Value of distributed energy resources (VaDER)*[24] provide methodologies for determining the economic cost of export curtailment and value of DER, respectively. Guidance notes such as the *DER integration expenditure guidance note*[25] outlines the AER's expectations for how DNSPs should develop business cases and quantify value when making network investments to increase the hosting capacity for better DER integration.

Several DNSPs are approaching their regulatory reset where the AER will determine network expenditure for the next five-year period. This process will set precedents for how networks will approach DER integration for the remainder of the decade and supporting evidence is being collected through a variety of means such as tariff trials, DER trials, studies and consumer research.

22 https://www.aemc.gov.au/rule-changes/access-pricing-and-incentive-arrangements-distributed-energy-resources
23 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/customer-export-curtailment-value-methodology/final-decision
24 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/assessing-distributed-energy-resources-integration-expenditure-guidance-note/update
25 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/assessing-distributed-energy-resources-integration-expenditure-guidance-note/final-decision

## 2.3 LOCAL CONSTRAINTS




Increased uptake of DER results in changing patterns of usage on the local distribution network, which can be highly variable across the network. These patterns will continue to change over time as more DER is installed. Networks are currently addressing these changing usage patterns with tools such as building more network, non-network solutions (or NSS), and inverter performance standards (e.g. AS4777). In the longer term, tariff reforms can also support more efficient use of the networks.

A new tool being developed is dynamic operating envelopes (DOEs). DOEs are the upper and lower limits on the import or export of power in a given time interval for each – or all – of the DER assets at a site and can change depending on network power flows. For example, during times of normal operation of the network or high demand, export limits can be increased to reflect the excess of local capacity that can support additional generation. Conversely, export limits may decrease during times of high generation to share scarce export capacity to consumers in that part of the network. DOEs have the advantage in some situations of being more cost effective, equitable, and benefit-increasing compared to other tools networks use to manage local capacity.

The application of DOEs to export limits, also called flexible export limits, is currently being rolled out in jurisdictions with very high levels of rooftop solar uptake (Western Australia, South Australia, Queensland). It is increasingly important to create some form of export control as more rooftop solar and DER is installed on the system. AEMO has identified that the NEM will not be able to be maintained in a secure state under certain conditions by 2026, and that managing solar exports will become a critical feature of system security[26]. Future DOEs will need to manage both local and system security.

This approach to managing constraints is related to DER market participation, as the amount of network capacity each consumer has, and how that capacity is allocated, impacts how they can participate in markets. Additionally, the ability to communicate limits to retailers or aggregators provides more certainty about how much consumers could export or import when providing market services.

Some of the current challenges in managing local constraints through DOEs are:

- The need to develop national consistency in approach or settings where appropriate.
- Determining the correct objective function (such as maximising solar exports or equally allocating capacity) for different types of networks and DER penetration.
- Ensuring proper registration, installation, and maintenance of assets.
- Providing clear information to consumers on connection offers, as well as information on who to contact if something goes wrong.
- How to apply DOEs to energy imports.

### Knowledge Sharing from Previous Trials or Studies

The **Evolve Project**[27] developed early models and options for managing local constraints through DOEs and outlined benefits of the approach. Software and protocols to calculate and send export limits were developed, and field trials with various New South Wales and Queensland networks deployed.

26 https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2022-integrated-system-plan-isp
27 https://arena.gov.au/projects/evolve-der-project/

The *DEIP DOE Workstream Outcomes Report*[28] "focuses on the use of DOEs for export management and seeks to identify the current 'state of play' of DOEs and capture the future policy, regulatory, technical and industry actions needed to implement a nationally consistent model that will work in consumers' interests." The report list twenty-seven recommendations in three areas:

1. Supporting the roll-out of DOEs. This includes the balance between supporting innovation and flexibility in implementation, and the need for standardisation and linkages to international processes.
2. Supporting consumers in their choices. Giving consumers options or alternatives to DOEs, ensuring they're well informed and protected, and designing mechanisms to encourage the uptake of DER and the efficiency of network investments.
3. Nationally consistent approaches to implementation. Aligning networks and market bodies to support the consistent implementation of DOEs throughout the NEM to reduce costs and simplify participation.

The **SA Power Networks and Ausnet Flexible Exports for Solar PV Trial**[29] is an in-field trial where consumers in constrained parts of the network are offered 'flexible exports'. Flexible exports are dynamic export limits that are often much higher than their typical static export limit. Hundreds of consumers and tens of installers have participated to date, giving real world learnings of what a broad rollout of flexible export limits could look like.

In this trial the networks are using CSIP-AUS[30] as the protocol to communicate flexible export limits. Technology providers Fronius, SMA, and SolarEdge (inverters) and SwitchDin (gateway) are integrating against this CSIP-AUS signal to receive export limits and operate onsite generating equipment to remain below that limit.

Some of the current learnings to date are:

- The solar industry has many touch points with consumers and solar retailers or installers are well placed to provide information about the program to consumers. However, solar retailers must be well trained in providing information on flexible export programs and solar installers trained in installing and commissioning hardware under these arrangements.
- There is currently a lack of compatible technology that is flexible exports capable. This can increase the costs of participation (due to having to install a gateway or a more expensive compatible inverter) or cause a consumer to be ineligible for the program (AusNet identified that 90% of their existing consumers with solar in constrained network areas would be ineligible for the program due to their inverter).
- Consumers tend to have a good understanding of the offer and are overall satisfied with the installation and program. SA Power Networks (SAPN) and collaboration partners focused on developing clear and simple communications explaining the offer and analysing results to quantify the benefits achieved by consumers, such as increasing the amount of solar they were able to export.

## Approaches from Current Market Integration Trials

All four of the trials are using DOEs to manage local network constraints. **Project Symphony, Project Edith** and **Project Converge** are using the Evolve platform to calculate and communicate envelopes to traders using CSIP-AUS or an extension of it. Project EDGE's data exchange is used to transmit DOE information between the DSO and trader and can use flexible message formats, therefore being able to support CSIP-AUS.

A main area of examination for the trials is different allocation methods for the DOEs. DOEs inherently have a trade-off in that simpler, uniform envelopes applied to all consumers are in many respects fairer (for DER owners) and lower cost to implement, whereas envelopes based on inverter size, forecasted exports, or cost of energy are more efficient from an overall outcome (such as maximising the amount of solar exported).

28 https://arena.gov.au/knowledge-bank/deip-dynamic-operating-envelopes-workstream-outcomes-report/
29 https://arena.gov.au/projects/sa-power-networks-flexible-exports-for-solar-pv-trial
30 https://arena.gov.au/knowledge-bank/common-smart-inverter-profile-australia/

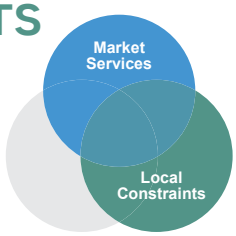
**Project Edith** is using a form of DOE allocation with the trader selecting a 'subscription level' for the minimum capacity a consumer needs, whereas Project Converge is at the other end of the spectrum using shaped operating envelopes (SOEs), which is explained further in the Market Services/Local Constraints section. Project EDGE and Project Symphony are researching a range of sophisticated allocation methodologies.

### Current Reforms

**Dynamic export management programs** are being developed in South Australia[31], Queensland[32], and Western Australia[33]. The need for rolling out these programs in these states is primarily to manage system level issues such as minimum system load where solar may need to be curtailed to maintain system security. The tools and methods used to achieve these system level objectives also support sending information on local network capacity, allowing consumers to have a greater level of average export to the grid compared to current static export limits.

**The Energy Security Board** is developing advice on a DER interoperability policy for focusing initially on CSIP-AUS for the flexible exports limits use-case[34]. This policy will include a framework for assessing if, how and when standards should be applied, and applying it to consider implementing CSIP-AUS as a standard. Standardising the use of this or another communications protocols means that traders and devices can easily send and receive information from the DSO regardless of which network area or Australian state they're in. The continued development of CSIP-AUS and other DER interoperability objectives is overseen by the DEIP's Interoperability Steering Committee (ISC)[35].

## 2.4 MARKET SERVICES + LOCAL CONSTRAINTS




One interesting interaction between the different functions is using DER in markets while adhering to local network constraints. How local network capacity is allocated, and pricing models to access greater capacity, impacts how capacity will be bid into system level markets. For example, if a site is given a flexible export limit of 5 kW, it can only be dispatched for up to 5 kW of export capacity into market services. Therefore, how local capacity is allocated may affect the level of market services offered from those DER.

In these interactions, there are four actors involved:

1. The **distribution system operator (DSO)**, who monitors network capacity and calculates envelopes.
2. The **market operator**, who accepts bids from generators and loads, and dispatches the system in an economically efficient manner.
3. The **trader**, who bids DER services into markets and operates within the local network constraints.
4. The **consumer**, who owns the DER and elects a trader to bid and operate their assets.

These actors, with different functions and objectives, create many models and complexities for how DER services participates in markets while adhering to local network constraints.

The simplest model is for the DSO to create DOEs for each site, send them to the trader or the trader's technology provider, and then the trader bids their portfolio into the market, ensuring the capacity offered can be delivered while not breaching the DOEs at any sites.

31 https://www.energymining.sa.gov.au/industry/modern-energy/solar-batteries-and-smarter-homes/regulatory-changes-for-smarter-homes/Technical-Regulator-Guidelines-Distributed-Energy-Resources.pdf
32 https://www.talkingenergy.com.au/dynamicconnections
33 https://www.wa.gov.au/organisation/energy-policy-wa/emergency-solar-management
34 https://www.energy.gov.au/government-priorities/energy-ministers/priorities/national-electricity-market-reforms/post-2025-market-design/der-implementation-plan-interoperability-policy-framework
35 https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/interoperability-steering-committee/


Figure 2. Simplified model of providing market services while adhering to constraints.

There are other options that can expand this model that, while often add complexity, may lead to better operational outcomes for AEMO, traders and consumers, such as:

- Sending the DOEs from the DSO to the market operator in addition to the trader. This enables the market operator to better understand constraints and network capacity within a trader's portfolio.
- Optimising envelopes based on bids. This is similar to how transmission-connected generation is allocated capacity and dispatched, in that where there is a constraint the capacity is allocated to the lower priced bids.
- Trading of spare capacity from one site to another. This will depend on local constraint mapping to ensure local limits are not breached.

## Knowledge Sharing from Previous Trials or Studies

The **Advanced VPP Grid Integration**[36] is a collaboration between SAPN and Tesla to demonstrate how a VPP can operate in energy markets while adhering to local, dynamic export limits. The trial used the 'simple' model where SAPN would send site-level export limits to Tesla via an application programming interface (API) and Tesla would ensure all bids into the market (made by Energy Locals as the registered market participant), and how the VPP operates, would adhere to these limits. The trial demonstrated that:

- The total export capacity of the VPP could be increased from 5 MW to 6-8 MW during solar hours, thereby increasing the amount of network capacity available to system-level markets.
- SAPN were successfully able to override forecasted export limits for planned maintenance or unplanned outages.
- SAPN and Tesla developed an API (based on IEEE 2030.5) to transmit data over the internet, such as registration, operational data, and the dynamic export limits.

## Approaches from Market Integration Trials

**Project Symphony** uses the simple model from Figure 4, where the DSO (Western Power) calculates and sends site-level limits to the trader, who then ensures bids made to the market operator conform to those limits.

**Project Converge** uses shaped operating envelopes (SOEs). SOEs are DOEs with an allocation methodology similar to how capacity is allocated on the transmission network. Under this model:

1. The trader submits its unconstrained market bids to the DSO.
2. Where there is a constraint, the DSO preferentially allocates capacity to sites that have a lower cost bid to export energy (or higher cost in the case of importing) via SOEs, to increase the amount of low-cost energy in the market.
3. The trader then submits the same bids to the market operator but adjusts the capacity to only represent network capacity they've been allocated through the SOEs.
4. The market operator sends dispatch instructions to the trader that will conform with the SOEs.

36 https://arena.gov.au/projects/advanced-vpp-grid-integration/


Figure 3. Market bids first sent to the DSO to create shaped operating envelopes.

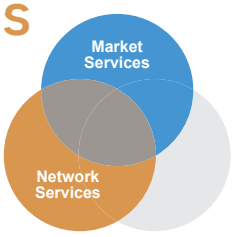
This model can also be simplified for the trader, by the trader submitting bids to the market operator, then the market operator and DSO coordinating to allocate local capacity and determine dispatch instructions.

This method allocates capacity to the cheapest sources of generation which can reduce overall energy costs to the system, particularly when this capacity is bidding and scheduled. A trade-off to this method is the perception of fairness, as some households will receive greater export limits than others depending on how their aggregators bid. Another complexity is managing disorderly bidding[37], a behaviour common at the transmission level where generators bid below their marginal energy cost to be allocated greater local capacity on a constrained part of the network. SOEs may be suitable for a subset of consumers that are involved in dynamic market-facing VPP programs, and fairness issues can be resolved by traders distributing the benefits equally across consumers.

**Project Edith** uses the 'simple' model for communicating prices, constraints and bids between the DSO, trader and market operator. This involves the DSO, in this case Ausgrid, sending the trader DOEs and DNPs for each site, and the trader, in this case Reposit, only bidding capacity that will conform to the limits of the DOEs. A key part of Project Edith is to trial the interaction between DOEs and DNPs, with a focus on using pricing to incentivise efficient use of the network.


Figure 4. Dynamic operating envelopes and prices sent to the trader before market bidding and dispatch.

## 2.5 MARKET SERVICES + NETWORK SERVICES




Due to market services and network services being procured by separate actors (the market operator and DSO respectively), there is complexity to manage when offering DER capacity into both markets.

For example, consider a scenario in which a battery that can discharge for two hours at full output is enrolled in both a network support program and the Reliability and Emergency Reserve Trader (RERT) market service. On a hot summer day, the DSO would like the battery to provide network support by discharging at full output at midday for two hours, and the market operator would like the battery to provide RERT by discharging at full output at 2pm for two hours. In this scenario it's impossible for the battery to fulfil both requests as it cannot contain enough energy to discharge for the full four hours.

A simple way to resolve some of these issues is to maintain time separation between when the different services are procured. For example, in this scenario, if network support can be requested by the DSO 12-24 hours before the event, that provides time for both the trader and market operator to adapt to that capacity no longer being available for other services. Another way to resolve this would be to dispatch both market service and network services through the same entity which can coordinate capacity in both markets. Lastly, it's important that traders only allocate capacity to one

37 https://www.aemc.gov.au/sites/default/files/2019-03/Fact%20Sheet%20disorderly%20bidding.pdf

service that requires that capacity to be firmly delivered when requested, or if participating in multiple services have a plan to resolve capacity conflicts that all parties agree to. One way of resolving these capacity conflicts is during the development of roles and responsibilities, where it can be agreed on which services would take a priority over others.

### Knowledge Sharing from Previous Trials or Studies

**Ausgrid's VPP trial** experienced this conflict in priority of delivering services when the VPP was scheduled to dispatch network support between 17:00-21:00, yet the VPP had conflicting RERT obligations which meant the network support dispatch start time had to be adjusted to 16:30.

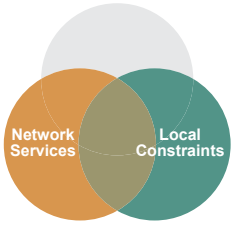
### Approaches from Market Integration Trials

**Project EDGE** coordinates the delivery of market and network services by electing the aggregator to manage bids into wholesale markets and deliver network services. Aggregators must "consider and incorporate any capacity commitments to a DNSP for local network support services. In this way, the bids and offers provide a mechanism to mitigate the risk of double dispatch or conflicting dispatch signals between wholesale and local services."

**Project Symphony** dispatches network support through market operator, providing the market operator with full visibility of the services that traders will be delivering and can better coordinate dispatch of market and local services.

**Project Edith** signals the value of network support through (negative and positive) two-way pricing and allows the Trader to optimise their value stack without committing to the provision of network services. Where a hard network constraint is likely to be breached, DOEs are used as guardrails.

## 2.6 NETWORK SERVICES + LOCAL CONSTRAINTS




When local constraints are forecast, a decision is required between increasing the hosting capacity on that part of the network (through network upgrades or non-network solutions) or constraining capacity at sites. Site capacity is currently constrained via AS4777 power quality settings, where solar inverters will reduce real power output during times of high voltage through their volt-var and volt-watt responses. The introduction of DOEs creates another tool to avoid network expenditure by limiting output, and therefore processes will need to be introduced to determine when these tools should be used.

To determine how DSOs should make these trade-offs, policy makers need to provide clear guidance on how networks should evaluate and resolve constraints in their planning and operational processes. Many of the reforms related to network services and local constraints are developing the principles, methodologies, and guidance on how these different network management tools should be applied. *Access, pricing and incentive arrangements for DER*[38] outlines the principles and directions for adapting network infrastructure and offerings for DER, and AER guidelines such as the *Customer export curtailment value methodology (CECV)*[39], *Value of distributed energy resources (VaDER)*[40] *and DER integration expenditure guidance note*[41] provide information and expectation from the regulator on how they expect networks to manage expenditure and service offerings to consumers wishing to export energy.

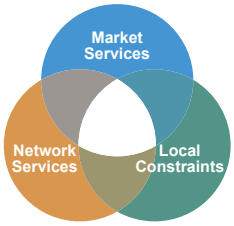
38 https://www.aemc.gov.au/rule-changes/access-pricing-and-incentive-arrangements-distributed-energy-resources
39 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/customer-export-curtailment-value-methodology/final-decision
40 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/assessing-distributed-energy-resources-integration-expenditure-guidance-note/update
41 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/assessing-distributed-energy-resources-integration-expenditure-guidance-note/final-decision

It is also important that processes are developed that provide transparency to traders and consumers on the level of access they can expect, and do, receive from the network to develop trust in the system, avoid confusion and ensure fairness.

**Project EDGE, Project Symphony** and **Project Converge** are all developing systems to identify local network constraints and procure network services to resolve these constraints. Those systems will need to operate in ways that reflect the valuation and processes outlined in rules and guidance notes.

In **Project Edith** the DSO is the administrator of the dynamic price to use the network and further work will be required to ensure appropriate oversight from the AER as this develops.

## 2.7 MARKET SERVICES + NETWORK SERVICES + LOCAL CONSTRAINTS




Putting all four core functions together creates a complex mix of actors and functions involved in the operation of DER. One of the main focuses is how the different actors receive access to, and transmit, information.

There are different categories of information such as:

- DER and site registration. This includes installing new DER, joining a flexible exports plan, or joining a trader's portfolio.
- Real-time operational data. This includes both what individual sites and aggregate DER is doing. This data has many uses from system operation to compliance and monitoring.
- Local network capacities and constraints. This includes both network limits sent to individual sites, as well as higher level visibility such as at substation level.
- Demand and price forecasts for planning and market purposes.
- Bids, dispatches and obligations across multiple system services and local services.

Depending on the model, various pieces of information may be required to go to multiple parties or need to be coordinated with other information. Coupled with this is the need to manage information flows across millions of devices, hundreds of traders, and 12 separate distribution networks in the NEM. Not only does this create complex requirements for market and network IT infrastructure that hasn't been seen before, having more devices and actors in the system poses the risk of additional cybersecurity threats that will need to be mitigated. While greater connectivity can create significant value for consumers, it also creates new attack vectors with increased magnitudes of impact to consumers and the power systems in the event of cyber breaches.

### Knowledge Sharing from Previous Trials or Studies

**Open Energy Networks (OpEN)**[42] was a project lead by Energy Networks Australia (ENA) and AEMO to explore models that can better integrate distribution level assets and actors in the distribution system. Four architectural models were developed with different roles for actors in the energy system:

1. **Single Integrated Platform (SIP)** is where AEMO runs a centralised market platform, co-optimising system services, network support, and local constraints.
2. **Two Step Tiered (TST)** features a central market platform run by the market operator, and local market platforms run by DSOs where local services can be procured to solve distribution network constraints.

42 https://www.energynetworks.com.au/projects/open-energy-networks/

3. **Independent Distribution System Operator (IDSO)** is a centralised market platform run by the market operator, and local market platforms operated by independent system operators. DNSPs continue to build, maintain, and operate physical infrastructure, whereas the IDSO procures services from DER to manage local network capacity.
4. **Hybrid** is a middle ground between SIP and TST where AEMO and DSOs work jointly on operating local and system level mechanisms for coordinating DER.

All four market integration trials are testing variants of a Hybrid model.

## Approaches from Market Integration Trials

A key aspect **Project EDGE** is testing is how all the different parties can transfer data between each other. A hypothesis of Project EDGE is that a data hub, where all parties can connect once to exchange data with all different parties, is more efficient and preferrable to alternative architectures such as point-to-point with standards (e.g. a trader connecting to each DNSP through a common protocol such as CSIP-AUS is an example of point-to-point with standards).

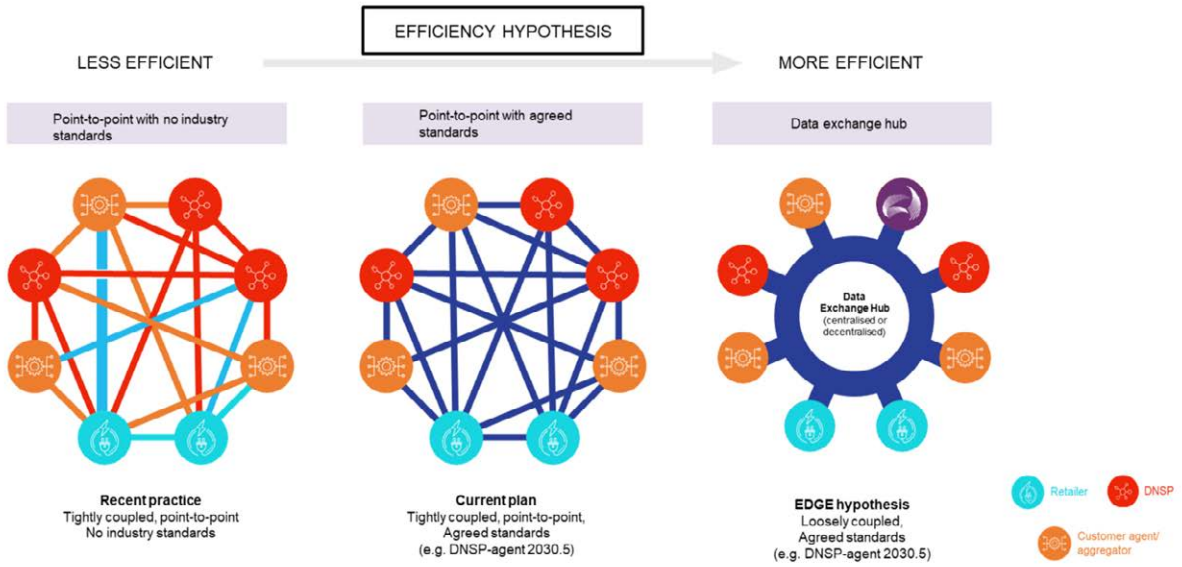



Figure 5. Different information architectures. Source: EDGE Public Interim Report (June 2022)[43]

Project EDGE is testing both a centralised data hub and a decentralised data hub. The centralised data hub is similar to AEMO's existing e-Hub where all messages and information is sent to a centralised platform that then forwards the information to the intended recipients. A decentralised data hub allows for many parties to host the hub as a 'node', in which parties can send a message to a node in the system, and that message is forwarded to the intended recipients.

**Project Symphony** is creating three, interconnected platforms to manage different functions of DER participation:

1. **DSO Platform (Western Power).** Responsible for identifying maximum renewable energy hosting capacity, forecasting consumer generation and load, and using this information to create DOEs that equitably allocate network capacity to consumers. Western Power intends to leverage and extend the Evolve solution used in previous NEM trials to construct and communicate DOEs.
2. **DER Integration Platform (AEMO).** Responsible for receiving bids from aggregated DER via the aggregator and dispatching them in wholesale electricity and network support markets (as requested by the DSO), while ensuring dispatches conform to the constraints of the network.
3. **Aggregator Platform (Synergy).** Responsible for onboarding DER, managing and dispatching flexibility, and post-event analysis.

43 https://arena.gov.au/knowledge-bank/project-edge-interim-public-project-report/

These interconnected systems must be tightly integrated as considerable data is passed between them.

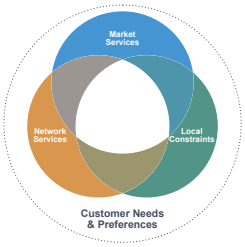
**Project Edith** aims to leverage existing systems and processes to reduce the cost and complexity of DER integration. The trial uses a point-to-point architecture with standards, where the DNSP communicates with the trader through a standardised interface (e.g. CSIP-AUS), and the trader operates in the market as they currently do through MarketNet and the Market Management System (MMS). This reduces short term costs and allows for an iterative implementation approach, limiting complex interactions where simpler solutions prove sufficient.

### Current Reforms

**The Energy Security Board** is currently developing advice on an interoperability policy for Consumer Energy Resources[44]. This work is currently considering mechanisms to implement CSIP-AUS as a standard. CSIP-AUS is a communications protocol used support interoperability and data sharing between parties, for example transmitting DOEs between the DSO and trader or site. Standardising the use of CSIP-AUS and/or communications protocol would allow traders and devices to easily send and receive information from the DSO regardless of which network area or state they're in. This is the first step in standardising how information can be sent between different DER actors. The continued development of CSIP-AUS and other DER interoperability objectives is overseen by DEIP's Interoperability Steering Committee (ISC)[45].

Western Australia's **Distributed Energy Resources Roadmap**[46] has many actions around interoperability, communications, and data in respect to DER assets. This includes similar areas to the NEM such as improved inverter standards and communication protocols, better standing data of DER capability, and protocols to communicate constraints from the DSO.

## 2.8 CONSUMER NEEDS & PREFERENCES




While considerable DER uptake is forecast for the coming decades, and industry is building the necessary systems to integrate millions of connected assets, the question remains if and how consumers will participate in these programs. As the owners and decision makers on how DER is used, consumers will ultimately decide the extent of participation in future products, programs and markets. It is therefore imperative that consumer value, whether it is financial, social and environmental, is identified, unlocked and packaged into compelling offers that consumers can understand and evaluate.

There is considerable work for industry to rebuild trust and sentiment with consumers, particularly as the emerging models are complex and difficult to explain. For example, recent VPP trials have experienced a low participation from households with batteries and other controllable DER, which can be attributed to difficulty in clearly communicating the value proposition to consumers. While slow consumer engagement is a challenge for trial rollouts, there are important learnings in identifying gaps and deficiencies in consumer offerings that can be improved overtime. Further, having real-world insights of consumer experiences can inform larger system design, as ultimately traders will not only have to manage complex price signals, markets and obligations, but also translate that complexity into compelling and simple products and services for the consumer.

44 https://www.energy.gov.au/government-priorities/energy-ministers/priorities/national-electricity-market-reforms/post-2025-market-design/der-implementation-plan-interoperability-policy-framework
45 https://arena.gov.au/knowledge-innovation/distributed-energy-integration-program/interoperability-steering-committee/
46 https://www.brighterenergyfuture.wa.gov.au/distributed-energy-resources/

## Knowledge Sharing from Previous Trials or Studies

The **CONSORT Trial** included a social science aspect where researchers were able to gain an in depth understanding of 34 households over the course of the trial[47]. Speaking with consumers throughout the trial enabled the social science team to identify gaps in the technology or project early and help resolve issues that consumers may have faced.

The CONSORT social science research identified that households are diverse, and that understanding the context in which households make decision about energy is crucial to understanding their receptiveness to more complex or engaged DER products and services.
Other findings from the social science research were:

- DER at a consumer's house isn't a single system, it is a mixture of technology throughout a consumer's home which can create confusion about how the system works or who to contact if it goes wrong (if clear and correct information isn't given to the consumer upfront).
- Moving consumers onto time-of-use tariffs and providing information on their energy use through an app changed the timing of when participants used energy in a persistent way.
- Non-financial motivators are also important to many households, such as battery backup, community, and environmental values.

The **AEMO VPP demonstrations** had a social science stream that investigated consumers' experience within the trial and how they feel about allowing VPP operators utilise their assets[48].
Top level findings from this stream were:

- Consumers reported a positive experience of early VPPs in Australia, primarily being driven by cost savings, community, and environmental values.
- Most consumers were technologically savvy "early adopters". VPP recruitment initiatives will have to consider how to effectively reach a more diverse set of consumers as DER adoption increases.
- Consumers suggested ways that the VPP programs could be improved, such as providing clearer communications and education on how the technology works.
- This group of consumers generally considered the benefits of VPP participation were enough to allow a third party to externally manage their assets.

## Approaches from Market Integration Trials

**Project EDGE** has five planned stages of social science research to be conducted with current or potential trial participants. The first that has been released is an interim *Customer Insight and Engagement Study*[49] where sixteen in-depth interviews were conducted with consumers who had experience with VPP trials such as Project EDGE. In these interviews motivators and barriers for joining VPPs were examined and their perception of VPPs more broadly. Analysis of these interviews revealed three key themes:

1. Consumers interviewed were primarily motivated by non-financial benefits such as community and environmental values and increasing energy self-sufficiency. This differs from some other interviews in projects where consumers also highly value financial drivers such as cost savings and bill reductions, indicating the varied types of consumers in different trials. Upfront battery costs were seen as a significant barrier.
2. Consumers viewed the battery as primarily an energy asset to fulfil their own energy needs first, and excess (if any) could be used for energy trading.
3. The aggregator in the trial was viewed as more of a hardware supplier than energy aggregator, and consumers had concerns whether a commercial company could be trusted to use the battery in ways that benefitted the consumer and broader community.

47 https://arena.gov.au/assets/2019/06/consort-social-science.pdf
48 https://aemo.com.au/-/media/files/initiatives/der/2021/csba-consumer-insight-final-report.pdf
49 https://aemo.com.au/-/media/files/initiatives/der/2022/public-customer-insights-and-engagement-study-interim-report.pdf

Further studies will expand on these initial insights by gaining more information from larger groups and undertaking further analysis in later stages to better understand consumer concerns and test solutions to different aspects of the consumer experience.

**Project Symphony** is carrying out social science research through the retailer Synergy and an additional social science study conducted through the University of Tasmania (due to be submitted in 2023). Project Symphony has released a Public Aggregator Report[50] which summaries insights from research into consumer sentiment towards DER and third-party aggregators.

Synergy is the only retailer to small customers in the WEM. This means that commercial aggregators only have a role with contestable customers in the system. Due to this, and the commercial nature of these entities (Synergy is a state owned) consumers voiced concerns around profit motive, reliability, and degree of regulation. This creates hurdles for third-party aggregator models to gain a foothold in the WEM, as opposed to the NEM where vertical disaggregation, retail competition, and metering competition has created a norm of for-profit retail companies offering a range of products and services.

Consumers surveyed in Project Symphony also expressed a general lack of understanding of the concepts and benefits of DER, and had concerns about control, costs and risk. While WA has had a large uptake of rooftop solar, VPP programs are much rarer than in the NEM, which suggests more advanced DER products are still at an early stage in Western Australian consumer mindsets.

Similar to the earlier CONSORT trial[51], **Project Converge** has a large focus on social science research. This research focuses on revealing gaps in the sector's current understanding of what consumers want, and the capacity to meet them, in order to explore different ways that Project Converge could be deployed in real-world settings. Three areas of interest are:

1. How do trusted intermediaries, such as experts and commentators, view this kind of technology and its potential impact? This is important to understand as consumers often consider these sources more trusted and accessible, relative to other sources of information.
2. The role and capacity of aggregators to mediate the relationship between the energy market and households.
3. How do households view traders or market aggregators, and the concept of households participating in the energy market?

## Related Reforms

The **ESB's Customer Insights Collaboration** (CIC) is a work stream that synthesises stakeholder perspectives and research to identify consumer issues that need to be addressed to achieve reform outcomes. Each six months a priority issue is explored, with workshops and rotating industry steering groups providing an evidence base for reform actions in industry. The CIC benefits from insights and research from trials, and trials can take learnings and outputs from the CIC to better design and inform their trial.

The **ESB's Data Strategy**[52] considers how to adapt policies, regulations and systems related to the changing ways data can be collected and used in the energy system. Current priority projects are improving network visibility for market planning, the visibility of electric vehicle charging behaviour for planning and management purposes and improving bill transparency. In 2023 work with begin on the New Energy Data Framework which will design a fit-for-purpose, flexible regulatory framework to support the management of emerging data needs and capabilities during the transition.

50 https://arena.gov.au/knowledge-bank/project-symphony-aggregator-report/
51 https://arena.gov.au/assets/2019/06/consort-social-science.pdf
52 https://esb-post2025-market-design.aemc.gov.au/data-strategy

The **AER's Retailer Authorisation Review**[53] examines whether consumer protections and the National Energy Customer Framework (NECF) are suitable for new energy products and services that emerge during the energy transition. Many current consumer protections cover the essential supply of electricity, but it's imperative that protections are fit for purpose as the Australian energy system evolves and consumers have access to a range of essential and discretionary electricity uses. Recommendations from the AER's review are planned to be published at the end of 2022 and may cover aspects of the innovative offerings aggregators are developing as part of these market integration trials.

In Western Australia, Energy Policy WA has conducted a **Retail Electricity Licensing and Exemptions Review**[54] to ensure that customer protections are adequate for the new and emerging energy products and offers. The final report, Tailoring customer protections for alternative electricity services – a registration framework[55], recommended creating a flexible registration framework for alternative electricity services (AES) to small customers, with "behind-the-meter electricity generation and storage services" being the first prescribed AES.

53 https://www.aer.gov.au/retail-markets/guidelines-reviews/retailer-authorisation-and-exemption-review
54 https://www.wa.gov.au/organisation/energy-policy-wa/review-of-licensing-and-exemption-regulatory-framework
55 https://www.wa.gov.au/system/files/2020-11/Tailoring%20customer%20protections%20for%20alternative%20electricity%20services%20-%20a%20registration%20framework_%20recommendation%20report.pdf

# 3. RECOMMENDATIONS

In the past, DER trials explored the fundamental aspects of DER functionality: Can they provide network support? Can they dispatch into energy markets? Can they adhere to dynamic local constraints? These trials could be run independent of each other and deliver early insights into the capabilities that DER can provide. Increasingly, trials have been focusing on more mature stages of technology development such as end-to-end demonstrations and testing systems that could be deployed in industry. Based on research and stakeholder interviews, this report recommends that mature DER integration trials should have:

1. **Stronger connection between industry needs and trial learnings.**

   Many functions that market integration trials are testing will need to go through various regulatory processes before becoming a reality. It is therefore important that trials understand potential reforms or pathways their demonstration can take to becoming a reality, and tailor learnings that will inform those paths.

   Market bodies can aid this activity by communicating potential information gaps in their reform processes that could be aided by studies or demonstrations and advise potential trials how they could include elements in the design of the trials.

   More complex integrated trials of a similar nature should also be in regular communication and coordination with each other. Rather than viewing these trials individually, it may be more useful to view them as a portfolio of trials, where we are trying to optimise for good outputs from the group of trials, rather than each individual one. This means encouraging trials to identify areas of synergy with each other, where findings from one trial can build and support others or standardising certain aspects. An example of standardisation is a common methodology to carry out certain cost-benefit assessments, allowing stakeholders to understand and compare economic feasibility of the trials more easily.

2. **Develop evidence bases on implementation feasibility (where possible) before rolling out in-field trials.**

   While there is often a "learn by doing" approach to trials, sometimes infeasible paths could be identified early on through desktop research. This early detection allows trials to adapt their approach or change to alternative paths before spending large amounts of money and time developing demonstrations of these approaches.

   Where there are areas of uncertainty in knowledge or the feasibility of DER integration pathways, and these uncertainties are suitable to cost-effective research, this research should be carried out before large in-field trials commence. This could be through third-party entities carrying out that research on general issues identified that are likely to impact future trials, or trials having an initial desktop research phase into aspects where outcomes can be improved through this research. This can avoid scenarios where trials test options that are later deemed infeasible and focus the scope of what is investigated through in-field trials.

3. **Social science studies to play a more active role in testing options and solutions.**

   Social science research has played a pivotal role in many trials by identifying gaps and improvements that can better align solutions to consumer needs. Often this is done through interviews with current or potential trial participants to understand their motivators and experience in the programs.

   As more mature trials commence, there is an opportunity for social science research to play a more active role in testing solutions. For instance, we know that consumers need to receive clear and understandable information in VPP programs, but what information in which form may be effective? While we can test this in-field by deploying a product through a multi-year trial, there are various social science and consumer research techniques that can provide answers in quicker and more cost-effective ways. An example of this is the social science research in Project EDGE which has identified that compelling value propositions are important for the success of VPP programs. The social science researchers will now carry out further analysis to identify an optimal mix of product attributes which maximises the attractiveness of VPP programs.

# APPENDIX A: TRIAL SUMMARIES

## PROJECT EDGE

Project EDGE[56] is the earliest of the end-to-end DER integration trials, and is a collaboration between AEMO, Ausnet, and Mondo. This project is testing a DER marketplace where aggregators or traders can offer a range of local and system level services facilitated via a common data exchange hub. This data hub caters for traders bidding into energy markets, receiving dynamic operating envelopes, and offer network support capacity through a local services exchange (LSE).

The objectives of Project EDGE are to demonstrate scalable and cost-effective solutions to many DER integration challenges such as:

- How DER can participate in future wholesale markets, trade network services, and adhere to the local constraints of the network.
- How data should be exchanged efficiently and securely between the many parties involved through an integrated software platform.
- A better understanding of consumer opinions on the complexities of DER integration through a social science study.

For energy market integration Project EDGE is testing wholesale bidding models aligned with the Trader role considered under AEMO's Flexible Trading Arrangements (FTA) and Scheduled Lite reforms, and a bidding format aligned to a Scheduled bidirectional unit (BDU) under the Integrating Energy Storage (IESS) rule change. This includes testing options in the trial such as:

- Allowing aggregators to bid load and generation in a single portfolio (or DUID) with up to 20 price bands, reflecting the IESS design.
- Testing three different types of dispatch methods that may inform Scheduled Lite models:
  1. Visibility, where an aggregator bids capacity at different price levels, and is sent a dispatch target, but is not required to respond to the target.
  2. Self-Dispatch, where an aggregator self-nominates a dispatch target and must meet that dispatch target regardless of price.
  3. Scheduled, where an aggregator bids capacity at different price levels, and is sent a dispatch target that it must meet.
- The trial is testing aggregated bids of capacity measured at either the connection point or at a measurement point behind the meter that represents all controllable DER at site, called 'flex'. The 'flex' option is similar to approaches being developed in the Flexible Trading Arrangements rule change.

The LSE is where local network services can be procured from DER to improve power quality or allow more energy to flow on the local network. Through this platform networks would publish service requirements, select aggregators, and dispatch the procured local service. Currently network support services are procured via bilateral contracts with set conditions and pricing. Through a digital marketplace these services can be procured more flexibly, transparently, and competitively. Project EDGE is testing two main local services: demand increase/reduction, and voltage management. For these services there are three level of firmness: high, medium, and low. High firmness services can be used for network planning and capex deferral, where are low firmness can be used more opportunistically such as a spontaneous market event that may create the short-term need for a local service.

56 https://arena.gov.au/projects/project-edge-energy-demand-and-generation-exchange/

Project EDGE is testing a variety of methods to allocate network capacity through DOEs. The University of Melbourne have designed three objective functions that can be used to allocate capacity in Project EDGE:

1. **Maximise aggregated services:** that maximises the total volume of imports and exports from active consumers. Fairness among participating DER consumers is not considered in this objective, which could lead to these consumers getting materially different DOEs at times of network constraint.
2. **Equal allocation:** active consumers in a local area are allocated the same DOE limits or limits proportional to their installed DER capacity.
3. **Weighted allocation:** similar to maximising aggregated services, this method can bias its allocation between consumers based on a priority such as maximising imports for sites with the lowest cost of exports.

A key aspect of Project EDGE is testing is how all the different parties can transfer data between each other. A hypothesis of Project EDGE is that a datahub, where all parties can connect once, to exchange data with all different parties, is more efficient and preferrable at scale to alternative architectures such as point-to-point with standards (e.g. a trader connecting to each DNSP through a common protocol such as CSIP-AUS is an example of point-to-point with standards).

Project EDGE is testing both a centralised data hub and decentralised data hub for scaled data exchange between industry participants. The centralised data hub is conceptually similar to AEMO's existing e-Hub where all messages and information is sent to a centralised platform that then partitions and forwards that information to the intended recipients. A decentralised data hub allows for many parties to host the hub as a 'node', in which parties can send a message to any node in the system, and that message is forwarded to the indented recipient.

Project EDGE has five planned stages of social science research to be conducted with current or potential trial participants. The first that has been released is an interim *Customer Insight and Engagement Study*[57] where sixteen in-depth interviews were conducted with consumers who had experience with VPP trials such as Project EDGE. In these interviews motivators and barriers for joining VPPs were examined and their perception of VPPs more broadly. Analysis of these interviews revealed three key themes:

1. Consumers interviewed were primarily motivated by non-financial benefits such as community and environmental values and increasing energy self-sufficiency. This differs from some other interviews in projects where consumers also highly value financial drivers such as cost savings and bill reductions, indicating the varied types of consumers in different trials. Upfront battery costs were seen as a significant barrier.
2. Consumers viewed the battery as primarily an energy asset to fulfil their own energy needs first, and excess (if any) could be used for energy trading.
3. Mondo was viewed as more of a hardware supplier than energy aggregator, and consumers had concerns whether a commercial company could be trusted to use the battery in ways that benefitted the consumer and broader community.

Further studies will extend on these initial insights by gaining more information from larger groups or using analytical tools and techniques in later stages to better understand concerns and test solutions to different aspects of the consumer experience.

57 https://aemo.com.au/-/media/files/initiatives/der/2022/public-customer-insights-and-engagement-study-interim-report.pdf

# PROJECT SYMPHONY

Project Symphony[58] is a collaboration between AEMO, Western Power, Synergy testing DER market integration through an in-field VPP pilot in Western Australia's Wholesale Electricity Market (WEM). This emerged from actions in WA's DER Roadmap outlining that a trial should be commenced to demonstrate technical and market systems to orchestrate DER and provide better end-to-end integration of DER into the energy system.

WA's WEM differs from the east coast's NEM in different ways such as:

- A single, state-owned distribution network (Western Power), and single retailer (Synergy) for small customers (less than 50 MWh/year) simplifies some of the roles and responsibilities and IT integrations.
- WA's main grid, the Southwest Interconnected System (SWIS), is an isolated grid with no interconnections to other regions. This can create trickier operating conditions during periods of high renewable generation as energy or system services can't be sent to or procured from other regions.
- The WEM has some similar markets to the NEM, such as contingency and regulation FCAS, and some different ones, most notably using a capacity and balancing market for wholesale energy as opposed to the NEM's real-time energy only market.

While the WEM structure differs in some ways there are many similarities to the NEM with respect to DER integration, and areas where coordination or harmonisation Australia wide may make sense such as standards, cyber security, and interoperability.

Project Symphony is creating three, interconnected platforms to handle different functions of DER participation:

1. **DSO Platform (Western Power).** Responsible for identifying maximum renewable energy hosting capacity, forecasting consumer generation and load, and using this information to create DOEs that equitably allocate network capacity to consumers. Western Power intends to leverage and extend the Evolve solution used in previous NEM trials to construct and communicate DOEs.
2. **DER Integration Platform (AEMO).** Responsible for receiving bids from aggregated DER via the aggregator and dispatching them in wholesale electricity and network support markets (as requested by the DSO), while ensuring dispatches conform to the constraints of the network.
3. **Aggregator Platform (Synergy).** Responsible for onboarding DER, managing and dispatching flexibility, and post-event analysis.

These interconnected systems must be tightly integrated as many pieces of data are passed between them. Knowledge from developing and integrating

On the market side there are four 'must have' on-market and off-market services and scenarios will be demonstrated:

1. **Energy Services – Bi-directional:** participation in the balancing market which determines economic (most economically efficient) dispatch of generation to meet system demand as managed by AEMO.
2. **Network Support Services:** a contracted service provided to help manage network constraints – help manage distribution level peak demand and/or voltage issues as identified by the Distribution System Operator (DSO).
3. **Constrain to Zero:** the AEMO platform instructs the aggregator platform to constrain energy output from DER to zero export (net) or zero output (gross). This could be offered as a market or retailer service.
4. **Essential System Services (ESS) Contingency Raise:** DER response to help restore a local deviation in frequency to normal levels (due to loss of a large generator or load).

58 https://arena.gov.au/projects/western-australia-distributed-energy-resources-orchestration-pilot/

Project Symphony is testing network support services (NSS) by the DSO forecasting capacity shortfalls or degraded power quality that could be resolved through NSS. They then enter into bi-lateral contracts with aggregators for that service. When that service is required, the DSO instructs the AEMO (via the DER Integration Platform), who sends that request as part of the market dispatch process. Project Symphony will also assess cost and benefits of NSS on their network.

Project Symphony has developed a range of methods to allocate network capacity through DOEs called Distribution Constraint Optimisation Algorithms (DCOA)[59]. These algorithms can easily be swapped in and out of the DSO systems which create the DOEs, allowing for different network capacity allocation methods to be easily tested. These DCOAs prioritise different objectives such as a proportional allocation of network capacity based on inverter size or giving larger export limits to sites that are expected to export more energy.

Project Symphony is carrying out social science research through the retailer Synergy and a social science study conducted through by the University of Tasmania (due to be submitted in 2023). Project Symphony has released a *Public Aggregator Report*[60] which summaries insights from research into consumer sentiment towards DER and third-party aggregators.

As Synergy is the only retailer to small customers in the WEM, commercial aggregators currently don't have a role in the system. Due to this and the commercial nature of these entities (Synergy is a state owned) consumers voiced concerns around profit motive, reliability, and degree of regulation. This creates hurdles for third-party aggregators models to gain a foothold in the WEM, as opposed to the NEM where vertical disaggregation and retail competition has created a norm of for-profit retail companies offering a range of products and services.

Consumers surveyed also had a general lack of understanding of the concepts and benefits of DER, and had concerns about control, costs, and risk. While WA has had a large uptake of rooftop solar, VPP programs are much rare than in the NEM which suggests more advanced DER products are still at an early stage in Western Australian consumer mindsets.

An aim of the project is to acquire approximately 500 consumers with at least 900 DER assets to test the end-to-end operation of the systems. This provides an opportunity for social science research conducted by the University of Tasmania to examine areas such as:

- A review of key learnings and gaps from other trials and industry on how consumers respond to relevant new energy technology.
- Understanding how a range of consumers respond to the design, benefits, and experience of Project Symphony.
- Examining the social equity implications of Project Symphony's technologies, systems, and pricing, as well as how this can inform a larger roll-out of DER aggregation.

The project began in 2021 and is expected to be completed in mid-2023. Related work on designing market arrangements for DER participation in the WEM is also underway through the DER Roadmap, creating a pathway from the pilot project into market design decisions and arrangements. The current go-live date for WEM participation of DER Aggregators is October 2025.

59 https://arena.gov.au/knowledge-bank/project-symphony-distribution-constraints-optimisation-algorithm-report/
60 https://arena.gov.au/knowledge-bank/project-symphony-aggregator-report/

# PROJECT EDITH

Project Edith[61] is a trial run by project partners Ausgrid and Reposit Power to test tools for managing power flows on the distribution network, as well as how that can co-exist with market participation from DER.

A theme of the project is to leverage and extend existing infrastructure, as well developing tools which may be simpler to implement to reduce costs and complexity of upgrading systems to support high levels of DER uptake. The project builds on the platform developed for Project Evolve.

The two main tools used in Project Edith to manage network capacity are DOEs, which defines the absolute limits at each location and DNPs, which incentivises actions that are beneficial for reducing network costs within those limits.

DNPs are network charges (and rewards) that can reflect the level of constraint at different locations in the network. Traders and retailers with price responsive DER could elect to be exposed to these dynamic prices instead of typical network charges, giving consumers the opportunity to be further rewarded for their flexibility and making better use of our electricity infrastructure.

DNPs make network tariffs more cost reflective at a given location on a given day and shares value with DER. For example, on a sunny, mild day the network costs for importing energy in the middle of the day is likely to be very cheap, or even negative. On a cloudy, hot day though, the price for importing is likely to be more expensive as there's less locally generated energy and more locally consumed energy due to increased air conditioning usage.

DNPs can leverage a lot of the systems and processes created for DOEs such as:

- Using similar inputs to DOEs such as weather, DER information, network state and time of day.
- Extending existing protocols to communicate the DNP and the DOE to the trader in the same message.
- Tools to operationally understand how DER and traders are responding to limits and incentives.

Project Edith uses the "simple" model for communicating prices, constraints, and bids between the DSO, trader (or their technology partner) and market operator. This involves the DSO, in this case Ausgrid, sending the trader DOEs and DNPs for each site, and the trader, in this case Reposit, only bidding capacity that will conform to the limits of the DOEs.


Figure 6. Dynamic operating envelopes and prices sent to the trader before market bidding and dispatch.

The trial began in 2021 with the first phase involving sending DOEs and DNPs to Reposit Power, who is operating batteries on behalf of consumers. This allows time for Ausgrid to develop pricing engines and understand how an aggregator may respond to dynamic pricing. The project is using an agile approach to development, incorporating lessons along. Recently a subscription model was introduced to help with the allocation of network capacity through DOEs while considering different consumer equipment capabilities. As was noted earlier, the Flexible Export for Solar PV trials found a high percentage of existing inverters are not able to comply with operating envelopes. Through a subscription model, the consumer (through their trader) can select and pay for a minimum limit that can be complied with, therefore creating an incentive for flexibility while accommodating existing capabilities. This subscription model replaces part of the consumer's current network tariff.

Future phases of the project are expected to involve more aggregators, and a tighter integration against AEMO systems.

61 https://www.ausgrid.com.au/About-Us/Future-Grid/Project-Edith

# PROJECT CONVERGE

Project Converge[62], the newest of the four projects, is a collaboration between Evoenergy, ANU and Zepben to test tools designed to increase the benefits created by DER without breaching the physical and operational limits of the distribution. Two of the tools they are testing are shaped operating envelopes (SOEs), which prioritises allocating network capacity to sites that have the lowest cost of energy, and a 'real-time RIT-D' system that can more efficiently procure network support at a lower cost to existing processes.

When generators in an area want to export more than the capacity of that part of the network, a constraint occurs. In this scenario local network capacity is a scare resource that needs to be allocated to the different generators. There are many capacity allocation methodologies such as a uniform allocation where all generators get the same amount of network capacity or allocating based on nameplate capacity, so a generator twice as big as another will get twice the network capacity.

On the transmission network capacity is allocated preferentially to generators behind the constraint with the lowest cost bids, under the assumption that these generators have the lowest cost of operation, and therefore its efficient from a system level to dispatch these generators before generators with higher bids.

Shaped operating envelopes are dynamic operating envelopes, with an allocation methodology similar to how we allocate capacity on the transmission network. Under the Project Converge model:

1. The trader submits its unconstrained market bids to the DSO.
2. Where there is a constraint, the DSO preferentially allocates capacity to sites that have a lower cost bid to export energy (or higher cost in the case of importing), to increase the amount of lower cost energy in the market.
3. The trader then submits the same bids to the market operator but adjusts the capacity to only represent network capacity they've been allocated through the dynamic operating envelope.
4. The market operator sends dispatch instructions to the trader that will conform with the dynamic operating envelopes.


Figure 7. Market bids first sent to the DSO to create shaped operating envelopes.

This model can also be simplified for the trader by the trader submitting bids to the market operator, then the market operator and DSO coordinating to allocate local capacity and determine dispatch instructions.

Project Converge is also exploring a 'real-time RIT-D' process that can more easily procure non-network solutions for smaller constraints. Currently the regulatory investment test for distribution (RIT-D)[63] is a process where networks are required to consider non-network solutions where there are augmentations or network constraints that would cost more than $6 million to resolve. The current process can be costly and slow, leading to a low amount of interest from asset owners, and the inability to apply the currently process to smaller and more transient constraints. Project Converge is testing a new platform which may result in more cost-effective non-network capacity procurement through improving processes such as:

- Identifying and communicating constrained parts of the network, and opportunities for DER to provide network support within a reduced timeframe.

62 https://arena.gov.au/projects/project-converge-act-distributed-energy-resources-demonstration-pilot/
63 https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/rit-t-and-rit-d-application-guidelines-2018

- Streamlining commercial engagement processes such as establishing commercial, technical, and operational arrangements from traders on a fixed basis, as opposed to having to engage with traders on a case-by-case basis per project.
- Improving operations of constraint management mechanisms with more automation and greater use of industry-standard protocols.

Similar to the earlier COSORT trial[64], Project Converge has a large focus on social science research. This research focuses on revealing gaps in the sector's current understanding of what consumers want, and the capacity to meet them, to explore different ways that Project Converge could be deployed in real-world settings. Three areas of interest are:

1. How do trusted intermediaries, such as experts and commentators, view this kind of technology and its potential impact? This is important to understand as consumers often consider these sources more trusted and accessible relative to other sources of information.
2. The role and capacity of aggregators to mediate the relationship between the energy market and households.
3. How do households view traders or market aggregators, and the concept of households participating in the energy market?

Project Converge will operate from the second half of 2021 until Jan 2024 building tools and processes, conducting social science research and operating an in-field trial. The in-field trial will leverage consumers who have batteries through the ACT NextGen program[65] and will offer them a financial incentive to participate.

64 https://arena.gov.au/assets/2019/06/consort-social-science.pdf
65 https://www.climatechoices.act.gov.au/policy-programs/next-gen-energy-storage

# APPENDIX B: RELATED TRIAL AND STUDY DETAILS

| TRIAL/REPORT | AREA | DETAILS |
|---|---|---|
| ARENA-AEMO RERT Trials | Market Services | The ARENA-AEMO RERT Trials Trials tested participation in the RERT demand response market from residential, commercial, and industrial consumers. |
| AEMO VPP Demonstrations | Market Services | The AEMO VPP Demonstrations tested the ability for DER to provide a market service (contingency FCAS) through a trial specification, while responding to other energy market price signals. |
| CONSORT Bruny Island Battery Trial | Network Services | The CONSORT trial tested novel approaches to households on Bruny Island providing network support from their battery and PV system. |
| Networks Renewed | Network Services | An early trial with New South Wales and Victorian distribution networks to test how solar and batteries can support network voltage. |
| Ausgrid VPP Trial | Network Services | The Ausgrid VPP trial (trial still operating) is testing household batteries providing network services. |
| DEIP DOE Outcomes Report | Local Constraints | The report identifies the current 'state of play' of DOEs and capture the future policy, regulatory, technical and industry actions needed to implement a nationally consistent model that will work in consumers' interests. |
| Evolve | Local Constraints | The Evolve Project developed early models and options for implementing local constraints through DOEs and outlining benefits of the approach. |
| Project Shield | Local Constraints | Project Shield (trial still operating) is developing software to aggregate a range of sources to help DNSPs have better visibility and management of DER on their network. |
| SAPN Flexible Exports | Local Constraints | An in-field trial where consumers are offered flexible export limits, giving real world learnings that could inform a larger rollout. |
| Advanced VPP Grid Integration | Market Services + Local Constraints | A collaboration between SAPN and Tesla to demonstrate how a VPP can operate in energy markets while adhering to local, dynamic export limits. |
| Open Energy Networks | Market Services + Network Services + Local Constraints | A project lead by Energy Networks Australia (ENA) and AEMO to explore models that can better integrate distribution level assets and actors in the distribution system. |
| Review of licensing and exemption regulatory framework | Consumer Needs and Preferences | A report from Energy Policy WA that proposes a regulatory framework that facilities businesses providing behind-the-meter electricity services to consumers with adequate consumer protections. |