

DER Market Integration Consultative Forum



25 May 2023



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

We pay respect to their Elders past, present and emerging.

AEMO Competition Law Meeting Protocol

AEMO is committed to complying with all applicable laws, including the Competition and Consumer Act 2010 (CCA). In any dealings with AEMO regarding proposed reforms or other initiatives, all participants agree to adhere to the CCA at all times and to comply with this Protocol. Participants must arrange for their representatives to be briefed on competition law risks and obligations.

Participants in AEMO discussions **must**:

- Ensure that discussions are limited to the matters contemplated by the agenda for the discussion
- Make independent and unilateral decisions about their commercial positions and approach in relation to the matters under discussion with AEMO
- Immediately and clearly raise an objection with AEMO or the Chair of the meeting if a matter is discussed that the participant is concerned may give rise to competition law risks or a breach of this Protocol

Participants in AEMO meetings **must not** discuss or agree on the following topics:

- Which customers they will supply or market to
- The price or other terms at which Participants will supply
- Bids or tenders, including the nature of a bid that a Participant intends to make or whether the Participant will participate in the bid
- Which suppliers Participants will acquire from (or the price or other terms on which they acquire goods or services)
- Refusing to supply a person or company access to any products, services or inputs they require

Under no circumstances must Participants share Competitively Sensitive Information. Competitively Sensitive Information means confidential information relating to a Participant which if disclosed to a competitor could affect its current or future commercial strategies, such as pricing information, customer terms and conditions, supply terms and conditions, sales, marketing or procurement strategies, product development, margins, costs, capacity or production planning.

Today's meeting

Time	Item	Speaker
1:30 – 1:35 pm	Welcome and Introductions	Rachel Rodrigues McGown (AEMO)
1:35 – 2:05 pm	EDGE Preliminary Results: Real World Scenarios	Nick Regan (AEMO)
2:05 – 2.50 pm	Customer Insights Study: Survey Results	Associate Professor Josh Newton
2.50 - 3:00 pm	Q&A & Meeting Close	All

Project EDGE

Results – Energy price arbitrage in real world scenarios

Nick Regan (AEMO)



Building on BAU observations, aggregator performance was tested for infrequent, high impact market price events



Focus of this analysis

Subset of the research question 4 regarding the ability of aggregated DER to **respond to wholesale price signals** while participating in wholesale dispatch. The analysis tested the ability of aggregators to:

- Respond to more extreme market events with a high-level of accuracy to their scheduled dispatch target by active re-bidding, cognisant of fleet capacity.
- Coordinate DER fleets to respond to forecast and unforeseen negative and high price events.

Relates to 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?

Key insights discussed

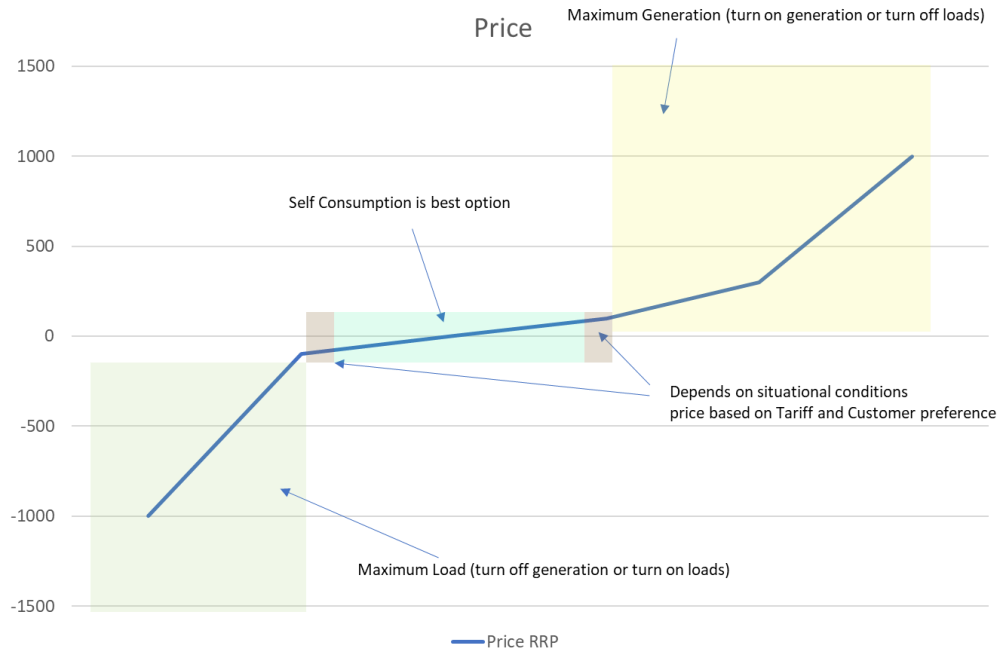
- Aggregators have the potential to deliver a step-change response to price events though results were inconsistent across events.
- Bidding strategies can undermine conformance. Aggregators that do not actively re-bid but submit a 'set and forget' price bands' bid risk non-conformance penalties and missed revenue opportunities
- Aggregators need to actively re-bid to reflect quantities that are achievable or desirable (e.g. a self-consumption, Local Services and State of Charge)
- Longer range forecasts are needed for market price-formation and bidding in good faith
- Aggregators need understanding that a dispatch instruction reflects their bid and they are therefore in control.

Aggregators demonstrated capability to perform (with promise) in a variety of services and complex market events. Capabilities can be built on over time and aggregators could benefit from a progressive (simple to complex), service-based stepping-stone approach, aligning revenue opportunities with system development and to fund portfolio growth.

Hypothesis: Extreme price event opportunities require different capabilities compared to aggregator BAU (self-consumption)



Hypothesised VPP behaviour



- Other field tests throughout the trial have analysed 'BAU' that is, individual site optimisation for solar-self consumption during benign wholesale prices (-\$50 - \$300/MWh).
- Aggregators noted that based on their customer preferences, set price band parameters were used to fulfill self-consumption product (turquoise band)

The focus of this analysis was to uncover insights on aggregator behaviour and performance capabilities to operate under maximum generation (yellow bands) or maximum load (green bands) in response to extreme price events.

During extreme high prices, it was hypothesised the aggregators would:

- Re-bid to increase the quantity offered in higher price bands to maximise revenue from the market event and prepare as necessary (e.g by charging batteries).
- Turn on generation or turn off loads, resulting in a step change to perform accurately to the dispatch instruction.

During extreme negative prices, it was hypothesised the aggregator would:

- Re-bid to increase the quantity offered in more negative price bands to maximise revenue from the market event and prepare as necessary (delay charging batteries).
- Turn off generation and/or turn on loads, resulting in a step change to perform accurately to the dispatch instruction.

Hypothesised impacts of this behaviour

- Performing as hypothesised would enable aggregators to earn and share greater financial returns with their customers (from market and/or business to business services e.g supporting retailers). However, it would mean aggregators would not be providing self-consumption to all customers during these events.
- Aggregators would need communicate with customers to provide assurance that during certain times, there is greater value in not self-consuming during these uncommon events, and ensure the customer receives net benefit in the long-term.

A broad range of price events were simulated in the field trial using historical event prices (forecast & actual) delivered to aggregators via Data Hub



Three of the simulated price events are presented in this analysis

(SE7) Sustained high price during midday, followed by spike

- Forecast high prices
- Sustained high price spike
- \$13,000/MWh from 12:00 until 12:30
- Prices drop to just above \$0/MWh (still positive)
- High price spike (\$13,000/MWh) at 13:00 for one interval
- Price drop back down

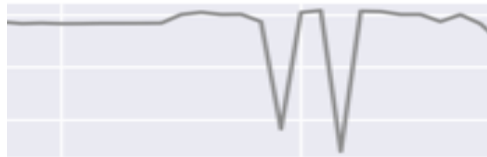
Slide 8



(SE12) Low price spike during morning

- Sudden low price spike
- -\$400/MWh at 08:25
- Prices return to just above \$0/MWh (remaining positive)
- -\$500/MWh at 08:40

Slide 9



(SE15a) Sustained high price during in the late afternoon

- Sudden sustained high price
- \$4,000/MWh to \$15,000/MWh from 18:50 until 21:00
- Lead up to Administered Pricing Cap event

Slide 10



All event types:

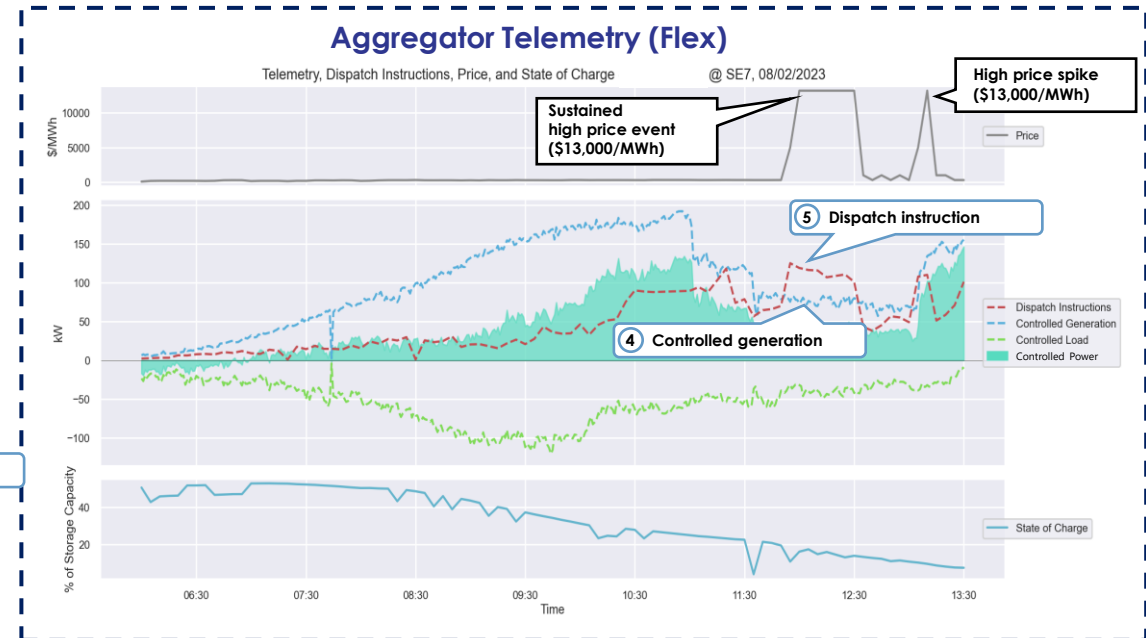
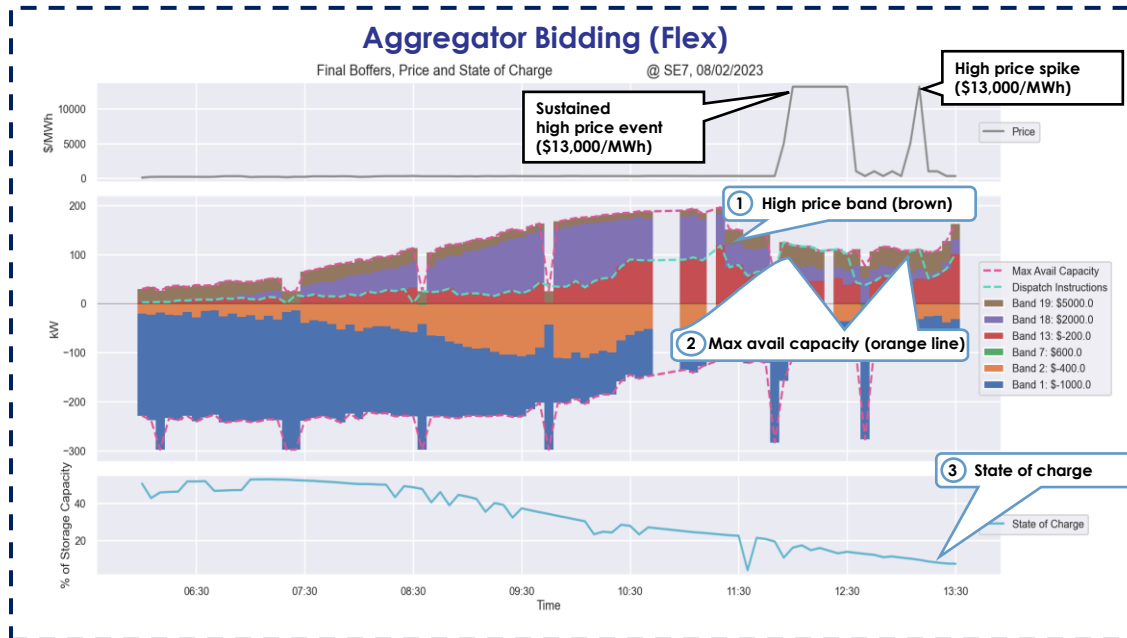
Using historical clearing and forecast prices in the field

1. Sudden unforeseen price spike to ceiling (e.g. gen trip)
2. Sudden unforeseen price spike to floor (e.g. loss of load)
3. Administered Price Cap (APC)
4. High volatility day (e.g. saw tothing)
5. Lack of Reserve (LOR1) days
6. Minimum System Load (MSL1) days

'Set and forget' re-bidding approach resulted in missed market opportunities – forecast high prices



(SE7) Sustained high price during midday, followed by spike: Using historical clearing and forecast prices



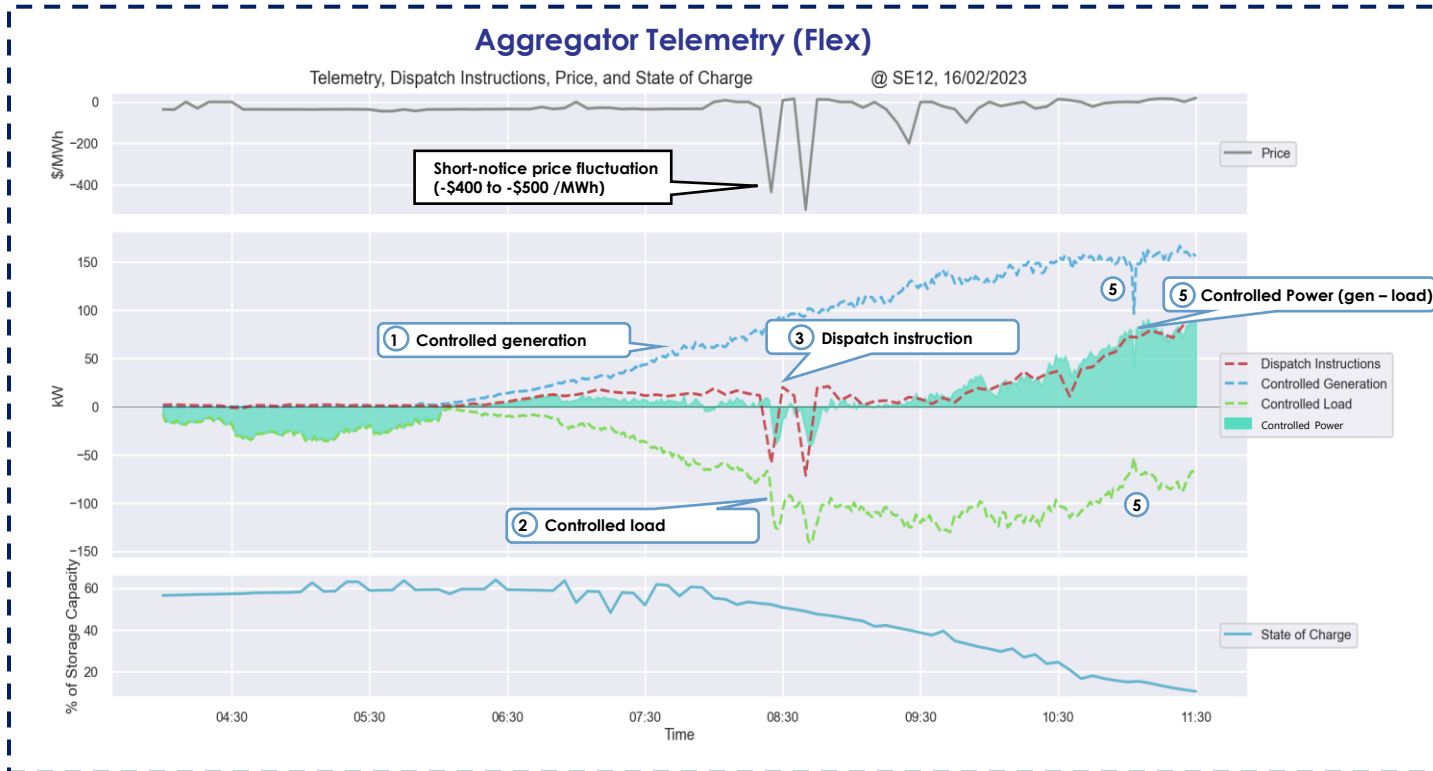
- 1 The **distribution of bands does not change** (qty bid in high price band (brown) remains relatively consistent to portfolio maximum available capacity (red line). Expected response was significant increase of quantity in this band. Consistent with previously observed short term forecasting trends (generally similar at all time horizons until < 2hr lead time)
- 2 This means **the aggregator did not re-bid to respond to the sustained high price event**
- 3 This is also reflected in the **max available capacity not changing to indicate the aggregator could not respond**. The near depleted storage capacity suggests it may be due to equipment status or decision not to prepare for forecast high prices by charging batteries

- 4 The **controlled generation** (blue dashed line) **decreases**.
- 5 This results in the **dispatch instruction** (red dashed line) **not being met**. Contributing factors were:
 - the portfolio's storage capacity was insufficient to discharge more generation
 - controlled load decreases (indicating stopping battery charging and a drop in generation), but not enough to meet the dispatch instruction
 - the boffer seems to have reflected the fleets total capacity but not the capacity it was willing or able respond with

Aggregators achieved more accurate portfolio-wide responses when controlling load compared with generation in response to a price fluctuations



Low price spike during morning: Using historical clearing and forecast prices for Minimum System Load (MSL) days in Summer



- ① Controlled Generation steadily increases, serving customer solar self-consumption needs.
- ② The aggregator controls load to bring net controlled in conformance with dispatch instruction without charging batteries
- ③ conformance with dispatch instruction without charging batteries
- ④ This was a short-notice event. Only the 5 minute forecast provides an indicator to the aggregator

This demonstrates capabilities to respond quickly to volatility (as the aggregator did not prepare for this event)

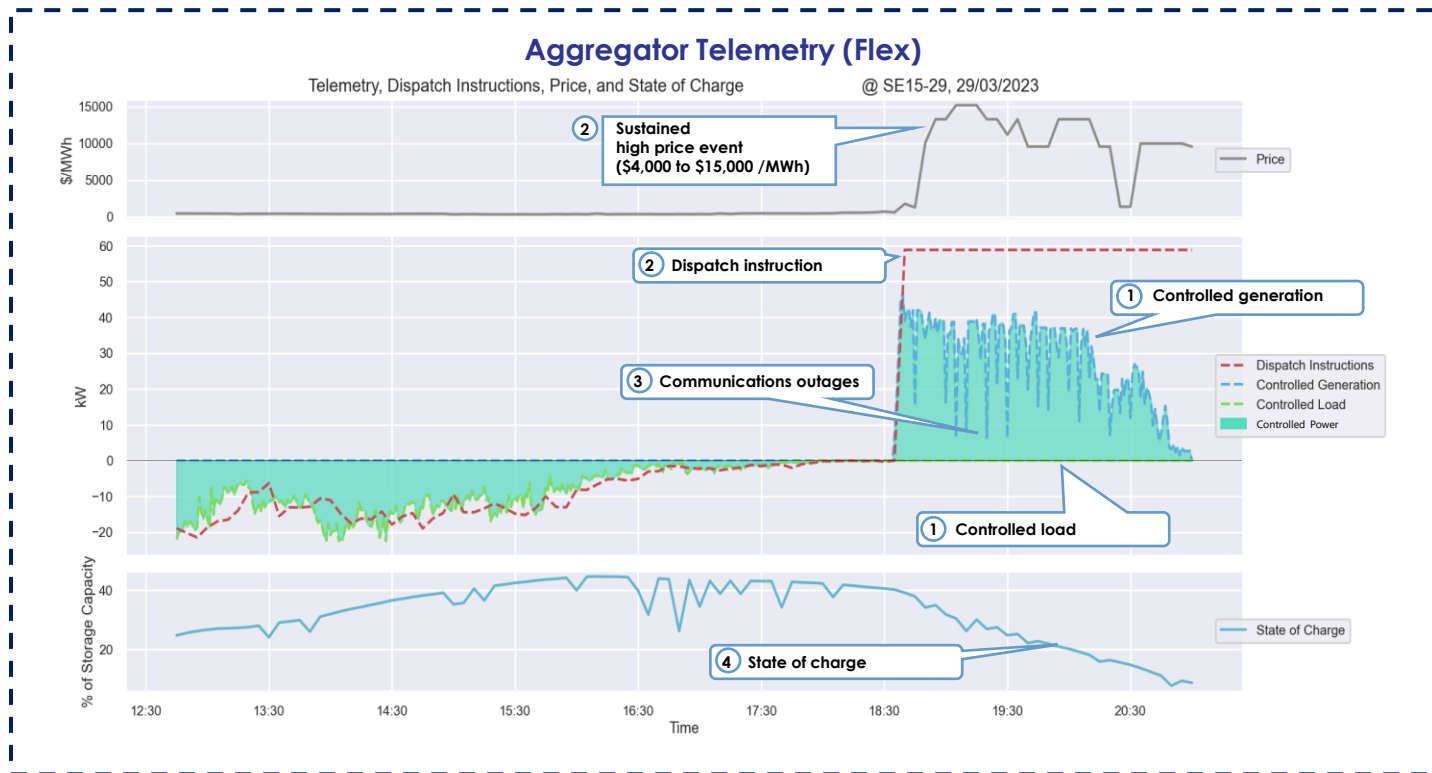
- ⑤ Instance outside of simulated event: controlled load decreased along with a decrease in controlled generation. This resulted in the net controlled remained in conformance.

This provides an example of the value of aggregator capabilities to control both generation and load to achieve a desire outcome.

An important aggregator capability to develop in future is rebidding in response to battery state of charge



Sustained high price during early evening: Using historical clearing and forecast prices prior to 2022 market suspension (administered pricing cap)



① The aggregator **controls batteries to discharge (controlled generation) in attempt to conform with dispatch instruction**

② This was a short-notice event. Only the 5 minute forecast provided an indicator to the aggregator

This is another example of the aggregator demonstrating capabilities to respond quickly to volatility (as the aggregator did not prepare for this event)

③ The sharp saw-tooths indicate a communications outages. This may have been a contributing factor to non-conformance

④ Another factor is battery state of charge forecasting error combined with this been a sustained event (almost 2 hours). The state of charge was not at, or near, maximum at the start of the event, to be able to support the offered capacity for the entire duration.

Additionally, high price and quantities and/or max avail generation were not rebid lower in response to not meeting dispatch instructions (red dashed line).

Summary findings: Energy arbitrage

Focus of this analysis

Tested the ability for aggregators to respond to price events with a high level of conformance to dispatch instructions by re-bidding. And to understand if aggregators can coordinate DER fleets to respond within time windows to negative or high price events.

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:

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.

Insights:

- Aggregators have the potential to deliver a step-change response to price events with inconsistent results
- Bidding strategies can undermine conformance. Aggregators that do not actively re-bid but submit a 'set and forget' price bands' bid risk non-conformance penalties and missed revenue opportunities
- Aggregators need to actively re-bid to reflect quantities that are achievable or desirable (e.g. a self-consumption, Local Services and State of Charge)
- Longer range forecasts are needed for market price-formation and bidding in good faith
- Aggregators need understanding that a dispatch instruction reflects their bid and they are therefore in control

The impacts of these results are?

- **Aggregators would greatly benefit from developing capabilities to control load and generation to achieve more accurate dispatch conformance and fully capture revenue opportunities from market price spikes.**
- This capability could be used for both market (energy) and business to business services (Aggregators supporting Retailers)
- **The dynamic nature of DER portfolios means aggregators will likely need to rebid every 5 minutes to reflect their true capacity. Appropriate regulation will be needed to ensure aggregators are bidding in good faith.**
- Other field tests showed capabilities to deliver local network services. And at times, they ability to simultaneously respond to wholesale price signals and meet dispatch conformance.
- **Aggregators can more reliably provide simple (binary) responses if they are not bidding to their max possible generation or load (i.e. with enough headroom to support real-time operational or forecasting errors)**
- Time is needed to develop and refine capabilities. **A progressive (simple to complex), service-based stepping-stone approach should be taken by aggregators, to align revenue opportunities with system development and fund portfolio growth.**
- **Educational information on energy service provision requirements and performance capabilities of available services would assist industry wide VPP development** and should be tested prior to enrolment and participation in dispatch

Turning insights into action: Industry discussion



How should industry progress this discussion?

Industry needs support and resources to understand requirements for progressive energy market participation

- Potential participants will need to demonstrate capabilities to perform to requirements before enrolment in dispatch.
 - How should education and understanding of requirements and performance be fostered?

Is there a need for a participation 'graduation' step between initial Visibility and full Dispatchability models?

- Field test results support a stepping-stone approach to gradual participation.
- But feedback from aggregators is incentives may not be enough to support commercial viability (i.e. support the considerable costs of developing forecasting and communications capabilities)
- Project EDGE tested an Energy Fixed Loading (EFL) mode in between Visibility-only and Scheduled Dispatch modes.

Customer insights Project EDGE

A/Prof Josh Newton and the Better Consumption Lab
Deakin University

This research has been conducted with the support of:



Housekeeping

Recording in progress

- This webinar will be recorded for the benefit of those who are unable to attend
- The recording will be available on the AEMO website

Questions and answers

- There will be an opportunity for questions at the end of the webinar

Background



Over the past couple of years, our Project EDGE research has included:

- Surveying **potential residential customers** about their perceptions of adopting DER and joining a VPP
- Interviewing **potential C&I customers** about their perceptions of adopting DER and joining a VPP
- Interviewing **current residential customers of the three Project EDGE aggregators** about their VPP and aggregator perceptions and experiences

Background



Our current research, which involved surveying **current residential customers of the three Project EDGE aggregators**, sought to provide complimentary insights and to fill several research gaps we had previously identified in our review of the current DER/VPP literature, including:

- How to enhance customer trust in VPPs
- How to develop a relational style of interaction with VPP customers
- Whether customers are satisfied with the financial rewards of their VPP participation
- How to effectively communicate with VPP customers

Survey of residential VPP customers

Overview



Sample:

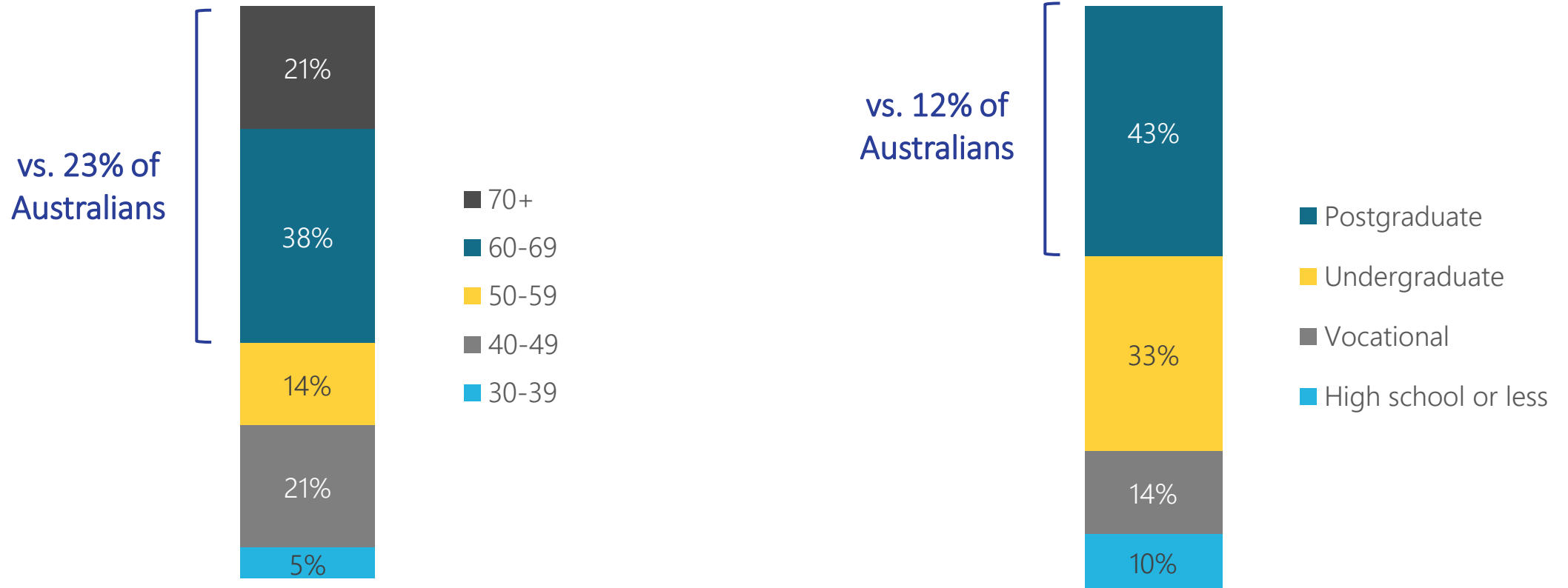
- 63 current VPP customers (29% email response rate) completed an online survey
- All were customers of the three Project EDGE aggregators

Data collection: April 2023

Customer profile: Age and education



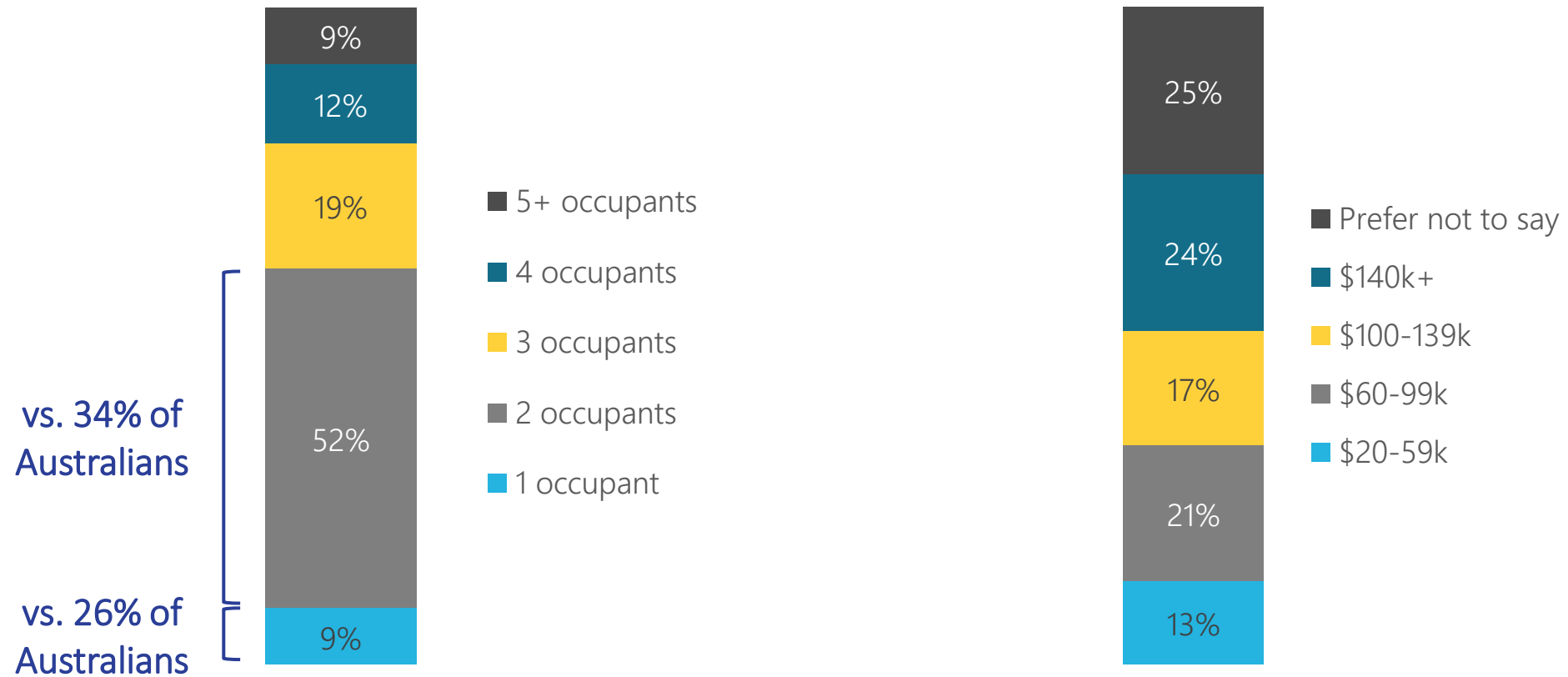
Customers were older and more likely to have a postgraduate education than the average Australian



Customer profile: Household occupants and income



Customers were more likely to live in dual-occupant households than the average Australian

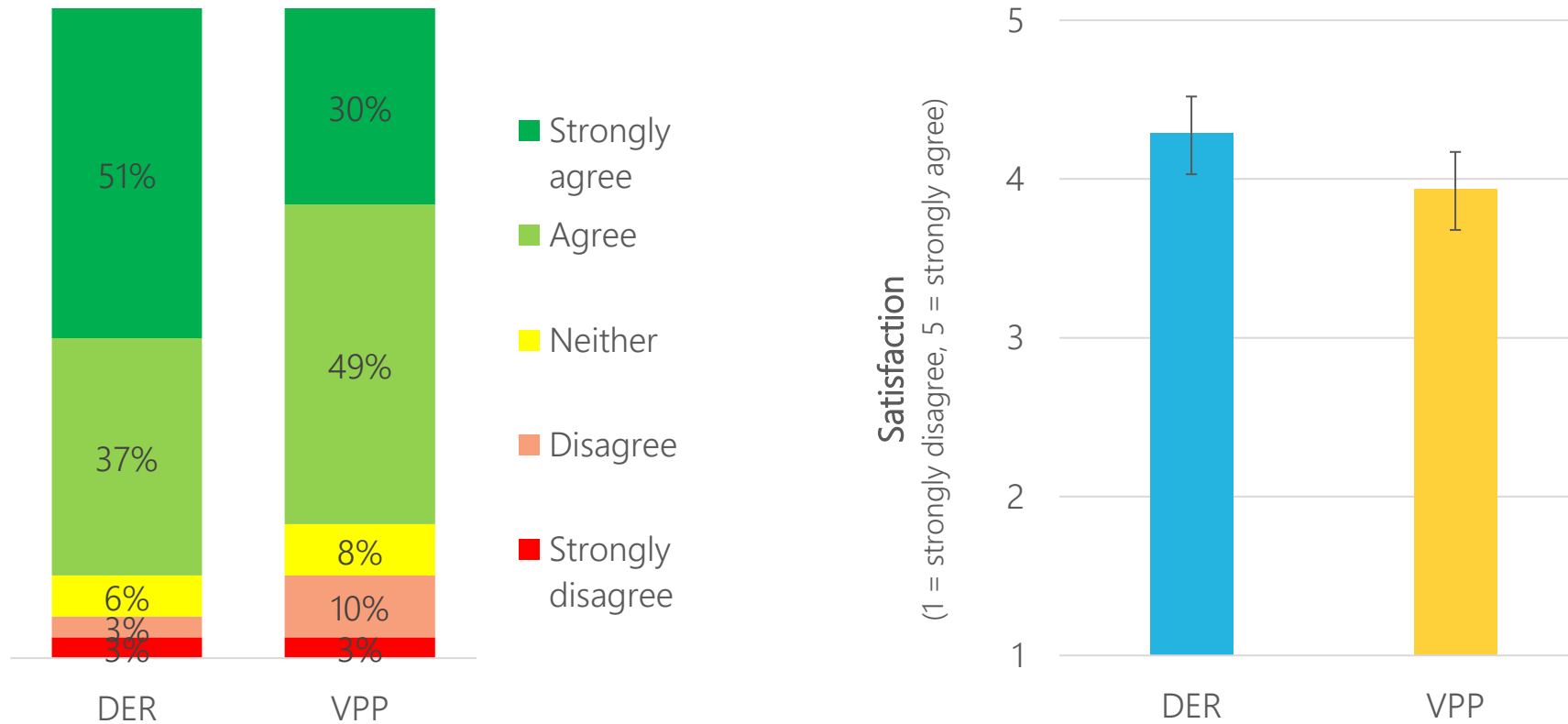


Reported number of household occupants and annual household income

Insight 1: VPP satisfaction was broad but fragile



Customers were generally satisfied with their DER and VPP...



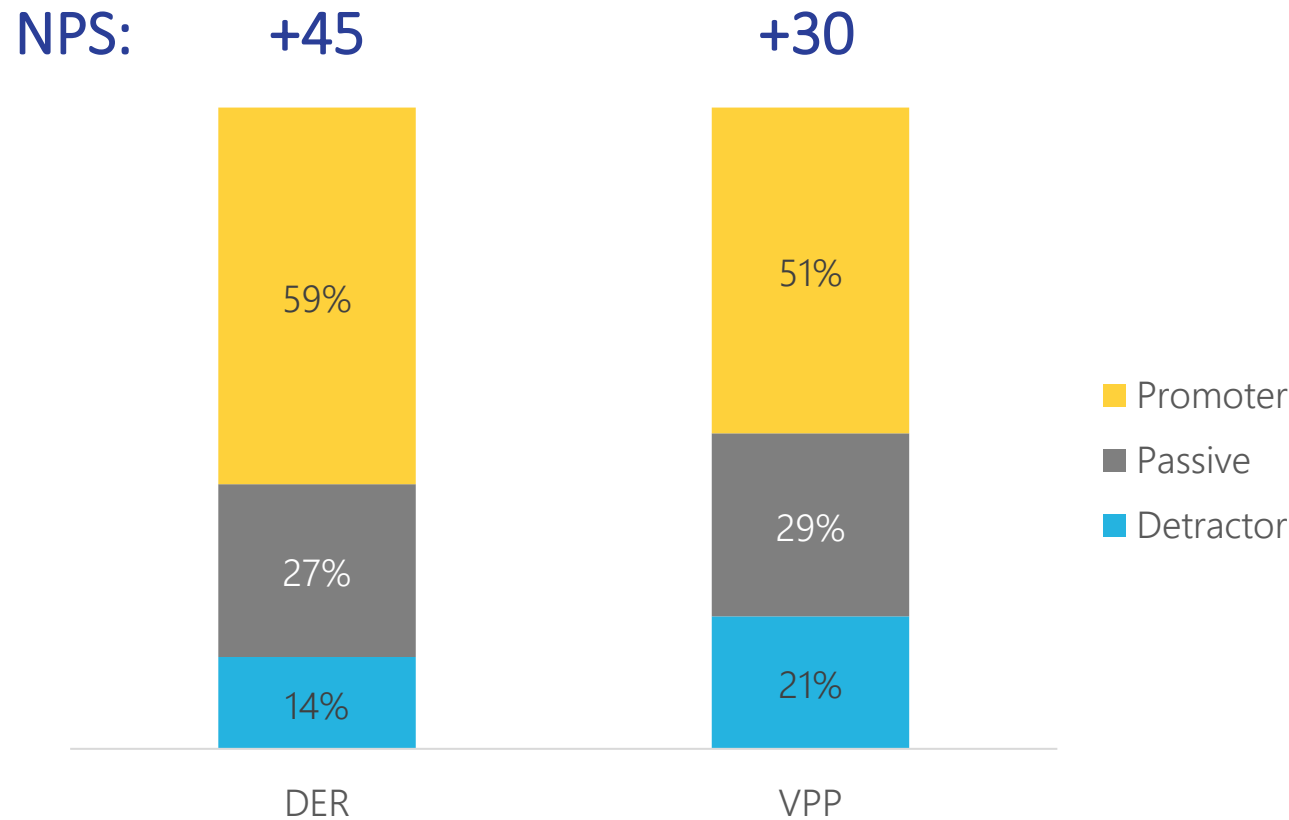
Customer satisfaction with their DER and VPP

Note: The error bars represent 95% confidence intervals. Columns with non-overlapping 95% confidence intervals significantly differ from each other.

Insight 1: VPP satisfaction was broad but fragile



Customers were generally satisfied with their DER and VPP...



Competitor NPS

+11 (average of 7 VPPs)

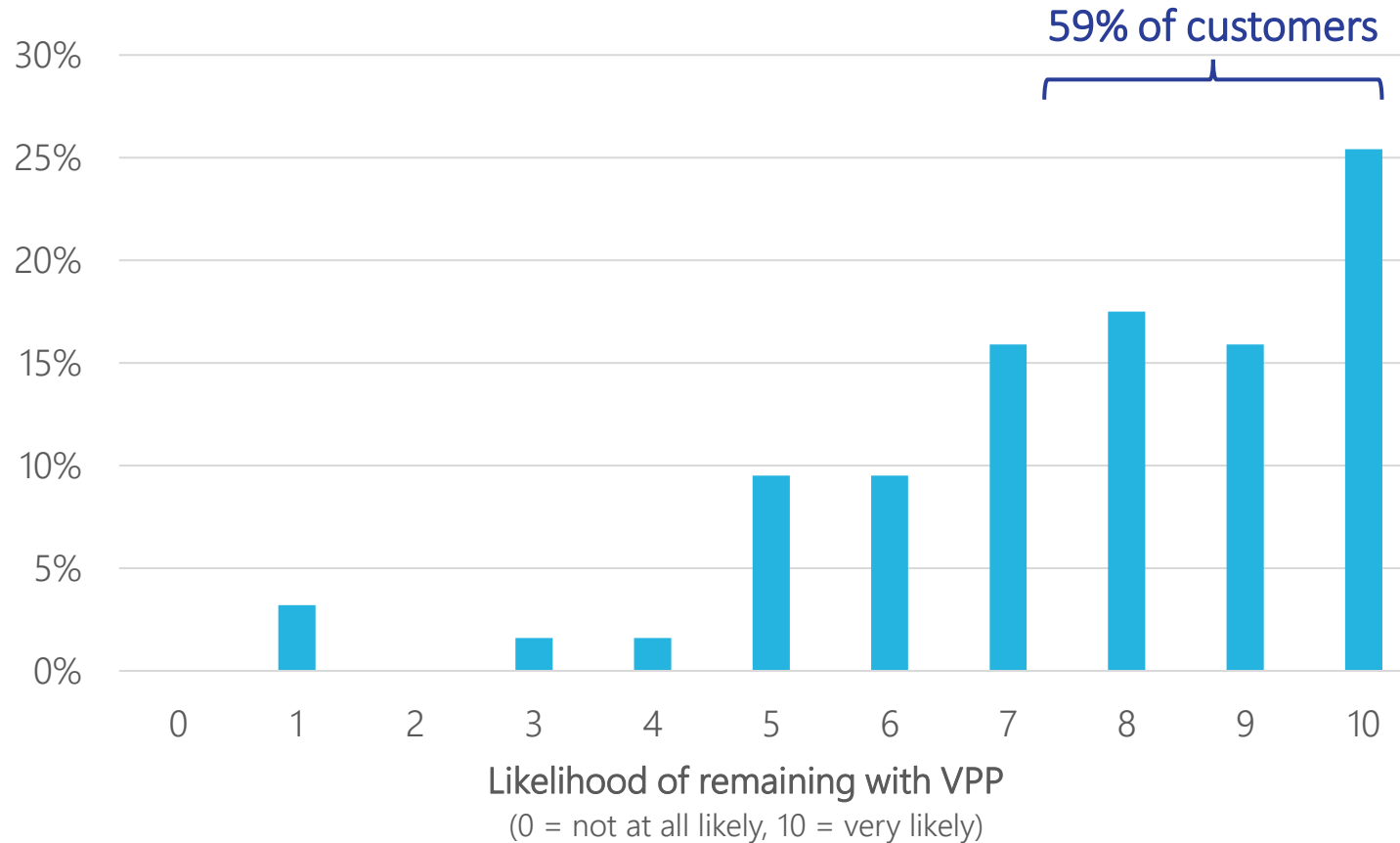
+65 (Simply Energy VPPx)

Net Promoter Score (NPS) for DER and VPP

Insight 1: VPP satisfaction was broad but fragile



Customers were generally satisfied with their DER and VPP...

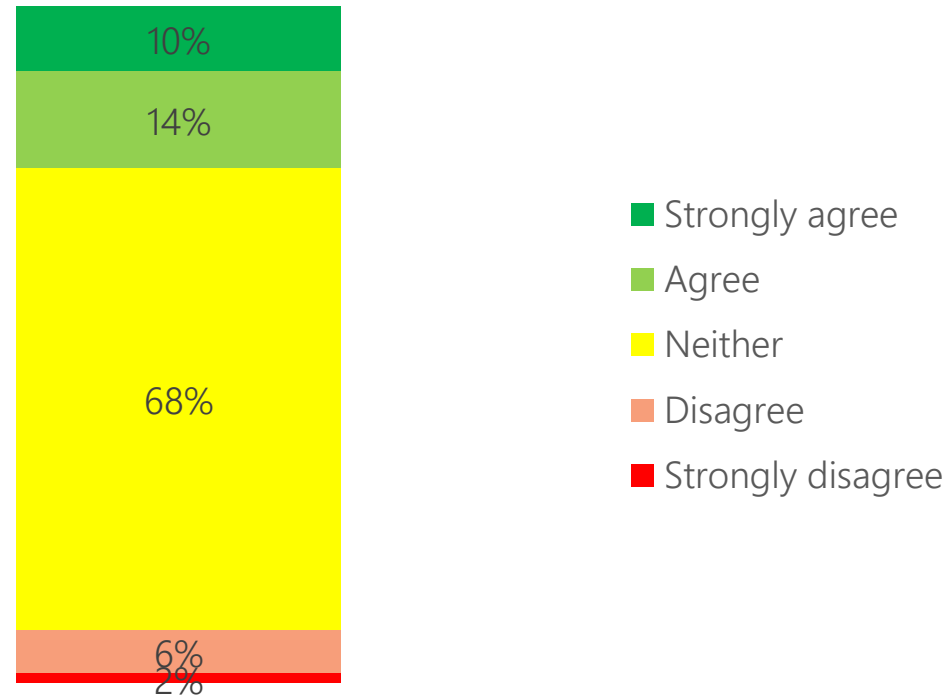


Likelihood of remaining with VPP following the conclusion of the trial

Insight 1: VPP satisfaction was broad but fragile



...but most (68%) could not tell whether their VPP was competitive relative to other VPPs...

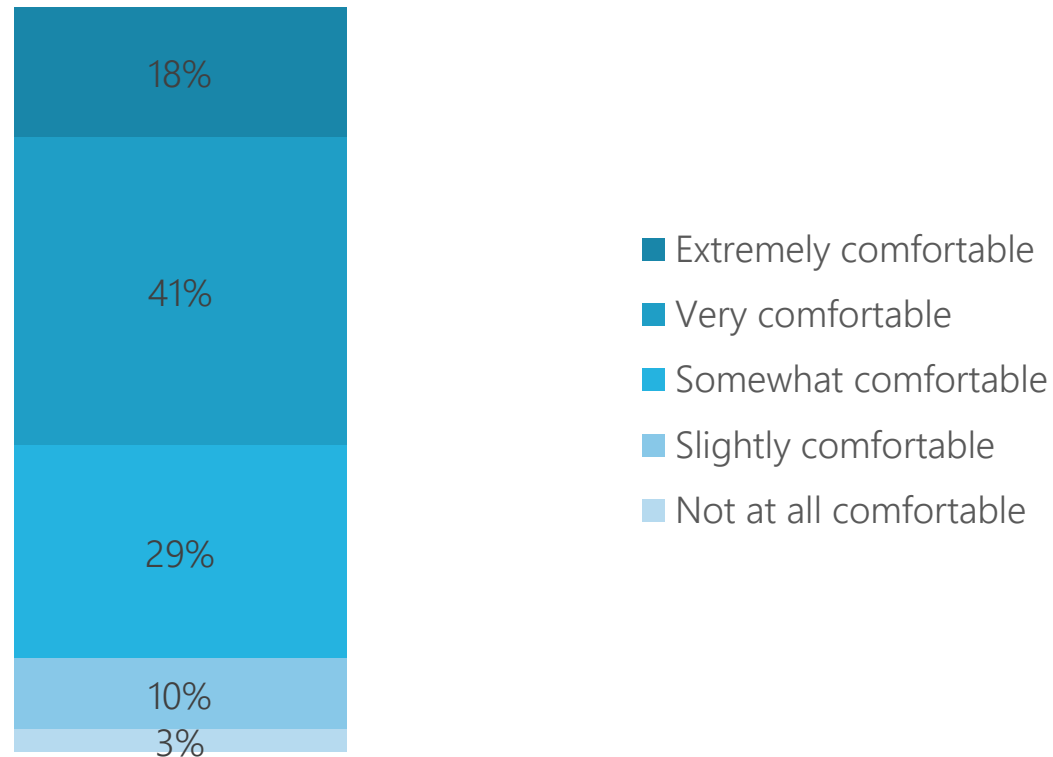


Perception that VPP compares well with other similar VPPs

Insight 1: VPP satisfaction was broad but fragile



...and only a little over half (59%) were very or extremely comfortable with the aggregator managing their DER

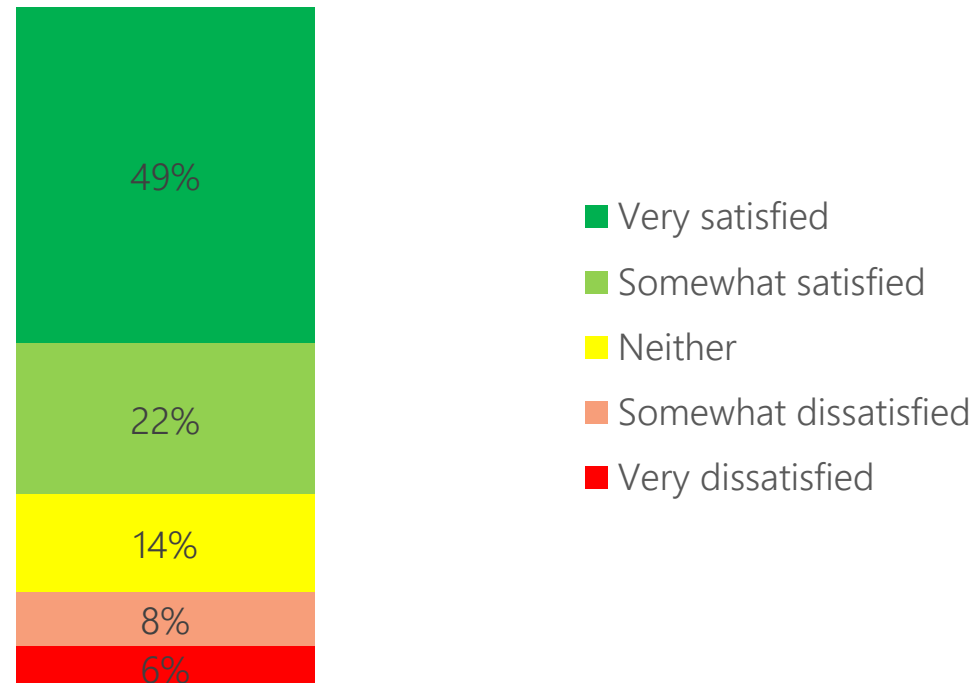


Customers' level of comfort with aggregator accessing and using DER

Insight 2: Value proposition requires work



Although most (71%) customers were either somewhat or very satisfied with the financial rewards they were receiving for participating in the VPP...

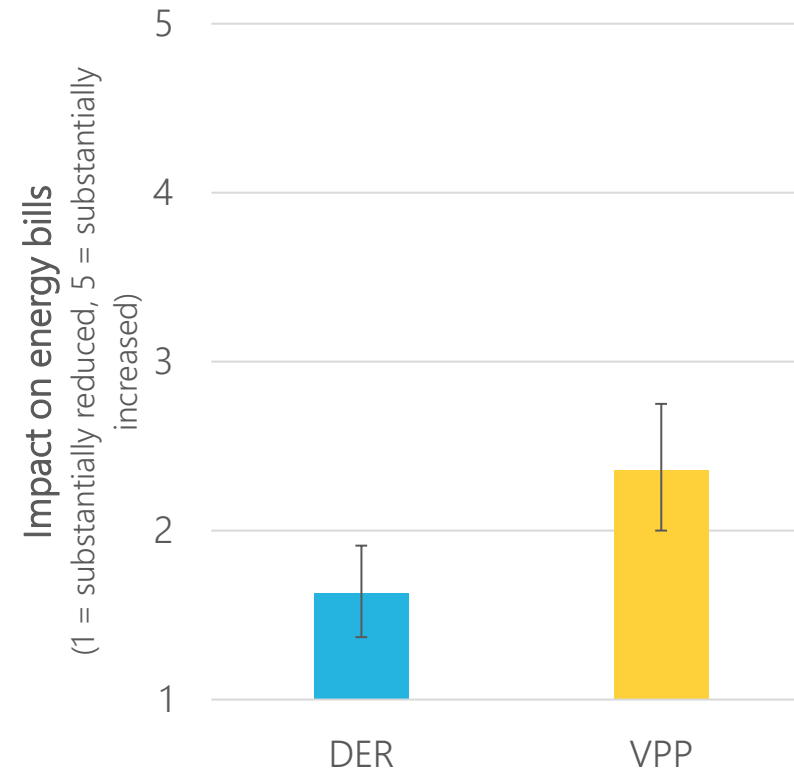
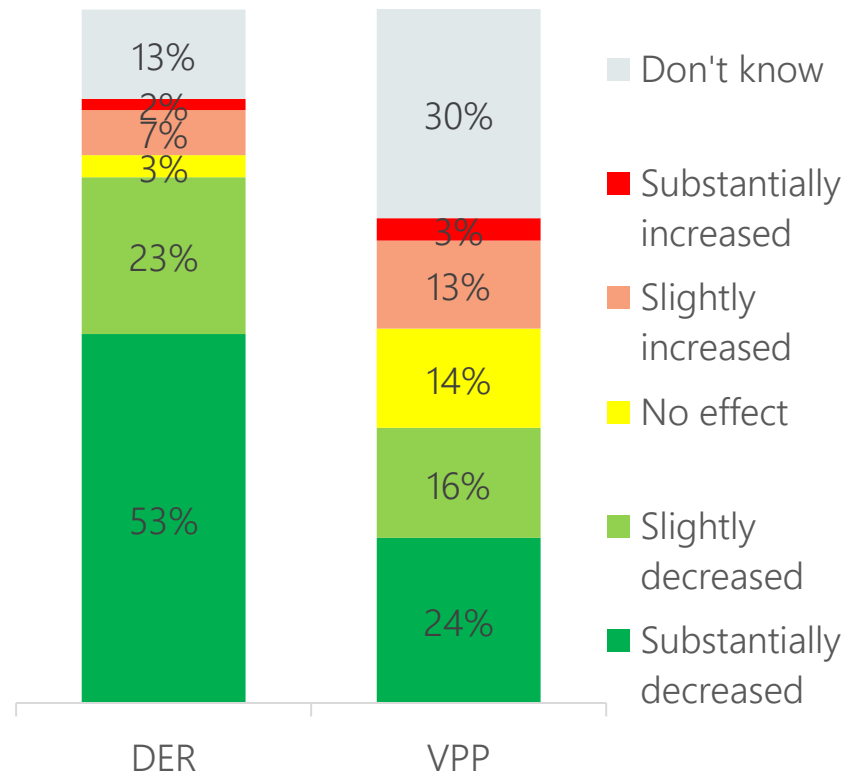


Satisfaction with the financial rewards received for participating in VPP

Insight 2: Value proposition requires work



...only 40% reported that joining the VPP had helped reduce their energy bills



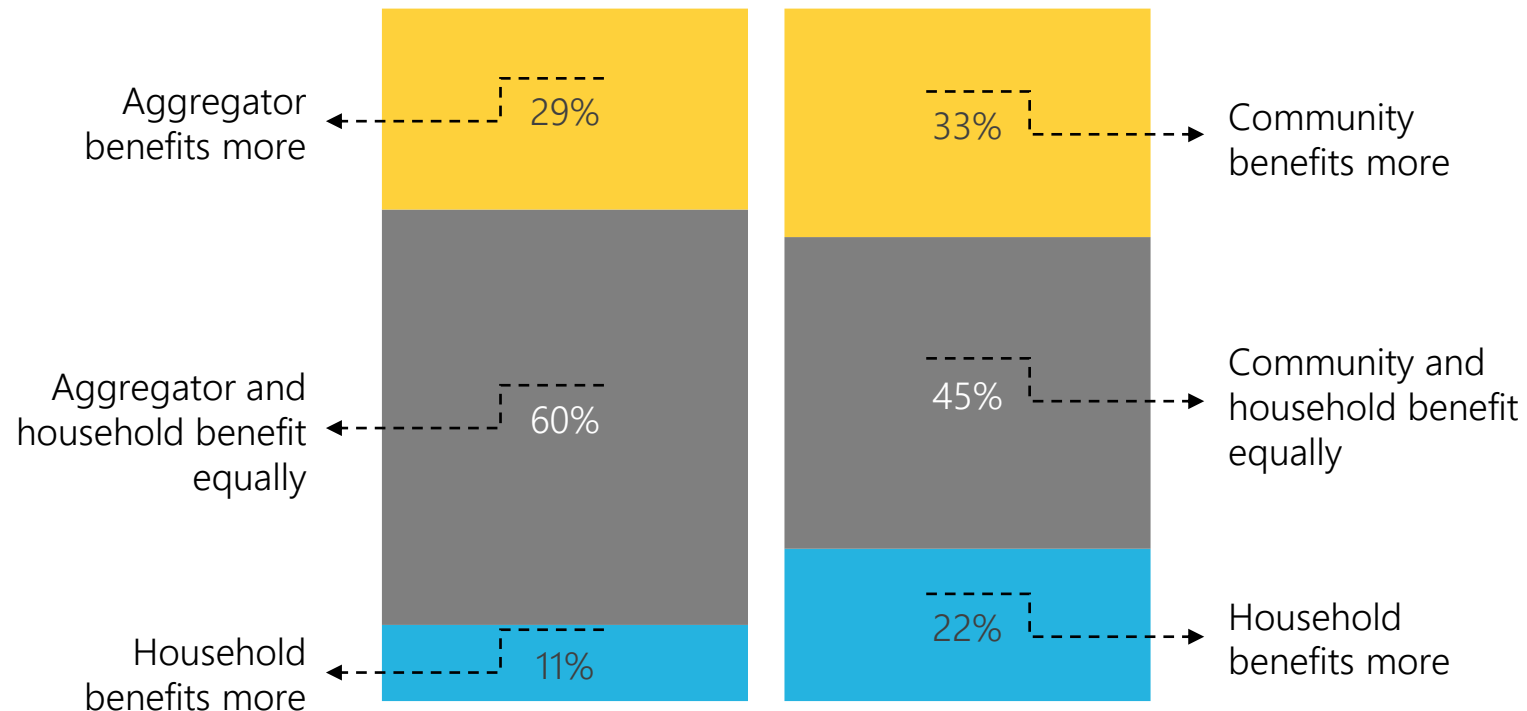
Perceived impact of DER and VPP adoption on energy bills

Note: The error bars represent 95% confidence intervals. Columns with non-overlapping 95% confidence intervals significantly differ from each other.

Insight 2: Value proposition requires work



Aggregator was seen to benefit more from VPP participation than households...

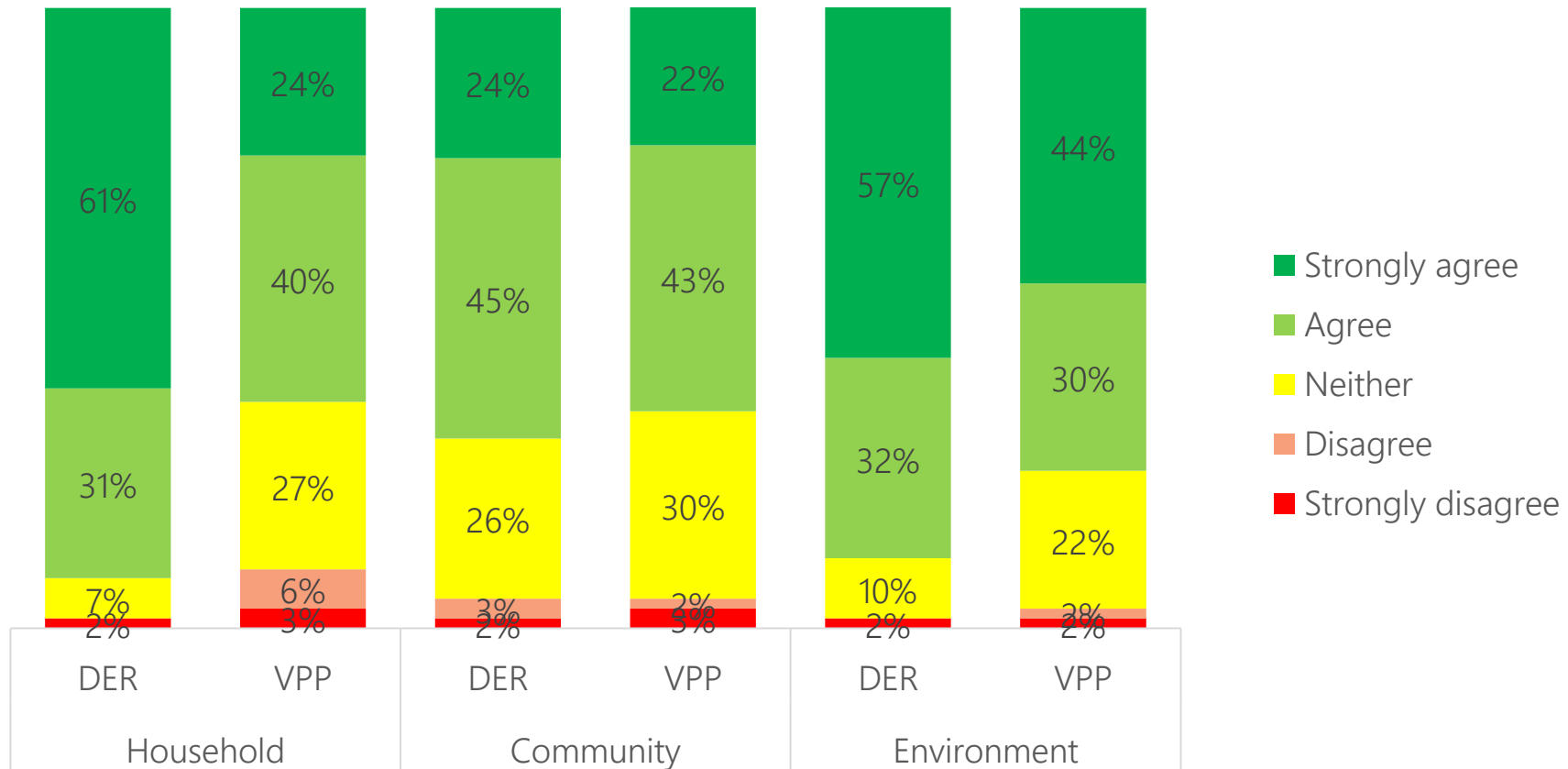


Relative sharing of VPP benefits between household/aggregator and household/community

Insight 2: Value proposition requires work



...and DER adoption was seen as delivering more benefits for households than VPP adoption

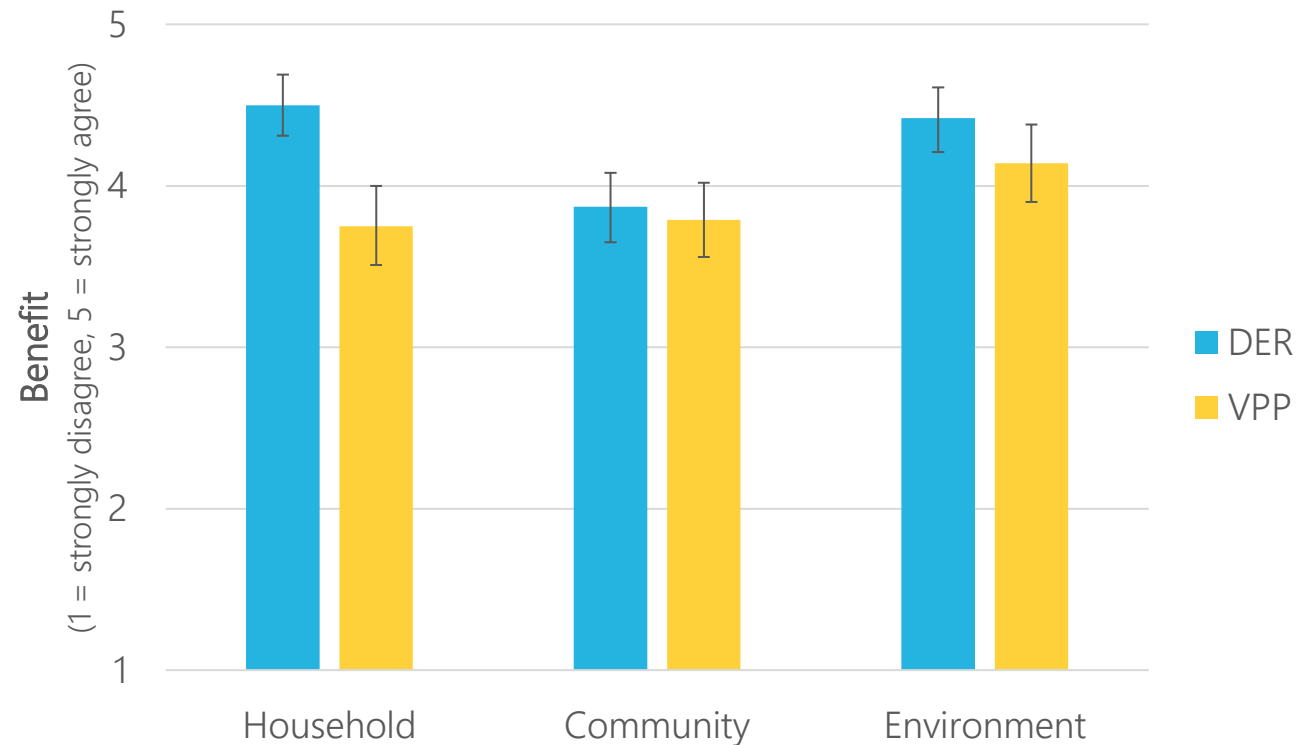


Extent to which household, community, and environment benefit from DER and VPP adoption

Insight 2: Value proposition requires work



...and DER adoption was seen as delivering more benefits for households than VPP adoption



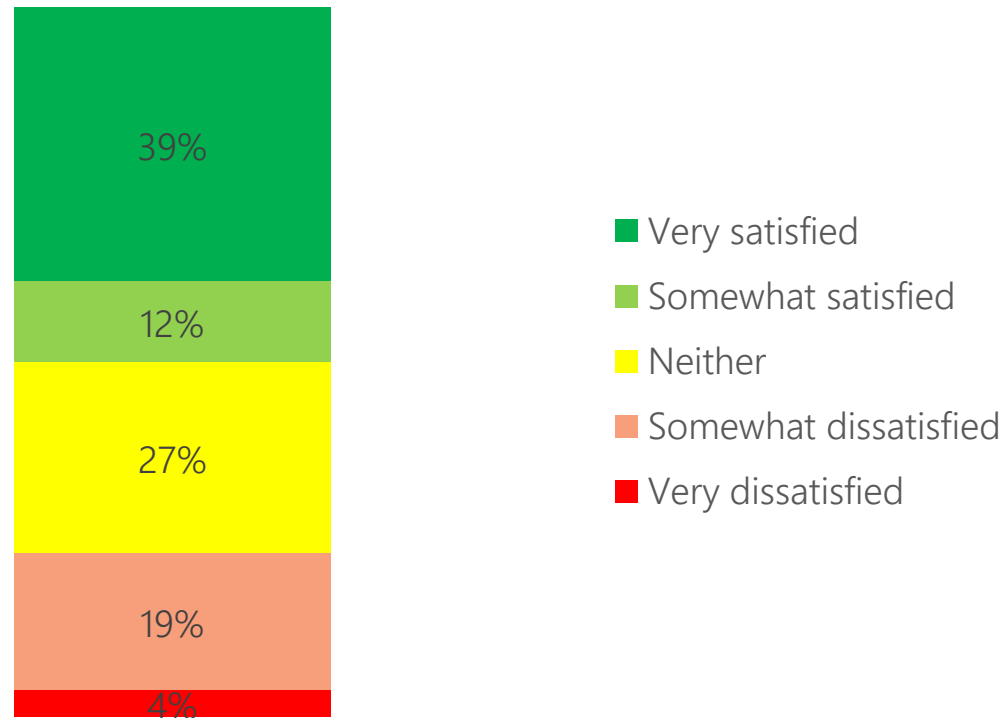
Extent to which household, community, and environment benefit from DER and VPP adoption

Note: The error bars represent 95% confidence intervals. Columns with non-overlapping 95% confidence intervals significantly differ from each other.

Insight 3: Customers were seeking improved communication and transparency



Of the customers who recalled seeing at least one message from the VPP, only half (51%) reported being satisfied with those messages



Satisfaction with the messages received from the VPP

Insight 3: Customers were seeking improved communication and transparency



Open-ended suggestions for improved communications included:

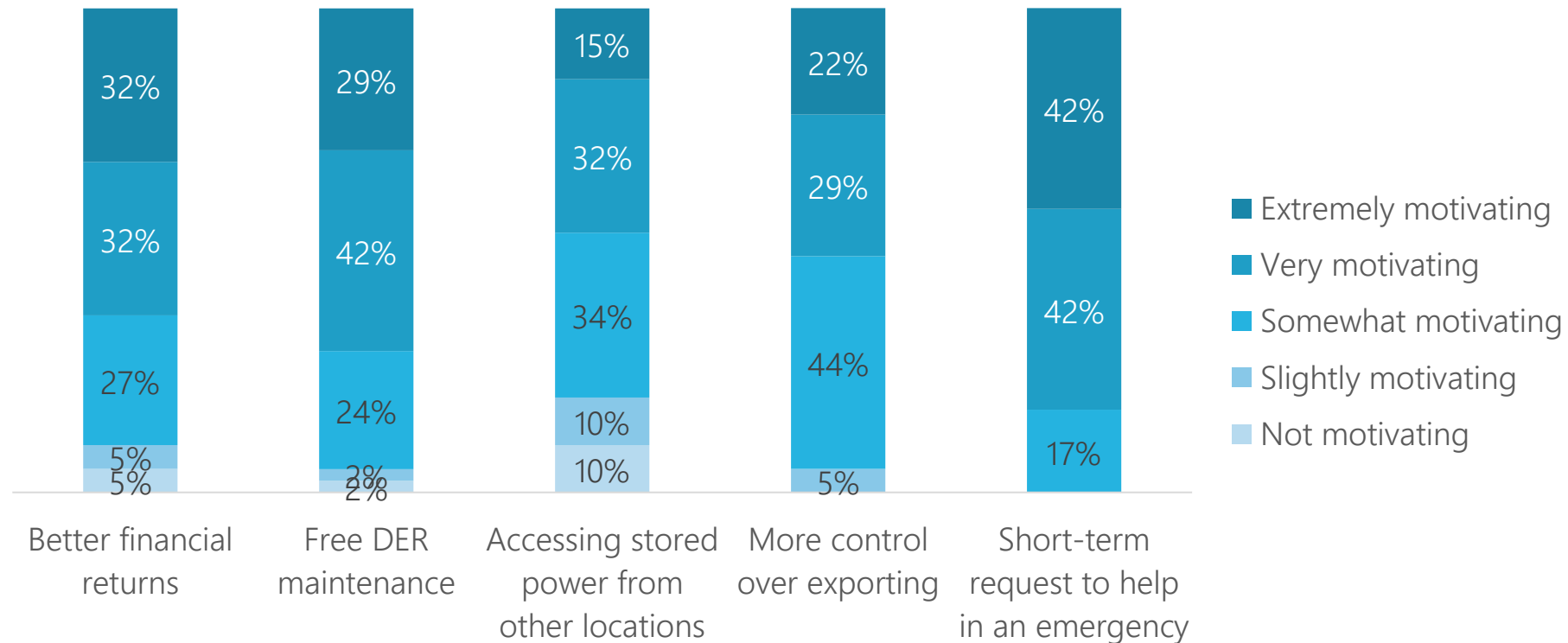
- Real-time impact of VPP activity
 - Customers wanted to know *when* and *why* their DER assets were being used
- Forewarning of VPP activity
 - Allow customers to plan their appliance use
- Project EDGE learnings
 - Highlights that for some customers, participation was driven by a desire to help develop a technology deemed essential for achieving community and environmental outcomes

Notably, these same suggestions were also given (in a separate question) as ways to improve customers' comfort with an aggregator actively managing their DER

Insight 4: Financial and non-financial strategies may motivate additional export activity



While all strategies were rated as very/extremely motivating by at least 47% of customers...

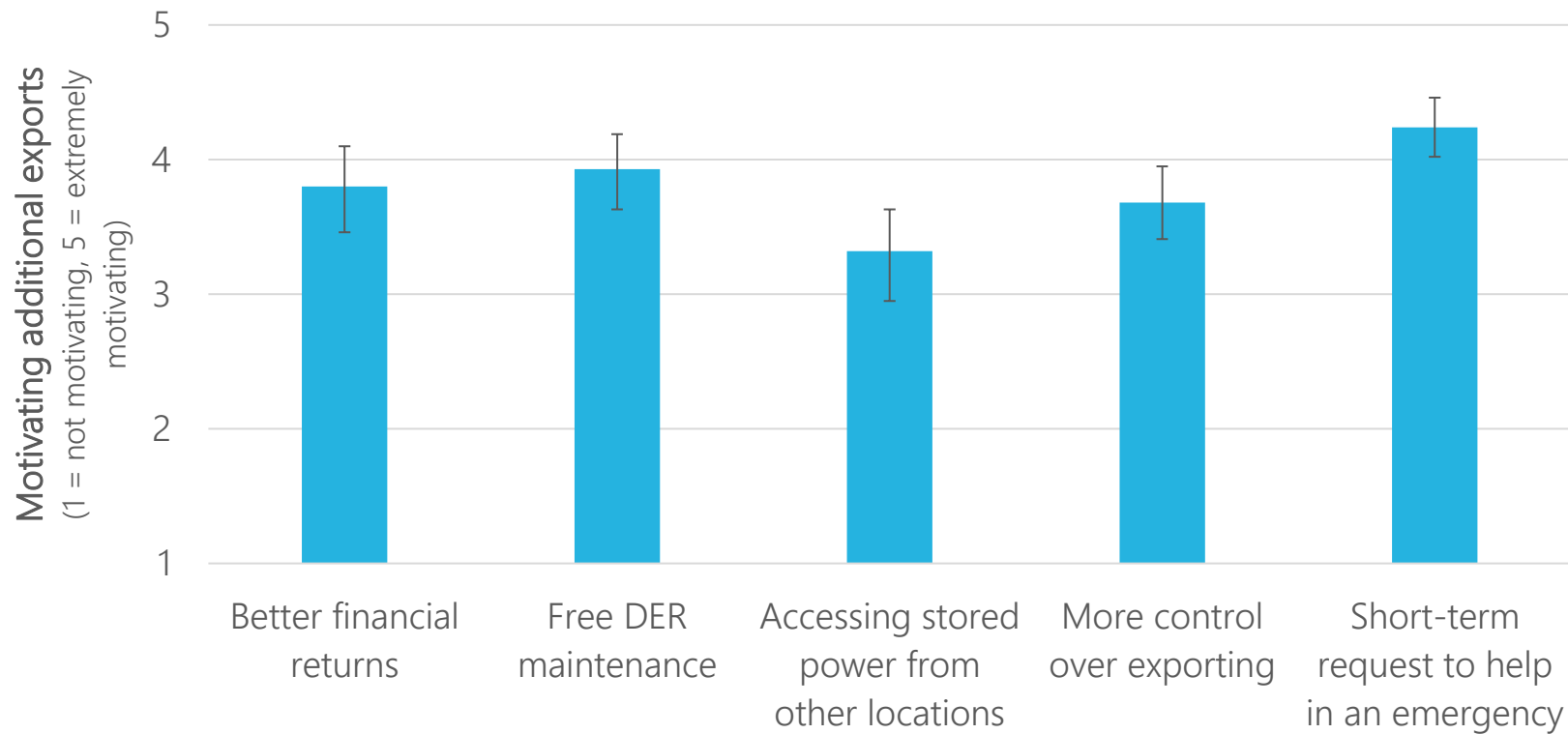


Perceived motivating influence of different strategies for increasing VPP export activity

Insight 4: Financial and non-financial strategies may motivate additional export activity



...philanthropically-focused requests were rated as very/extremely motivating by 84%



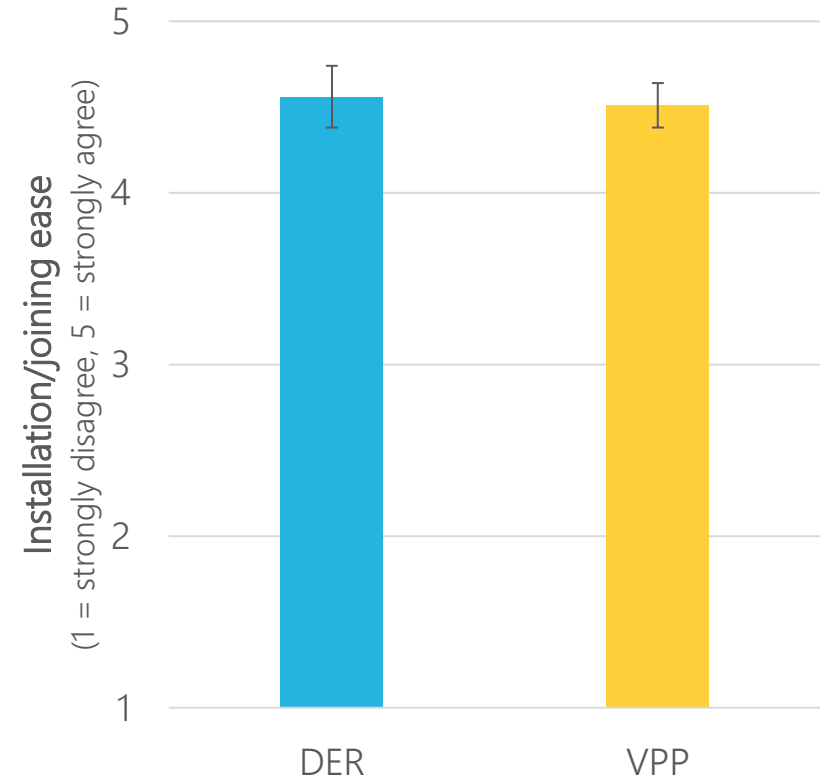
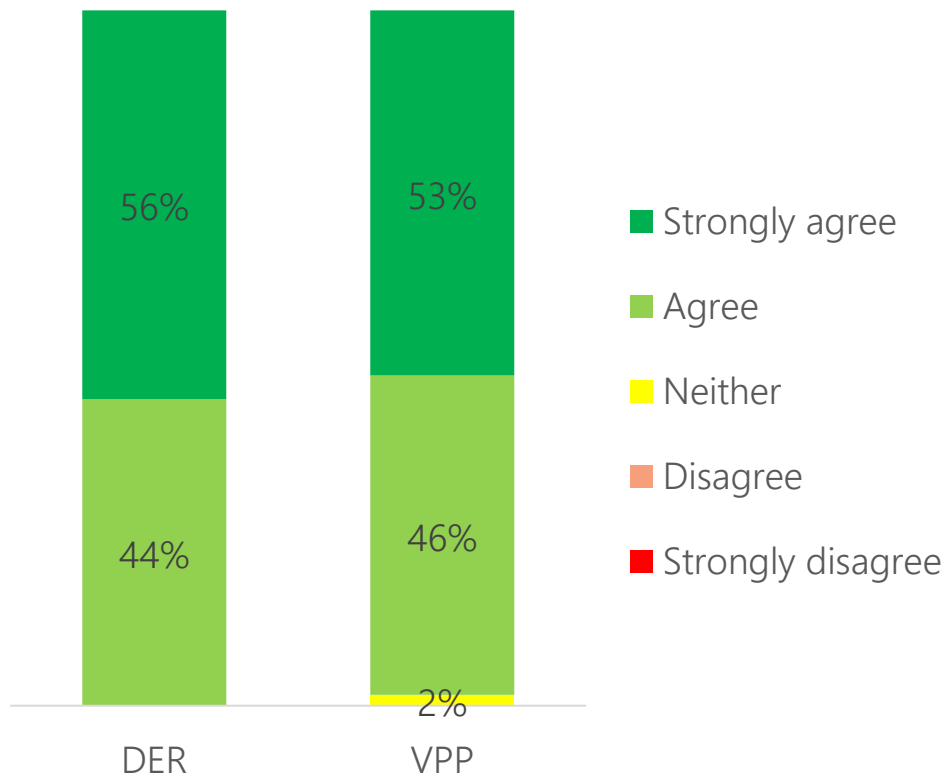
Perceived motivating influence of different strategies for increasing VPP export activity

Note: The error bars represent 95% confidence intervals. Columns with non-overlapping 95% confidence intervals significantly differ from each other.

Insight 5: While service experience was generally seen as good, areas for improvement were identified



Customers found the process of installing DER and joining the VPP easy...



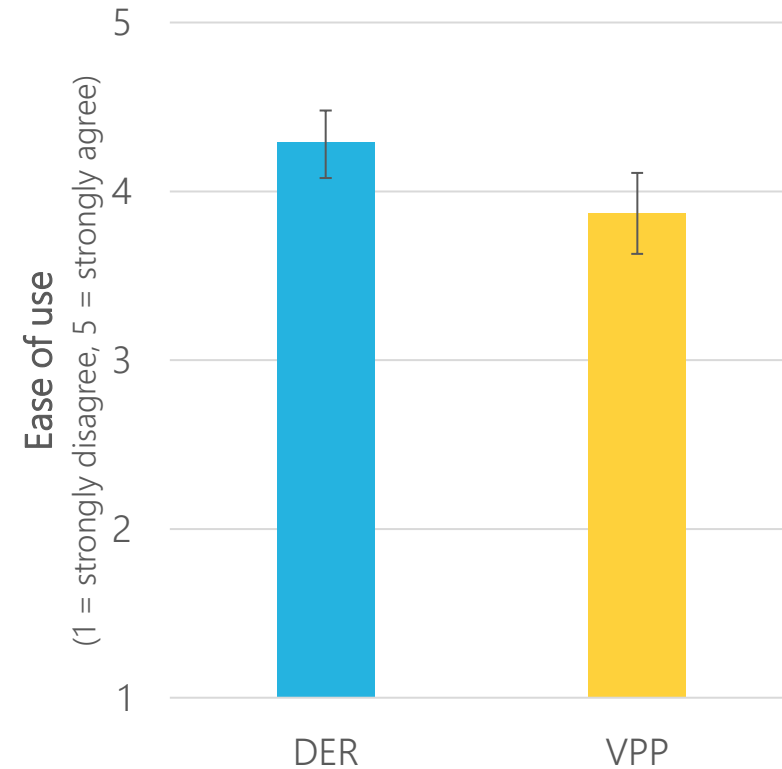
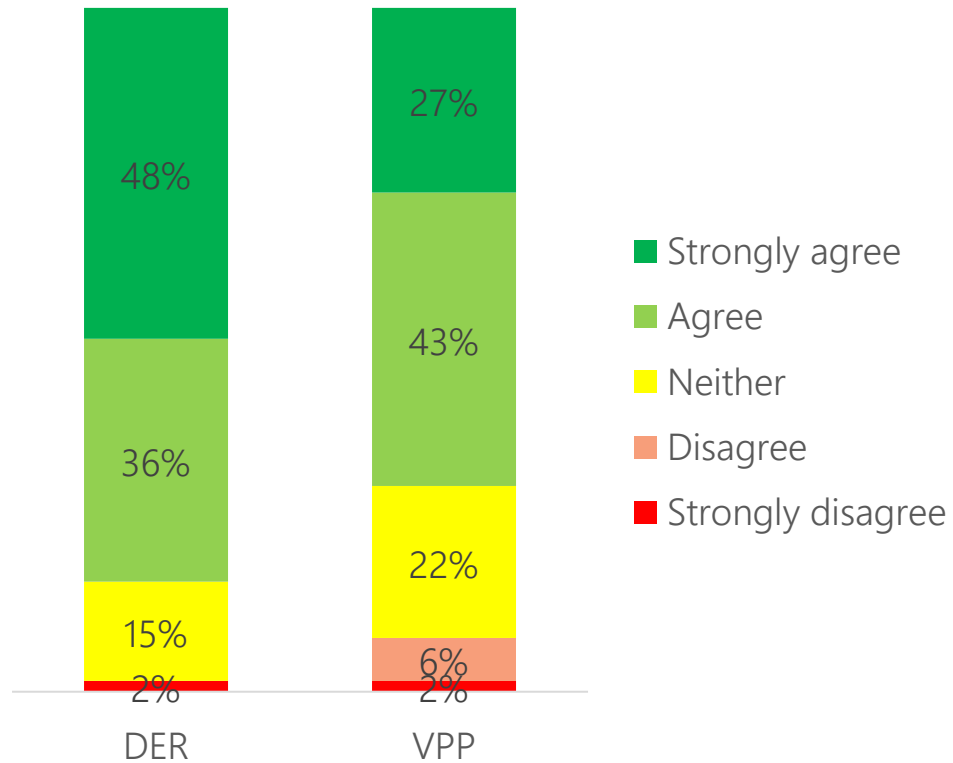
Perceived ease of installing DER and joining VPP

Note: The error bars represent 95% confidence intervals. Columns with non-overlapping 95% confidence intervals significantly differ from each other.

Insight 5: While service experience was generally seen as good, areas for improvement were identified



...but only 27% strongly agreed the VPP was easy to use despite most VPPs being automated...



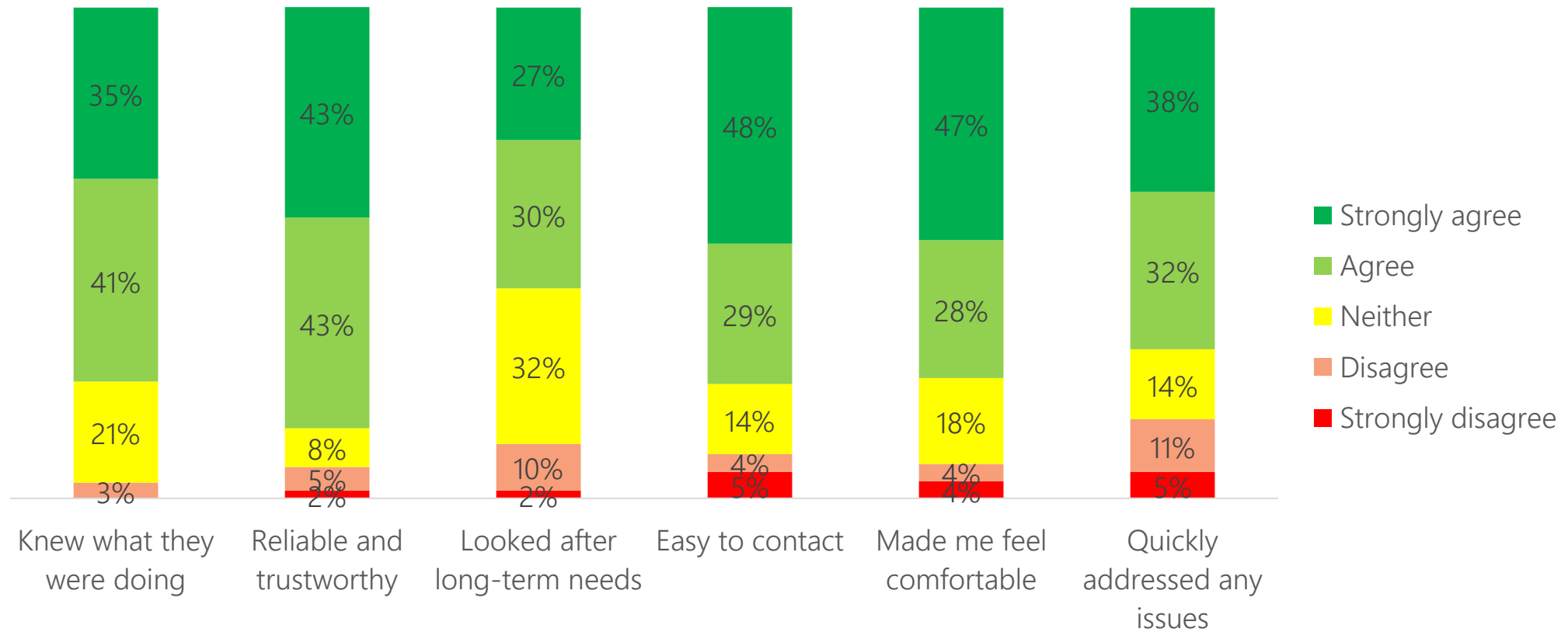
Perceived ease of using DER and VPP

Note: The error bars represent 95% confidence intervals. Columns with non-overlapping 95% confidence intervals significantly differ from each other.

Insight 5: While service experience was generally seen as good, areas for improvement were identified



...and only 57% agreed/strongly agreed that the aggregator was looking after their long-term needs

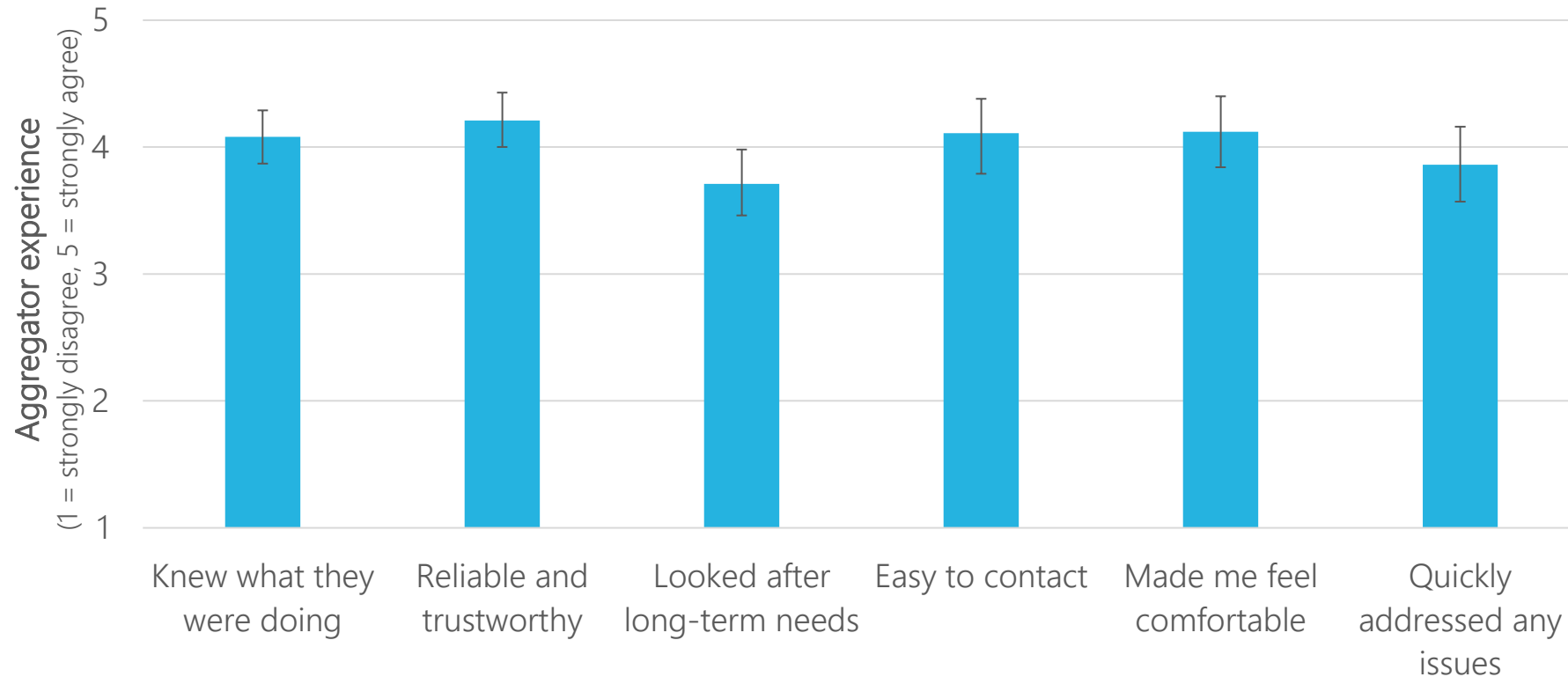


Perceptions of aggregator service experience

Insight 5: While service experience was generally seen as good, areas for improvement were identified



...and only 57% agreed/strongly agreed that the aggregator was looking after their long-term needs



Perceptions of aggregator service experience

Note: The error bars represent 95% confidence intervals. Columns with non-overlapping 95% confidence intervals significantly differ from each other.

Next steps

Next Steps



Customer Insights Study Public Webinar

- When: **Wednesday 7th June: 11am – 12:30pm**
- **What will be covered:** We are currently preparing a short overview that highlights key customer insights from all of the Project EDGE research we have conducted
- **Webinar invites:** To be sent at the end of week with details including the Microsoft Teams link, Agenda and Content of the Webinar. No registration required. If you haven't received an email by the end of the week, please contact: EDGE@aemo.com.au

Upcoming Report Publications

- Project EDGE: Qualitative insights into the experiences of customers participating in a Virtual Power Plant field trial
- Project EDGE: Surveying customers to understand their experiences participating in a Virtual Power Plant field trial

Further information



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

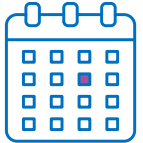
<https://aemo.com.au/initiatives/major-programs/nem-distributed-energy-resources-der-program/der-demonstrations/project-edge/project-edge-reports-1>

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

Questions?



Project EDGE - 2023 Knowledge Sharing Roadmap



PROJECT EDGE Knowledge Sharing Calendar



Completed

We Are Here

Incomplete

Project EDGE Publications

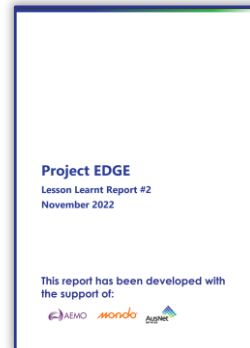


For any questions, comments or feedback please contact: EDGE@aemo.com.au

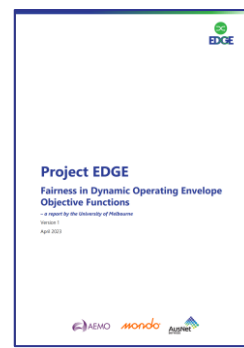
Knowledge Sharing Reports



[Cost Benefit Analysis](#)



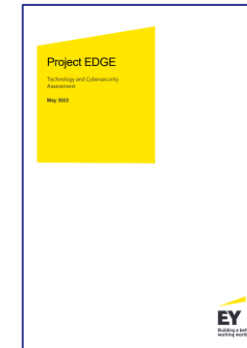
[Lesson Learnt #2](#)



[Fairness in DOE Objective Functions](#)



[DER Data Hub Lessons Learnt](#)

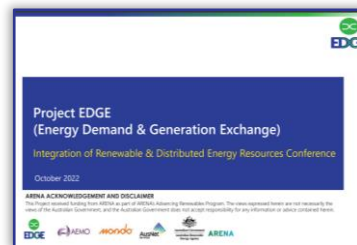


[Technology and Cyber Security Assessment](#)



[Customer Insights: Qualitative Insights of Customers in EDGE](#)

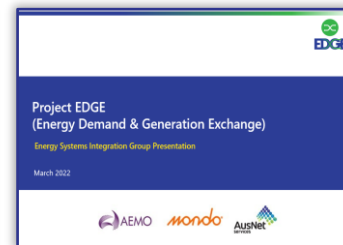
Conferences



[Energy Systems Integration Conference](#)



[DEIP Dive DER Market Integration Conference](#)

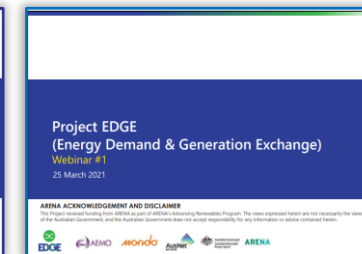


[Renewable and Distributed Resources International Conference](#)

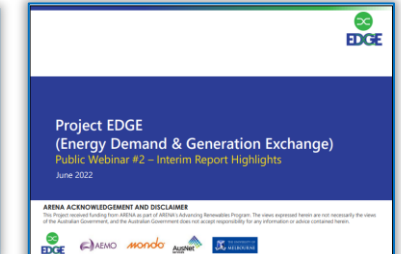
Public Webinars



[Research Plan](#)

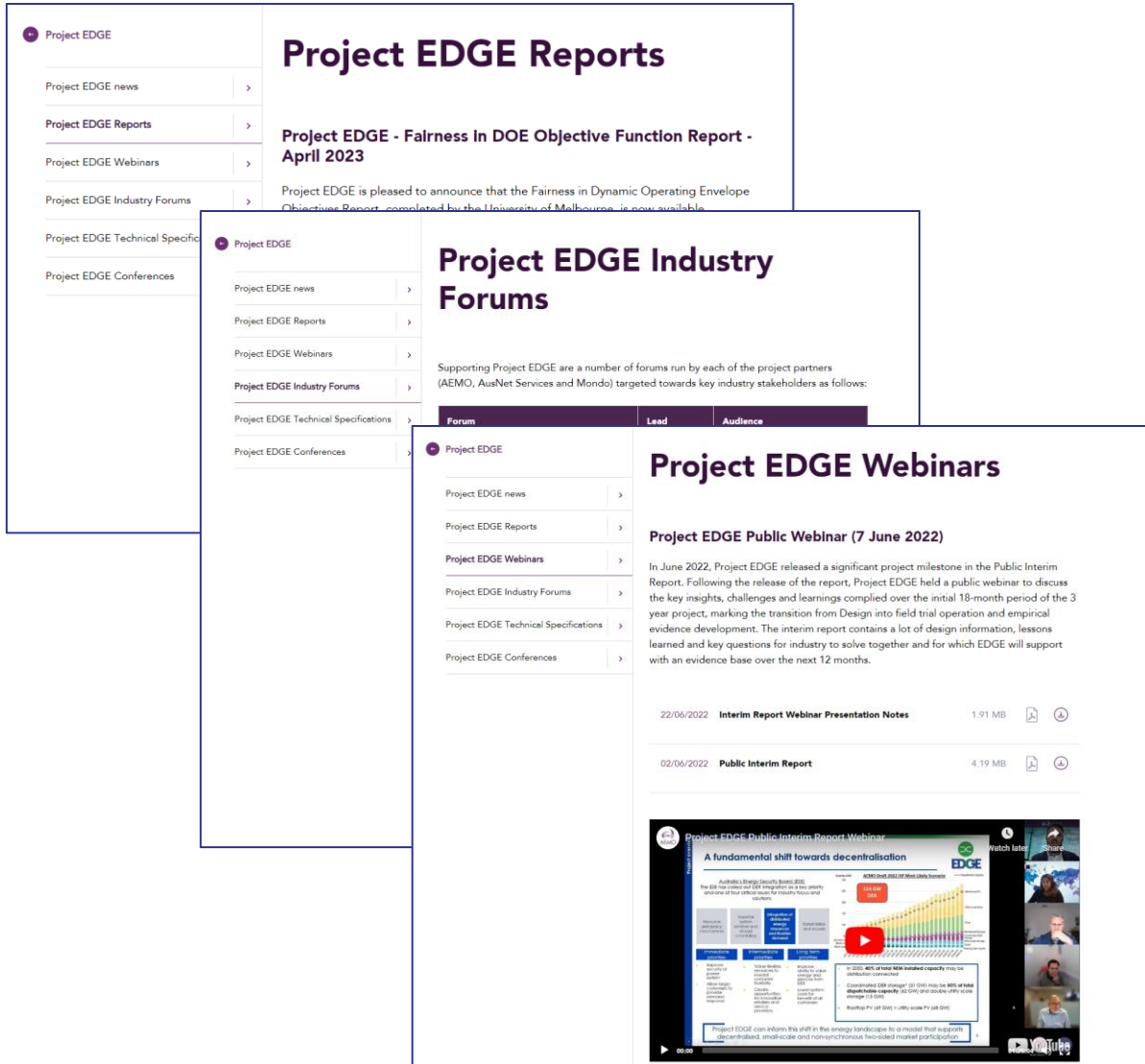


[Webinar #1](#)



[Public Interim Report Webinar](#)

Project EDGE Website Changes



The image displays three overlapping screenshots of the Project EDGE website interface, illustrating the new layout and content organization.

- Top Screenshot: Project EDGE Reports**
 - Navigation menu: Project EDGE, Project EDGE news, Project EDGE Reports, Project EDGE Webinars, Project EDGE Industry Forums, Project EDGE Technical Specifications, Project EDGE Conferences.
 - Section: **Project EDGE Reports**
 - Content: **Project EDGE - Fairness in DOE Objective Function Report - April 2023**. Text: "Project EDGE is pleased to announce that the Fairness in Dynamic Operating Envelope Objectives Report, completed by the University of Melbourne, is now available."
- Middle Screenshot: Project EDGE Industry Forums**
 - Navigation menu: Project EDGE, Project EDGE news, Project EDGE Reports, Project EDGE Webinars, Project EDGE Industry Forums, Project EDGE Technical Specifications, Project EDGE Conferences.
 - Section: **Project EDGE Industry Forums**
 - Text: "Supporting Project EDGE are a number of forums run by each of the project partners (AEMO, AusNet Services and Mondo) targeted towards key industry stakeholders as follows:"
 - Table:

Forum	Lead	Audience
- Bottom Screenshot: Project EDGE Webinars**
 - Navigation menu: Project EDGE, Project EDGE news, Project EDGE Reports, Project EDGE Webinars, Project EDGE Industry Forums, Project EDGE Technical Specifications, Project EDGE Conferences.
 - Section: **Project EDGE Webinars**
 - Section: **Project EDGE Public Webinar (7 June 2022)**
 - Text: "In June 2022, Project EDGE released a significant project milestone in the Public Interim Report. Following the release of the report, Project EDGE held a public webinar to discuss the key insights, challenges and learnings compiled over the initial 18-month period of the 3 year project, marking the transition from Design into field trial operation and empirical evidence development. The interim report contains a lot of design information, lessons learned and key questions for industry to solve together and for which EDGE will support with an evidence base over the next 12 months."
 - Table:

Date	Title	Size	Download
22/06/2022	Interim Report Webinar Presentation Notes	1.91 MB	[Download icon]
02/06/2022	Public Interim Report	4.19 MB	[Download icon]
 - Video player: **Project EDGE Public Interim Report Webinar**. Title: "A fundamental shift towards decentralisation". Includes a video player interface with a play button and a "Watch later" button.

What did we do? We divided the Project EDGE site into 6 sections

What will you find?

News: All articles and mentions of the Project

Reports: All reports produced by and about the Project

Webinars: All Public Webinars held by the Project

Industry Forums: All presentations produced across the 4 forums held by the Project

Technical Specifications: All documentation produced

Conferences: All presentations given by Project EDGE for domestic and International Conferences

Why?

We have produced a lot of content through the lifespan of the Project and want to make sure it is easy accessible for everyone. As we build to the release of our Final Knowledge Sharing Report, we will continue to make our [site](#) the central point for all things EDGE.



Final meeting: 29 June 2023

Future Meetings & Close



For more information visit

aemo.com.au