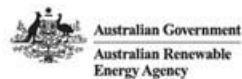


Project EDGE | Lessons Learnt Report #2

Demonstrations Insights Forum

6 December 2022



A photograph of a dense forest with tall, thin trees and lush green foliage. The sky is visible through the canopy, showing a clear blue color. The trees are mostly deciduous with green leaves. The ground is covered in grass and some low-lying plants.

Acknowledgment of Country

We acknowledge the Traditional Owners of country throughout Australia and recognise their continuing connection to land, waters and culture.

We pay our respects to their Elders past, present and emerging.

Agenda



Time	Description	Presenter
1.00-1.05pm	Introduction	EDGE team
1.05-1.15pm	Project update	Nick Regan
1.15-2.30pm	Lessons Learnt report #2	Nick Regan

Project EDGE

Lessons Learnt #2 Report

Nick Regan (AEMO)



Where are we now

Trial Ops

- We are in the operational and final phase of the trial, have run some extreme price events.
- All aggregators are participating in all field tests to answer questions under the Research Plan

CBA

- Finalised and published the CBA methodology – thanks for your input

Customer Insights

- Deakin University are working with Aggregators on two additional pieces of the Customer Insights Study.

DOEs

- University of Melbourne are working through testing different DOEs arrangements and DER penetrations with real work networks. Objective function study results to be published early 2023.

Data Exchange

- EY Tech and Cyber assessment being finalised for publishing in early 2023.

Knowledge Sharing

- Published knowledge sharing milestone in our Lessons Learnt #2 Report (wc 12/12). This report provides;
 - Sharing early insights aligned to research questions and hypothesis
 - Builds on previous knowledge sharing reports such as the Lesson Learned Report #1 and the Public Interim Report

Lessons Learnt Executive Summary

- The Research Plan independently designed by UoM is guiding the objectives of the Project.
- Diversified customer base and DER technology across the aggregators is strengthening the robustness of the insights produced in the trial
- The report focuses on a number of key areas such as:
 - **Alignment between Aggregator Customer Acquisition and Deakin University's Customer Insights Observations**
 - Consumers value financial benefits, trust and transparency when signing up to participate in a VPP.
 - Some early majority consumer groups have a more positive attitude to adopting DER than others.
 - **Early Field Trial observations**
 - Aggregators can follow AEMO intervention targets when directed during unexpected events and achieve this within Network Limits.
 - Early analysis shows progressive aggregator participation and understanding improves as the trial progresses.
 - **Preliminary Data Exchange Findings**
 - A **theoretical** evaluation of the data exchange approach indicates a data hub represents the higher value option for industry and consumers but shows current immaturity of technology around the decentralised model over the centralised model despite the benefits.
 - The aggregator experience is key in implementation and needs to be clear and progress over time.

Research Questions & Hypotheses targeted in LL #2

The below diagram outlines the research questions and hypothesis discussed throughout the report and where you can find further details.

Research questions discussed in this report	Summary of hypotheses discussed in this report	Chapter	
Customer	<p>RQ.1 How can the DER Marketplace be designed to enable simple customer experiences, deliver the needs of customers and improve social license for active DER participation?</p>	<p>HA: Consumer decisions to invest in DER and sign up with an aggregator (to participate in the DER Marketplace) are influenced by financial, social, cultural, environmental, and behavioural factors.</p> <p>HB: Customers are willing to let aggregators utilise their assets if offers are presented to them simply and provide sufficient value over time.</p> <p>HC: Enabling aggregators to deliver multiple services through minimising complexity of market participation for both parties (consumers and aggregators) will enable them to provide valuable and simple offers to consumers.</p>	<ul style="list-style-type: none"> • Chapter 2 • Sections 2.1, 2.2, 2.4 • Chapter 3 • Sections 3.1, 3.2, 3.3 • Chapter 4 <ul style="list-style-type: none"> • Chapter 3 • Sections 3.1, 3.2, 3.3 • Chapter 4 <ul style="list-style-type: none"> • Chapter 2 • Sections 2.1, 2.2, 2.4
Wholesale integration	<p>RQ.4 How can the DER Marketplace facilitate efficient activation of DER to respond to wholesale price signals, operate within network limits and progress to participation in wholesale dispatch over time?</p>	<p>HA: DER participation in wholesale energy markets can be achieved progressively, as DER fleets reach materiality thresholds, aligning with ESB visibility and dispatchability models.</p>	<ul style="list-style-type: none"> • Chapter 5
Efficient data exchange	<p>RQ.6 What is the most efficient and scalable way to exchange data between industry actors, considering privacy and cyber security, to benefit all consumers?</p>	<p>HA: A data hub model provides a scalable and long-term approach for DER Marketplace scalable data exchange compared with a web of many point-to-point interactions between industry actors.</p>	<ul style="list-style-type: none"> • Chapter 2, Section 2.3, 2.4 • Chapter 7

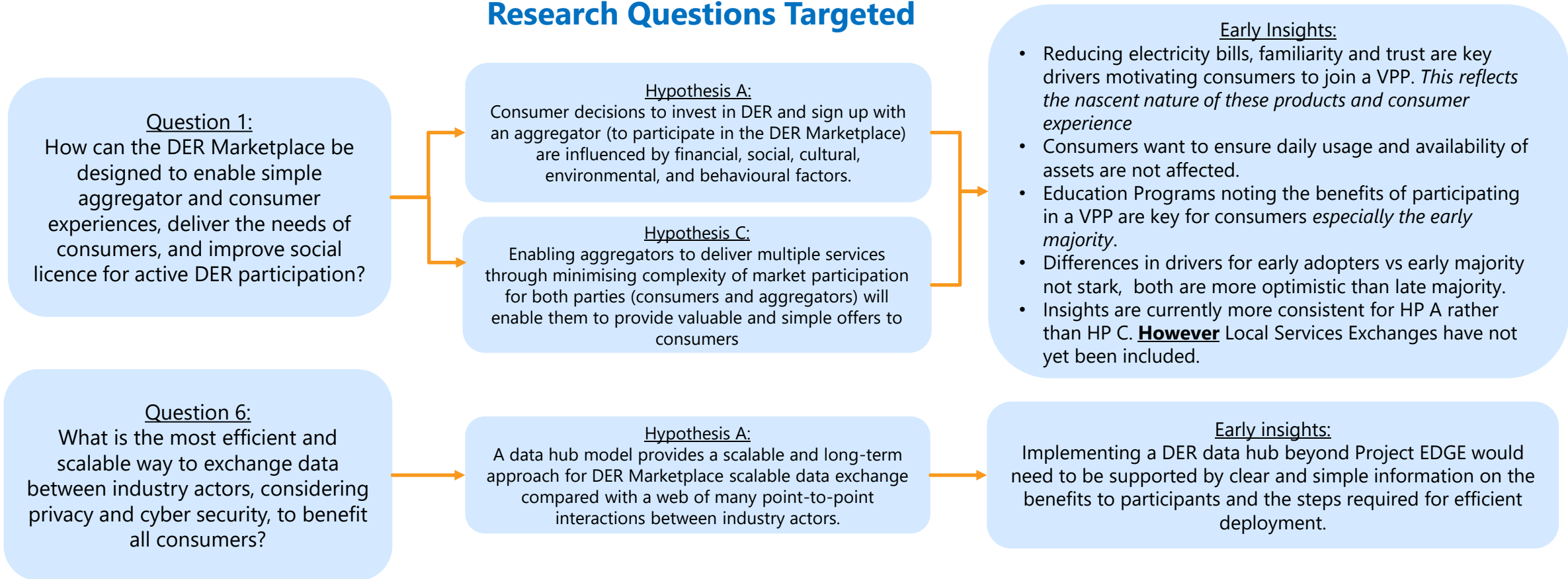
Early Insights from New EDGE Aggregators

The diversification of the aggregators has provided additional insights on:

- The different business models used for customer acquisition for VPPs.
- The variation of DER technology used in the trial.
- The risk profile and experience of each Aggregator participating in the DER Marketplace.

This combination of aggregators has diversified the consumer base and DER technologies participating in the trial, and deliver further insights for the Project EDGE evidence base.

Research Questions Targeted



Consumer Alignment shown between Deakin Research and the EDGE Aggregator Experience

The alignment of insights so far between the Consumer Insights Study and the acquisition experience of the two new EDGE aggregators in the trial indicates that:

- Aggregators are more able to provide **simple** and **compelling** offers to consumers if they are able to deliver electricity services (both wholesale and local) in a simple and consistent way across jurisdictions.
- A consumer's decision to sign up with an aggregator and participate in the DER Marketplace are influenced by a range of factors. But the primary drivers are **financial (guarantees)**, **cultural (trust)** and **behavioural (daily living impacts)**.
 - Forum question: *Might future products be able to separate value to DER owners from strict self-consumption?*
- Consumers are willing to let aggregators utilise their assets if offers are presented to them simply and provide sufficient value over time.
 - The critical insight here however is that unless a compelling value proposition is clearly and simply communicated, consumers are unlikely to perceive a benefit from joining and participating in a VPP.
- These factors are generally consistent among the **early adopter** categories and the **later adopter** categories. However, **early adopters** are more likely to have stronger interest in, and more optimistic and positive attitudes towards, adoption of DER and participating in a VPP compared to later adopters.

How are we testing in the field?

The field trial is cycling through the different pre-determined modes that test permutations on DNSP operating envelopes and aggregator bidding. These are designed to isolate effects of different variables

Mode	OE Frequency	DOE calculation	OE Active vs. Reactive	DOE Objective function	Bidding Type	Bidding	Bidding Qty	Dispatch instruction
1	Day ahead	Network + approximation	Active only	Equal allocation	Scheduled bidding	Visibility	Net NMI	Not actioned
2	Day ahead	Network only	Active only	Max service	Scheduled bidding	Visibility	Net NMI	Not actioned
3	Day ahead	Approximation only	Active only	Max service	Scheduled bidding	Visibility	Net NMI	Not actioned
4	Day ahead	Network + approximation	Active only	Max service	EFL	Self-dispatch	Net NMI	Actioned
5	Day ahead	Network + approximation	Active only	Max service	Scheduled bidding	Scheduled	Net NMI	Actioned
6	Day ahead	Network + approximation	Active only	Max service	Scheduled bidding	Scheduled	Flex	Actioned
7	Intra-day	Network + approximation	Active only	Max service	Scheduled bidding	Scheduled	Net NMI	Actioned
8	Intra-day	Network + approximation	Active + Reactive	Max service	Scheduled bidding	Scheduled	Net NMI	Actioned
9	Intra-day	Network + approximation	Active + Reactive	Max service	Scheduled bidding	Scheduled	Flex	Actioned

Further description and details of the Trial Modes can be found in **chapter 5 of the Lessons Learned report**

Early Data Observations – Research Question 4 – Hypothesis A

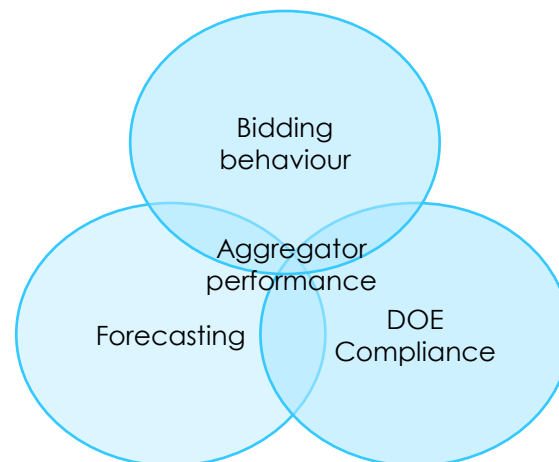
The guiding research question for this analysis was **Research Question 4**:

How can the Distributed Energy Resource (DER) Marketplace facilitate activation of DER to respond to wholesale price signals, operate within network limits and progress to participation in wholesale dispatch over time?

Hypothesis A for this research question is:

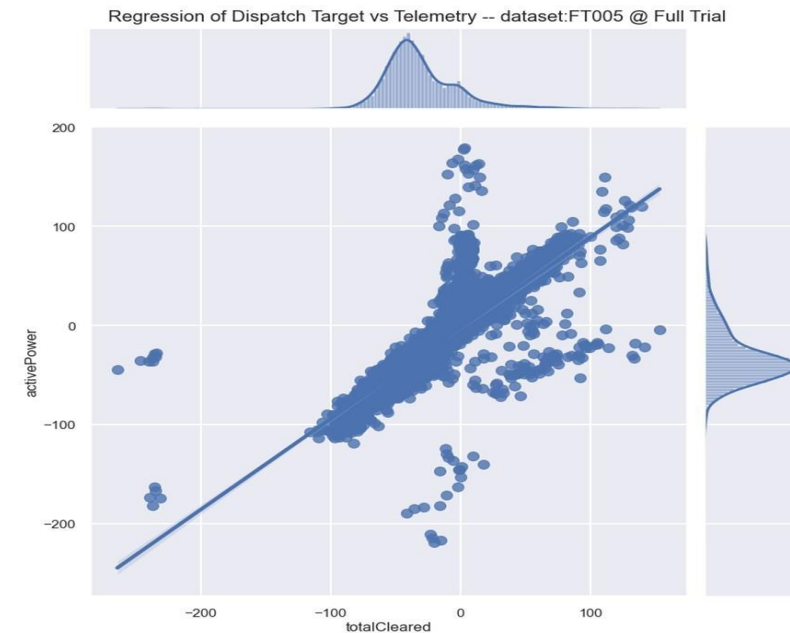
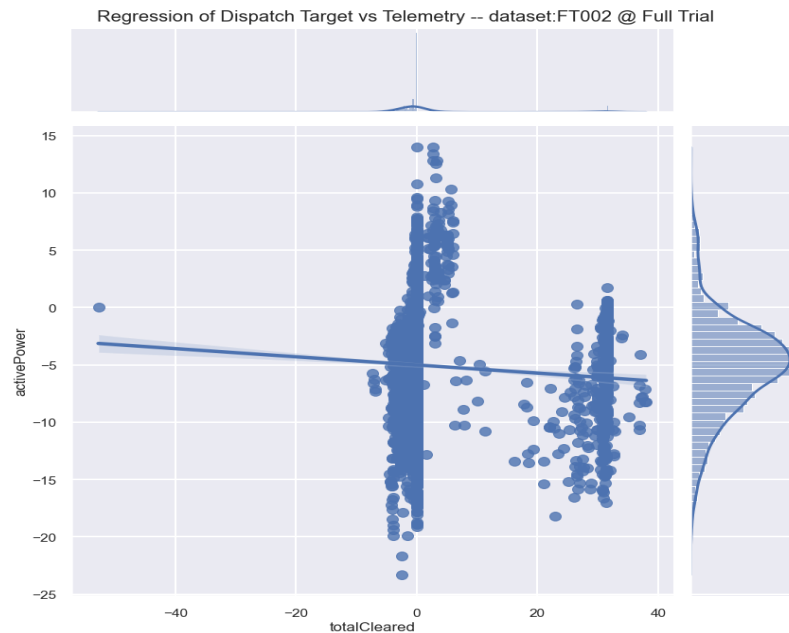
DER participation in wholesale energy markets can be achieved progressively, as DER fleets reach materiality thresholds, aligning with Energy Security Board (ESB) visibility and dispatchability models.

- The focus of the analysis was aggregator performance with dispatch instructions (targets).
- One element of the hypothesis being tested is that gradual participation by aggregators would allow them to develop their capabilities and sophistication in how they participate in wholesale dispatch.
- There are several other workstreams connected to this set of results. Overall aggregator performance to dispatch targets has intersection points that have implications on accurately forecasting and DOE compliance. These other activities form part of the same work package and over time will be viewed collectively to identify intersecting insights.
- With the **important caveat** that analysis so far has been limited to **some modes** and **one aggregator**, early results are beginning to suggest that performance with dispatch target improved over time.



Aggregator fleet size, and practice, support better performance

- Discussions with the aggregator analysed revealed that there were two key drivers supporting better performance over time:
 - Increased number of customers
 - Deliberate improvements in the algorithms
- This suggests that the size of the fleet is an important factor because it increases the diversity of customers that aggregator can draw upon to meet its dispatch targets
- This, along with the deliberate improvements in the algorithm have led to progression in forecasting available fleet capacity, more refined bidding quantities, and meeting more realistic dispatch targets.
- This progression over time can also be visualised through graphs illustrating the difference between the first field trial tested and a more recent field trial. The graphs show the correlation between targets and telemetry.



Summary of findings

These preliminary findings suggest the hypothesis may be true and begins to answer the research question by providing insights into how activation of DER to progress to participation in wholesale dispatch could be achieved.

Research question	How can the Distributed Energy Resource (DER) Marketplace facilitate activation of DER to respond to wholesale price signals, operate within network limits and progress to participation in wholesale dispatch over time?
Hypothesis	DER participation in wholesale energy markets can be achieved progressively, as DER fleets reach materiality thresholds, aligning with Energy Security Board (ESB) visibility and dispatchability models
Preliminary Insights	<ul style="list-style-type: none"> • Aggregators need a stepping stone approach to participate in the market reliably • Performance improves over time as aggregators develop and refine processes • The size of an aggregator fleet also supports more reliable performance
Next steps	<ul style="list-style-type: none"> • The preliminary results are based on the data of a single aggregator over a 5 month period • The hypothesis needs to be tested further to robustly answer that element of the research question <ul style="list-style-type: none"> • 3x Aggregators, differing fleet size and DER makeup, greater total customers • Further calibrate aggregator telemetry with smart meter data – trusted physical measurement is critical to market, system and settlement operations!

- Because the aggregator gradually improved as it refined its processes, it's too early to develop insights into whether a particular mode (i.e. the elements that define how a bi-directional offer is constructed) facilitates more reliable participation.
- The implication of these insights – if they hold true when stress-tested with additional data over the course of the trial – is that DER participation in wholesale markets is best achieved progressively in the interest of system security. Progressive participation allows DER fleets to reach a materiality threshold and refine processes to support reliable performance aligned with instructions from the market and system operator.
- These results support the Visibility and Dispatchability Model approaches proposed by Scheduled Lite.

EDGE Market Suspension field tests – June 2022



The AEMO, AusNet and Mondo team reacted quickly to establish a test plan to learn from this rare event

Why specific Market Suspension tests?

In Market Suspension AEMO was directing large scale generators.
What should this look like in a high DER future (via VPPs)?

Hypothesis 1:
 AEMO Dispatch Instructions that give a 'target' are more reliable than DOEs which give 'permissible limits'.

Hypothesis 2:
 These two signals together will conflict at times and this needs to be understood to be managed in future operations.

To operate the system AEMO needs:

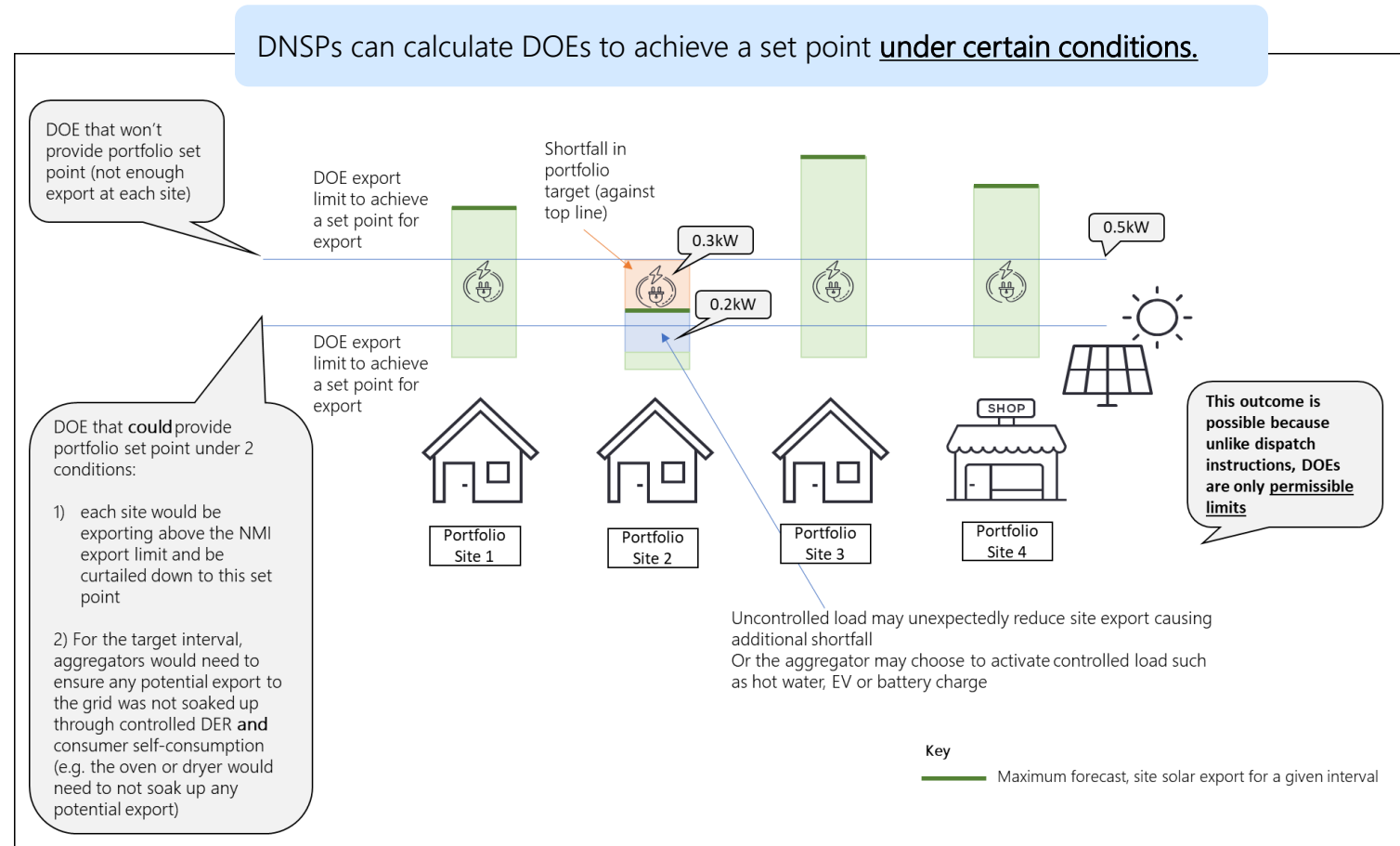
1. **Visibility** of telemetry in real time
2. **Predictability** of generator forecasts
3. **Controllability** of dispatch instructions
4. **Measurement** of telemetry (settlement)

What did we do?

Test	Summary
Test 1 Self-Dispatch (no AEMO direction)	<ul style="list-style-type: none"> In lieu of capability to dispatch VPPs at scale ('Controllability') i.e. current state, AEMO needs visibility (telemetry) and predictability (forecasts via boffers) to consider when directing large scale resources Q: What do VPPs do without AEMO direction?
Test 2 AEMO -> DUID direction via Dispatch Instructions	<ul style="list-style-type: none"> Under market suspension AEMO instructs generators/loads test is for future where controllability exists for VPPs (i.e. test will provide setpoints for aggregators to follow). How reliably can VPPs follow AEMO directions that differ from market incentivised behaviour?
Test 3 AEMO -> DNSP -> DUID direction via DOEs	<ul style="list-style-type: none"> Currently AEMO instructs NSPs to maintain a profile within their network, NSPs currently do this by shedding load or generation. Are DOEs a better mechanism than directing VPPs under a non-market use case (e.g. market suspension) ?
Test 4 Synchronous AEMO directions to DNSP and Aggregator (Test 2+3)	<ul style="list-style-type: none"> Testing synchronous instructions from AEMO to DNSP and Aggregator to see if this helps reduce potential conflicts. Test 2 & Test 3 together. Is it worth building capability to do both mechanisms for redundancy?

Market Suspension Event – Summary Learnings

- Aggregators can hit AEMO intervention targets in the absence of market signals, when directed.
- DNSPs can calculate DOEs to achieve a set point under certain conditions.
- However, DOEs alone may not elicit an aggregator response that is as accurate as dispatch instructions because they provide a permissible limit rather than a specific target.
- DOEs take priority to keep the network operating within secure limits, but need to be communicated to AEMO to ensure they **do not issue directions that exceed DOEs**.
- Visibility for AEMO of the DOEs was provided by the data exchange hub. This scalable data exchange approach allows multiple subscribers to receive certain data, including AEMO and aggregators.
- This supports **Market Suspension Hypothesis 1** that AEMO dispatch instructions that give a 'target' are more reliable than DOEs which give 'permissible limits'.
- The tests were inconclusive regarding **Market Suspension Hypothesis 2** that these two signals will conflict at times and this needs to be understood to be managed in future operations.



Preliminary Data Exchange findings – EY Tech & Cyber stream



EDGE’s Research Plan includes a theoretical evaluation of the data exchange models at the industry actor level.

The independent assessment is being conducted by EY, seeking to understand which architecture model would best support the NEO and ensure a secure, scalable and effective DER Marketplace.

Covers: Cyber risks and threats, Options assessment, Implementation benefits and hurdles and mitigating controls.

Preliminary findings

- In line with EDGE Hypothesis 6A, the assessment found a data hub approach to offer more efficient long-term outcomes for consumers than Point to Point.
- A decentralised approach can **theoretically** deliver greater benefits than centralised in each of four criteria assessed over the long term.
- One finding was that the maturity of some decentralised technology elements is not yet at enterprise grade and a phased implementation is recommended.
 - E.g. W3C standard for identities is emerging but not internationally recognised, MS getting involved. Also Self-Sovereign Identity and DLT applications in energy
- Implementing a decentralised data hub would require a long-term phased approach and need to consider a number of practical considerations to establish the feasibility of successful implementation, included Establishment, Governance, Ownership & Cost Recovery & Stakeholder Education

Assessment Framework: Data Exchange Options		
Success Criteria: Industry Alignment	Assessment Criteria	Assessment Rating
National Electricity Objective (NEO) To promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to: <ul style="list-style-type: none"> ▪ Price, quality, safety and reliability and security of supply of electricity ▪ The reliability, safety and security of the national electricity system. 	Scalable, Stable & Resilient 1 Ability for the integration approach to handle ad-hoc load (peaks and troughs incl. instability) without impacting the performance, stability and reliability of the national energy system	Each data exchange option will be assessed against the each of the four assessment criteria. The assessment rating will be measured utilising Likert scale response anchors of: Unlikely, Neutral, Likely in respect to the likelihood of the approach being suitable in achieving the purpose of the assessment criteria and the intentions of the success criteria.
Project EDGE: Data Exchange Principles <ul style="list-style-type: none"> ▪ Reduce cost, and complexity of data exchange ▪ Agree and implement standards ▪ Decouple actors and avoid hidden coupling ▪ Reduce barriers to entry ▪ Consistent user experience across regions ▪ Ensure data privacy, security and quality 	Interoperable, Modular & Flexible 2 Ability for the integration approach to support connection and communication across a diverse heterogeneous energy network (devices, systems and networks) in a coordinated and structured manner.	
Project EDGE: Research Plan <ul style="list-style-type: none"> ▪ Wholesale market participation enabled at scale ▪ Distribution network limits in wholesale dispatch considered ▪ Efficient and scalable trade of local network services enabled ▪ Efficient, scalable and secure data exchange enabled ▪ Integrated technology 	Secure, Trustworthy & Auditable 3 Ability for the integration approach to enable privacy-preserving energy scheduling that can be trusted to ensure the integrity of the national energy system in a transparent, integral and where required, confidential way. This includes mitigations against and considerations for cyber attacks across the future distributed national energy system	
	Standardised, Accessible & Fair 4 Ability for the integration approach to enforce standardised communication protocols across the network while supporting the long term interests of consumers through ensuring market accessibility (low barrier to entry) and equitable governance and operations	

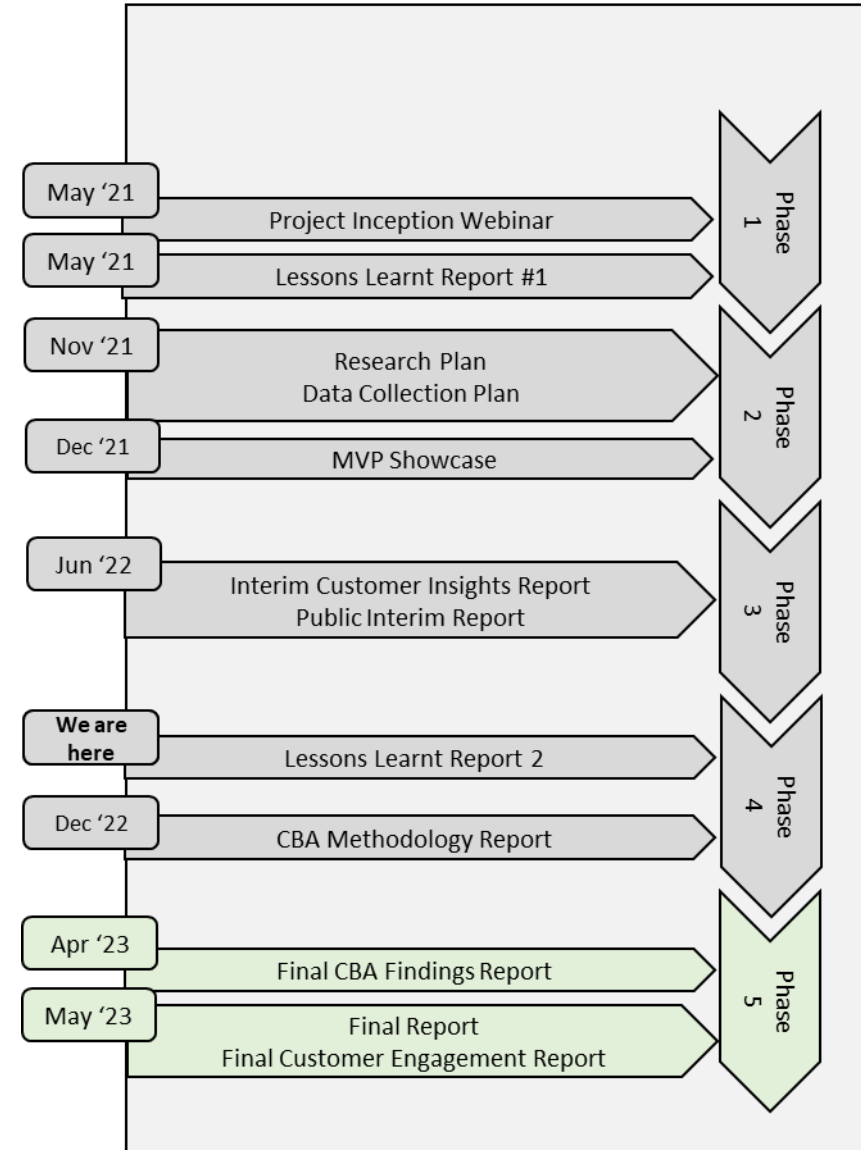
Point to Point Data Exchange

Centralised Data Exchange

Decentralised Data Exchange

Next Steps

- Continue to undertake the field trials to test against all research questions and hypothesis from the research plan
 - For current progress on the fields trials, please refer to Appendix A of the Lesson Learnt Report # 2
- Number of smaller reports to be shared before April (UoM, EY, Deakin)
- The CBA Findings Report is due March 2023
- The Final Report and Customer Insight Study Reports are expected to be shared in Mary 2023 with recorded webinars to follow in June 2023



Further information



Reports will continue to be made available via AEMO's Project EDGE news and knowledge sharing page:

<https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/project-edge/project-edge-news-and-knowledge-sharing>

If you have any queries about the research, please email me at j.newton@deakin.edu.au

Project EDGE Publications



Publications	Publication Date
Project EDGE Lesson Learnt #2 Report	December 2022
Project EDGE: CBA Methodology	November 2022
Project EDGE: Community Perceptions of DER & Aggregation Services	November 2022
Project EDGE: Literature Review : DER Customer Insights Research	October 2022
Project EDGE Public Interim Report	June 2022
Project EDGE Customer Insights Study	June 2022
Project EDGE Research Plan	March 2022
Project EDGE MVP Showcase	December 2021
Project EDGE Lessons Learned Report #1	May 2021
Project EDGE Public Webinar #1	March 2021
Project EDGE Factsheet	January 2021

For further news and knowledge sharing publications, please visit the [Project EDGE website](#)

For any questions, comments or feedback please contact: EDGE@aemo.com.au