Project EDGE

Qualitative insights into the experiences of customers participating in a Virtual Power Plant field trial

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This report has been developed with the support of:

Important notice

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PURPOSE

This report has been prepared for Project EDGE by Deakin University's Better Consumption Lab. The report provides insights derived from interviews with 35 customers of the three aggregators participating in Project EDGE. The report focuses particularly on understanding these customers' experiences in joining and interacting with a Virtual Power Plant (VPP).

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- the work of Deakin University in preparing this report; and
- the support, co-operation and contribution of the other Project EDGE participants and consultants in providing data and information used by Deakin University to prepare this report.

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Executive summary

Deakin University's Better Consumption Lab has undertaken a series of customer insight studies as part of Project EDGE, with examples of previous reports including:

- Interviews with customers across 16 households who had – or had considered – purchasing a battery to understand their interest in joining a Virtual Power Plant (VPP)[1].
- A literature review of research on customer experiences with Distributed Energy Resources (DERs) and VPPs[2].
- A survey of 893 homeowners within the broader Australian community to understand their perceptions and intentions to adopt DER and join a VPP[3].

The current report provides a complimentary set of insights by evaluating the experiences of actual VPP customers. In so doing, the report addresses a set of research gaps identified by the Lab in their review of existing DER and VPP research, including how to enhance customer trust in VPPs, how to develop a relational style of interaction with customers, and what customers consider to be a smooth installation and service experience.

This report presents an analysis of 35 semi-structured interviews conducted with customers of the three DER aggregators participating in Project EDGE. Interview findings relate to customers' DER and VPP experiences within the context of each aggregator's Project EDGE trial offering, which took place between May 2022 and March 2023. Key insights from these interviews are summarised as follows:

Customers' motivations for adopting DER and joining a VPP

- The motivations for adopting DER and joining a VPP triangulated with findings from other community- and customer-focused Project EDGE research conducted by the Better Consumption Lab, suggesting that a relatively common set of motivations underpin these decisions, irrespective of aggregator or customer cohort.
- The motivations for adopting DER and joining a VPP were multifaceted, suggesting that no one factor is enough to motivate most households to adopt DER and join a VPP.
- Some customers blurred the benefits of DERs and VPPs, which may pose challenges with: (i) helping customers understand the relative benefits of adopting DERs versus joining a VPP; and (ii) managing customers' expectations if issues encountered with one of these technologies is misattributed to the other.
- Customers may not need to see the distinct value of a VPP to still join a VPP if it is offered as part of an attractive bundle of broader energy services.
- Insufficient financial returns were a persistent concern of customers and may pose reputational risks for aggregators, with customers perceiving any substantive difference between consumption usage rates and fixed or variable feed-in tariffs as profit-taking activity

[1] Zenkić, J. Newton, J., Rotman, J., & Weber, V. (2022). Project EDGE: Public customer insight and engagement study interim report. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/public-customer-insight-and-engagement-study-interim-report.pdf?la=en

[2] Rotman, J., Newton, J., Weber, V., & Jacob John, J. (2022). Project EDGE: Gaps in existing DER customer insights research. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/project-edge-lit-review-der-customer-insights-research.pdf?la=en

[3] Newton, J., Jacob John, J., Weber, V., & Rotman, J. (2022). Project EDGE: General community perceptions of distributed energy resources. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/community-perceptions-of-der-and-aggregation-services.pdf?la=en

by aggregators. How aggregators manage the financial expectations of customers is therefore likely to be key to both customer acquisition and retention.

- In joining a VPP, customers were symbolically giving aggregators access to the heart of their home, and they wanted assurances that this would not leave them vulnerable to hackers.
- For some customers, joining a VPP was a 'leap of faith' that due diligence activities – such as seeking out information from independent third parties – could not fully overcome. For example, customers could not determine the net financial implications of participating in a VPP until after they had joined, if at all.

Customers' experiences with their DER aggregator

- Customers appreciated sales teams that were courteous, knowledgeable, and happy to answer questions, and these positive experiences laid the foundation for establishing trust in the aggregator.
- Customers expected the aggregator to coordinate the various third parties required to finalise installation while also keeping them appraised of the installation status.
- Several consistent gaps were identified between what customers expected and what they experienced. Some customers, for example, had heightened or unrealistic expectations about what DERs or VPPs could achieve. Actively managing customers' expectations to better align with their eventual experiences will likely be key to maintaining longer-term customer satisfaction.
- Aggregators with a strong brand and a reputation for delivering good service that was validated by independent third parties and reinforced by personal experiences were well-positioned to build and maintain the trust of their customers.

Customers' perceptions of the VPP

- While some customers were happy to get 'under the hood' and customise how or when VPP activity took place (if such functionality was available), most preferred for VPP activities to occur in an automated fashion. This preference arose because the value proposition for customising VPP activity was not deemed sufficient to justify overcoming the learning curve associated with undertaking that customisation.
- One consequence of the preference for automation was that the VPP often remained a 'black box', with many customers not knowing when their DER asset was being actively managed by the aggregator.
- Customers were not averse to increasing the amount of energy they traded through a VPP, provided it passed a 'better off overall test'. That is, customers wanted assurances that they would ultimately come out ahead from any additional trading activity.
- Personalised messages that highlight the amount of underutilised stored energy each household has, and which then offers the account holder an opportunity to export this energy through a VPP, may provide one means of motivating additional export activity.
- Many customers indicated that they would respond positively to one-off requests for additional VPP exports to help vulnerable communities, provided they were: (i) not personally disadvantaged by engaging in this additional export activity; and (ii) informed of the philanthropic impact those exports were having.

Recognising the value generated through VPPs

- Customers wanted to be treated by aggregators as equal partners given the value – in the form of self-owned DER assets – they were bringing to aggregators. Customers saw greater financial rewards as one way to form a more equal partnership, but non-financial remedies, such as aggregators providing ongoing maintenance of DER assets, were also suggested.
- Customers wanted government to keep recognising the value of their VPP participation by continuing to support DER adoption (via rebates) and VPP development (via R&D funding).
- Many customers initially overestimated the value of the contribution they would be making to other households within their community, believing that by joining a VPP, they would be directly subsidising energy costs for those in need. These customers were subsequently disappointed to learn that their participation in the VPP had not generated this level of community benefit.

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1. Introduction

A Distributed Energy Resource (DER) is a technology like rooftop solar photovoltaics (PVs), electric vehicles, household batteries, and solar hot water systems that households can use to generate, store, and/or distribute energy. Third-party providers have started to offer energy services that aggregate the distribution capabilities of many household DERs through the formation of virtual power plants (VPPs). Through these VPPs, aggregators can control when connected DERs import or export power to the National Electricity Market, allowing them to trade in this market and deliver a range of network services.

While the potential value that aggregators can deliver is being increasingly recognised, the perceptions and experiences of customers participating in VPPs remains underexplored. A literature review[4] conducted by Deakin University's Better Consumption Lab as part of Project EDGE, for example, identified a range of gaps within the existing literature on customer responses to VPPs. A selection of these gaps include:

- What is required to retain customers in a VPP long-term?
- How do other customer segments – beyond that of early adopters – perceive VPPs?
- What are customers' expectations about the financial returns of joining a VPP?
- How can VPP ease of use be reconciled with the desire for customisation?
- How do VPPs compare with the status quo or to other energy products?
- What are the potential pathways for increasing trust and reducing VPP risk perceptions?
- How can VPPs develop relational (vs. transactional) interactions with their customers?
- What must an aggregator do to ensure a smooth acquisition and installation process?

The Better Consumption Lab has undertaken a series of studies aimed at addressing these research gaps. A general community survey of 893 homeowners conducted by the Lab[5], for example, explored the VPP adoption intentions and perceptions of different consumer segments, examined their expectations about the financial returns they would receive from participating in a VPP, and determined how they perceived VPPs relative to other energy products.

To compliment these findings, the current report presents findings from interviews conducted with residential customers of three Project EDGE DER aggregators: Discover Energy, Mondo, and Rheem (operating in the trial under their Solahart brand). The focus of these interviews was to:

- Identify customers' motivations for adopting DER and joining a VPP.
- Understand customers' experiences with aggregators at each stage of the customer journey, from their initial interactions with sales teams through to their post-use experiences with a VPP.
- Examine how customers could be motivated to engage in additional VPP activities.

[4] Rotman, J., Newton, J., Weber, V., & Jacob John, J. (2022). Project EDGE: Gaps in existing DER customer insights research. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/project-edge-lit-review-der-customer-insights-research.pdf?la=en

[5] Newton, J., Jacob John, J., Weber, V., & Rotman, J. (2022). Project EDGE: General community perceptions of distributed energy resources. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/community-perceptions-of-der-and-aggregation-services.pdf?la=en

- Explore what customers deem to be an equitable sharing of the value generated through VPPs.

Through these interviews, this report also sought to address several of the gaps identified in the literature review, including:

- Exploring whether there is a tension between allowing VPP customisation while still maintaining customer ease of use.
- Identifying potential pathways for enhancing customer trust in VPPs.
- Determining how VPPs can develop relational (vs. transactional) interactions with their customers.
- Examining what customers deem to be a smooth acquisition and installation process.

2. Method

2.1 Participating aggregators

This report captures the perceptions and experiences of customers from the three energy aggregators participating in the Project EDGE trial: Discover Energy, Mondo, and Rheem. While each aggregator provided DER aggregation services, the types of aggregation services they offered differed. For example:

- Discover Energy and Mondo actively managed each customer's solar panels and household battery, focusing particularly on using customers' stored energy to deliver network services and/or supply power to the National Electricity Market.
- Rheem actively managed each customer's Powerstore, a proprietary smart electric water heater, so that water was heated during periods of low (rather than high) demand for power. Customers also had the opportunity to register other DER – such as solar PV, batteries, and electric vehicle chargers – with the VPP managed by Rheem.

2.2 Customer recruitment and interview process

Ethics approval for the project was obtained from Deakin University prior to the commencement of recruitment. Each aggregator circulated an invitation to participate in an hour-long interview to their customers participating in the Project EDGE trial. The invitation also indicated that:

- The interviews would be conducted by Deakin University's Better Consumption Lab.
- The aggregator would not know who participated in the interviews or what feedback individual customers had provided.
- Customers who participated in the interview would receive a $50 voucher in recognition of their time.

Customers interested in participating in these interviews registered their contact details on an online form hosted by Deakin University. Semi-structured interviews were then conducted via video call or phone, with members of the research team asking customers a pre-prepared set of questions and asking follow-up questions depending on customers' responses. This approach allowed the research team to delve deeper into customers' expectations, perceptions, and experiences with the aggregator.

In total, 35 interviews were conducted between October and December 2022, with customers recruited from Discover Energy (n = 7), Mondo (n = 20), and Rheem (n = 8). Recruitment proceeded until data saturation had been obtained.

2.3 Data analysis

Interviews were recorded and transcribed, and the ensuing transcripts were coded using thematic content analysis. In this analysis, concepts pertaining to unique motivations, perceptions, or experiences about DERs or VPPs were assigned their own code, and related codes were then grouped to form higher-order themes. NVivo, a qualitative software package, was used to assist in this coding process.

To preserve the anonymity of each aggregator, the customer quotes presented throughout this report have not been attributed to their aggregator. By extension, not all the experiences and perceptions outlined in this report relate to all three aggregators. The report instead provides an overview of the potential experiences and perceptions that customers of Project EDGE DER aggregators may experience.

Before presenting the results of this analysis, several other caveats are worth noting:

- Interviewees were current customers of a Project EDGE DER aggregator, so while their perceptions of DERs and VPPs provide important insights into how customers experience aggregation services, their views may differ to those held by non-customers (households that have yet to adopt DER/join a VPP) and former customers (households with DER that have left a VPP).
- Customers' perceptions were based on the service offerings of the three aggregators participating in the Project EDGE trial, with each aggregator offering a slightly different mix of aggregation services and VPP functionality. Other aggregators offering alternative combinations of services and functionalities may therefore result in a different set of perceptions.
- Given the current penetration of VPPs in the Australian marketplace, interviewees would typically be considered either innovators or early adopters in that they were within the first 2.5% (innovators) or next 13.5% (early adopters) of the general Australian population to have joined a VPP[6]. Whether the findings from this study generalise to non-innovators/early adopters remains to be seen.

[6] Rogers, E. (1995). *Diffusion of innovations*, 4th ed. New York, NY: The Free Press.

3. DER and VPP adoption motivations

Multiple factors were found to motivate and dissuade individuals from adopting DER and joining a VPP. These factors, which are summarised in Figure 1, are discussed in detail in the sections that follow.

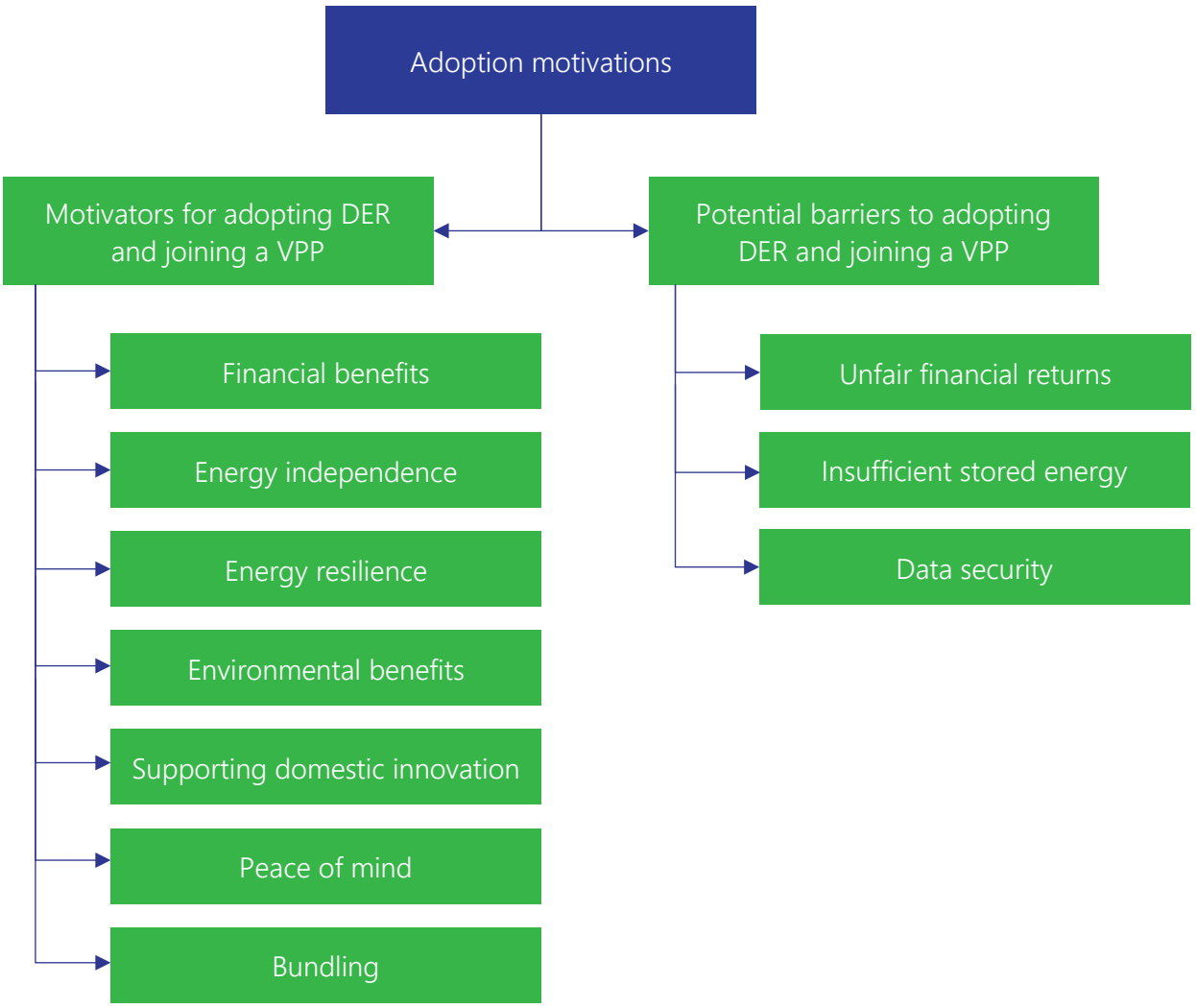

Figure 1 **Summary of the motivators and barriers associated with the decision to adopt DER and join a VPP.**

3.1 Motivators for adopting DER and joining a VPP

Customers perceived a range of benefits for adopting DER and joining a VPP, although before discussing these benefits, two broader trends are worth noting. First, some customers confused the relative benefits of DERs and VPPs, either equating the two or incorrectly attributing the benefits of one to the other. For example, when asked about the benefits of joining a VPP, one interviewee mentioned the assurance of having stable and reliable access to power during blackouts, a benefit more usually associated with DERs.

> “ It's fantastic. We had a blackout in the last week because there were a lot of storms in the area and our power didn't go off, and everybody else's did.

Any discussion of the perceived benefits that customers associated with adopting DER or joining a VPP should consequently be tempered by the fact that some customers found it difficult to distinguish between the DER and VPP components of their aggregator's product offering.

Second, many customers evaluated the benefits of DERs and VPPs in an integrated fashion, with several benefits combining to form an attractive value proposition. One customer, for example, alluded to financial, community, and environmental motivators for adopting DER and joining a VPP.

> “ For me, it's definitely the cost – financial cost. From the heart, it's probably the community, the idea of doing something good. We're all benefiting from nature's natural energy, without having to generate it through carbon fossils, or fossil fuels, or whatever.

Another customer highlighted that while achieving energy self-sufficiency had been a central motivator for adopting DER and joining a VPP, other ancillary benefits also had a motivating impact.

> “ But the core benefit is energy self-sufficiency, the unintended benefit is you…help to reduce the strain on supply maybe for those that still need to use coal-fired power. Hopefully, you drive their prices down too because high prices are generally driven by scarcity and if we drive the prices down because we can oversupply with solar, then that's a great thing.

Thus, while the sub-sections that follow will focus on specific benefits, each should be seen as typically sitting alongside other benefits that, in aggregate, had motivated or justified customers' decision to adopt DER and join a VPP.

Key takeaway: Customers sometimes blurred the benefits of DERs and VPPs.

In joining the Project EDGE trial, many of the interviewed customers had purchased DER through the aggregator. For some customers, this resulted in a blurring of the relative benefits of DERs and VPPs, with the benefits of one being misattributed to the other. This poses several important implications. First, there may be challenges in communicating the distinction between DERs and VPPs to certain consumer cohorts, particularly if both are adopted simultaneously as part of a bundled product offering. (See Section 3.1.9 for further discussion on product bundling). Second, technical or service issues encountered with one of these technologies could potentially be misattributed to the other, highlighting the importance of ensuring that customers receive seamless service across both the DER and VPP components of an aggregator's product offering. This implication is especially relevant for aggregators that rely on third-party providers to support the installation of DER assets. (See Sections 4.1 and 4.2 for further discussion on third-party providers involved in the sales and installation process).

3.1.1 Financial benefits (household)

Financial benefits received by the household were often identified as motivating DER adoption or the joining of a VPP. For example, customers saw rooftop PVs as helping to reduce their energy bills through self-consumption while also providing some financial return – through feed-in tariffs – for any extra energy they exported to the grid.

> Because we're retired, so we're older. We felt that we were doing [installing solar panels and a household battery] – obviously, it was going to help with our electricity bills.

By linking their DER to a VPP, customers also saw that they could take advantage of variable pricing in the energy market, such as by exporting stored power during periods of low supply/high demand.

> My understanding is that the VPP scheme would enable us to sell to the grid during periods of peak demand when the electricity price is high, and to store our own energy and use it when the energy price is low. That, I guess, was potentially a monetary benefit. We didn't think it was going to generate a lot of money, but we saw it as being more efficient than one, flat, low feed-in tariff.

3.1.2 Financial benefits (community)

Adopting DER and joining a VPP were seen to financially benefit the community across both immediate and longer-term timescales. Most immediately, customers valued the opportunity to financially help others – particularly those who could not access or afford solar PV – benefit from cheaper power through their energy exports.

> The idea of community – of people that didn't have solar panels being able to benefit from people who did have solar panels…[receiving power] at a reduced cost.

On a longer timescale, other customers believed that adopting DER and joining a VPP would reduce the need for future community investments in energy infrastructure, such as upgrading transmission lines or replacing aging generating capacity. This benefit was not exclusively altruistically motivated, however; as one customer noted, minimising future investments would also pay longer-term personal dividends by reducing future increases to their own energy bills.

> But for me, participating in this sort of thing should help lessen future investment in infrastructure. And I know that if we spend millions of dollars upgrading lines, then, as the consumer, I've got to pay for that. I'll wear it later, bit by bit over many years.

3.1.3 Energy independence and self-sufficiency

For some customers, the motivation for purchasing DER was based on a desire for energy independence.

> Well, I've always wanted a battery. As I said before, I wanted to be off grid as much as possible. Well, off-grid or on, that's a binary, isn't it? So, this was a move towards that.

This desire for energy independence was often grounded in a deeper concern about minimising future financial uncertainty or pains. One customer, for example, reflected on the fact that because they were self-generating almost all their current electricity needs, energy retailers were far less able to 'screw [them] around' through future pricing changes.

> I mean, long gone are the days where you'd get - originally it was 64 cent or 66 cents, and then it was 32 cents tariff rates, those days are long gone, unfortunately, but my view is that the sole reason to be doing any of this stuff was not the tariff rates because you're always at the behest of big companies who will screw you around and set things to their advantage. But it's quite simple: if you become energy sufficient, which on something like 96 or 97% now, nobody could charge you. Nobody could charge you, they can only charge you on that 3%, so yeah.

At one level, a desire for energy independence may appear at odds with joining a VPP, not least because it ties households more closely into the grid-based infrastructure required to facilitate VPP activity. However, customers explained that so long as sufficient power remained to cover their household's energy requirements, they appreciated being able to gain additional financial benefits (Section 3.1.1) and support the grid (Section 3.1.5) by participating in a VPP.

> Look, as long as it leaves us enough power, domestic use. I think it's terrific to be able to contribute to the grid.

> I want to be islandable in terms of my consumption but in terms of my excess generation I want to be able to export and get some money ideally for that.

3.1.4 Energy resilience (household)

Customers appreciated the additional resilience that having DER assets like a battery could bring to their household, particularly in ensuring continuity of supply during power outages. The salience of this motivator was often explained by pointing to either past outages or concerns about future outages.

> One of the biggest things is that if there is a black out, I'm of the understanding that if you've got a battery, you've always got power. We have had a few up here and the way the current market is, we may or may not have more up here during the coming summer and that probably is, apart from possibly only having a supply-only bill, yeah, that would probably be the biggest benefit, I think, to a consumer.

For some customers, the desire for energy resilience was further heightened by their dependence on household infrastructure that was critical for safeguarding the health and wellbeing of their family.

> We wanted a battery too because we rely on power for our water. During a bushfire, for example, we really need our water, and if the grid goes out then hopefully the battery would give us a little bit of breathing space.

> Because my ex, he's now my ex, is actually disabled [...] He's got medications that are refrigerated, for example. So, again, safety, wellbeing.

3.1.5 Energy resilience (community)

Some customers were motivated by a desire to shore up the resilience of the broader power grid. As the following quotes highlight, this benefit was often framed in moralistic terms (avoiding waste and providing support, particularly if others could benefit) or from an empathetic standpoint (helping others avoid challenges that they themselves had previously encountered).

> The same reason that we went solar in the first place, and participation in this [VPP] that if the grid needed support, because it was done in need, if we had surplus here, why just leave it in the battery?

> It helps balance the grid, which – like I said, I've had personal experience where I've seen the grid unbalanced. I've been at the end results of that for a short period of time, so I fixed it. But for me, participating in this sort of thing should help lessen future investment in infrastructure.

For customers residing in bushfire- or outage-prone regions, contributing to the energy resilience of their local community was also identified as a motivator for joining a VPP.

> I then got involved with them after the bushfires in black summer… So, a community like ours - bushfire-prone, remote and experiencing a lot of instability in access to power supply - a pretty good community [for this project].

3.1.6 Environmental benefits

Customers recognised the environmental benefits associated with adopting DER and joining a VPP. For some, the key benefit lay in the displacement of more polluting sources of energy, such that if DER and VPP adoption could be motivated at scale, the need for fossil fuel-powered sources of energy would diminish commensurately.

> I mean that's another benefit is if my power is in the grid and therefore used and therefore there is less need for baseload coming out of a coal fire power station, that's an excellent thing as well, absolutely.

> I think a lot of our power is all generated using coal and fossil fuels. I think that at scale domestic power generation through solar is an opportunity to deemphasise the reliance on those technologies, and to get rid of it to benefit the environment. That's the big one for me.

For others, the environmental benefit was more social in nature, with DERs and VPPs providing a platform through which likeminded individuals could pull together to achieve broader change.

> Feeling like you're part of a group participating, that's a positive from the environmental perspective.

Some customers with strong environmental motivations for joining the trial also framed their participation as helping support the development of a more sustainable energy system, even if this meant risking potential short-term financial losses.

> I think I can say that we're participating in this for the overall benefit. Not for the benefit of [aggregator] or for the benefit of any individual or even the benefit of ourselves. We're participating in this because it's going to lead to the development of something that will make the transition to renewable energy so much smoother and maybe quicker.

> I volunteered knowing that $50 a month might not cover me, I may be out of pocket, but like I said, I deal a lot with sustainability myself, and I thought, if I give to the community by helping and it costs me a few dollars a month extra, well, I've done my part for society.' So I didn't really see any benefits to myself as a consumer, other than knowing that the program should help in the future. That was it, that's all I get out of it.

3.1.7 Supporting domestic innovation

While some customers were motivated by being able to support a trial that could foster the emergence of new sustainable energy technologies (Section 3.1.6), others viewed their participation as a pioneering act, and one that was helping to support domestic innovation.

> This is the way of the future in terms of where the energy markets are heading. I know that it's early, that we are bleeding edge or might be leading edge. But without pioneers you don't get anywhere really.

> My views are that the model of centralised generation and distribution of energy is no longer a method that is optimal, and a decentralised model across a smart grid, leveraging the latest storage and distribution technologies - particularly from a digital point of view - is the way that the grid needs to operate.

> And look, I guess, in the bigger picture if it took off there might be more jobs in Australia. There might be a whole emerging industry. So, look, I just thought look, it's for the right reasons, let's be a part of this.

3.1.8 Peace of mind

As the overview of the previous motivators suggests, discussing energy with customers can quickly become abstracted to conversations about topics as varied as financial benefits, energy independence, grid resilience, and sustainability. At heart, however, is the ability of energy to supply customers with essential needs. This outcome was particularly valued by some customers, who saw DERs and VPPs as providing peace of mind by assuring continued access to these essential needs.

> Well, I guess you could say it's the savings on your bills, and you could also say it's being independent so that I'm not exposed to what happens with blackouts and things like that all the time. But basically the most important thing is to just be warm, even cooling. I know it'll be helpful with cooling, but just as an older person, to have the confidence to know that you can just have the heater on and that you're providing for it, that is really incredibly important. It makes a difference between moving from where you live and not.

3.1.9 Bundling

For some customers, participating in a VPP was an indirect benefit at best. Their involvement with the aggregator was instead motivated by the broader bundle of products and services that was being offered by the aggregator (and of which the VPP was a part). For these customers, having an integrated energy setup, with different energy sources and different energy technologies being managed as a single integrated energy offering, was what was ultimately deemed attractive.

> We were just with our other retailer. Then [aggregator] contacted us and said, 'This is what we do. We can do your electricity. We can do your gas bill.' One of the thing that attracted me to [aggregator], it wasn't the VPP that attracted me so much, but it was quite useful because they said that they could manage our electricity and our gas, and then if we had credit in the electricity account, they said, 'You can use that credit in the electricity account to offset your gas bill.

> Look, maybe a, say, a bundle so that our whole system worked together as a system and the benefit to me as a consumer would be less cost.

Key takeaway: The motivations for adopting DER and joining a VPP were multifaceted.

Consumers were motivated to adopt DER and join a VPP for reasons that spanned micro (household), intermediate (local community), and macro (societal, environmental) considerations. Moreover, these motivations often overlapped. For example, the desire for energy independence/self-sufficiency worked in concert with a desire for greater household financial benefits and greater community energy resilience. Thus, for many customers, the value stack for adopting DER or joining a VPP was multidimensional rather than emerging from a single, 'cut-through' issue.

Key takeaway: Identified motivations for adopting DER and joining a VPP triangulated with findings from other DER and Project EDGE research.

Many of the motivators identified in this report – such as a desire for financial returns or to deliver benefits to the environment or the community – are consistent with those that have been identified in other Australian research on DERs/VPPs[7] as well as other Project EDGE studies[8]. This triangulation of findings is important as it suggests that a relatively common set of perceptual factors underpin decisions to adopt DER and join a VPP, irrespective of the aggregator or customer cohort being examined.

Key takeaway: If offered as part of an attractive bundle of energy services, customers may not need to see the distinct value of a VPP to still join a VPP.

Understanding the motivations for joining a VPP is critical if VPPs are presented to consumers as a standalone product offering. This is not the only strategy for driving VPP adoption, however. Many consumers, for instance, are not deeply invested in energy technologies; for them, energy is but a means for 'unlocking' the use of desired appliances and devices. For this cohort, a unified solution that brings peace of mind by assuring continued access to energy may strongly resonate. Bundling VPPs into integrated energy offerings that provide consumers with a broad set of benefits could therefore represent an alternative strategy to driving the uptake of VPPs as a standalone product.

3.2 Potential barriers to adopting DER and joining a VPP

While interviewees identified several barriers to adopting DER or joining a VPP, these barriers had not been determinative in that all interviewees had ultimately elected to join an aggregator. Nevertheless, these barriers provide insights into factors that might influence retention decisions and negative word-of-mouth among existing customers or affect the adoption intentions of other consumer cohorts.

3.2.1 Unfair financial returns

The most salient barrier to adopting DER and joining a VPP mentioned by customers was the perceived lack of sufficient financial returns. Customers focused particularly on the discrepancy between feed-in tariff rates and usage rates, believing that it was unfair for feed-in tariff rates to be dropping while consumption usage rates continued to grow.

[7] Rotman, J., Newton, J., Weber, V., & Jacob John, J. (2022). Project EDGE: Gaps in existing DER customer insights research. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/project-edge-lit-review-der-customer-insights-research.pdf?la=en

[8] Newton, J., Jacob John, J., Weber, V., & Rotman, J. (2022). Project EDGE: General community perceptions of distributed energy resources. Available from: University. https://aemo.com.au/-/media/files/initiatives/der/2022/community-perceptions-of-der-and-aggregation-services.pdf?la=en; Zenkić, J., Newton, J., Rotman, J., & Weber, G. (2022). Project EDGE: Public customer insight and engagement study interim report. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/public-customer-insights-and-engagement-study-interim-report.pdf?la=en

> I feel ripped off that we're only getting the 10c for it. That hasn't gone up, even with the cost prices going up. And I just feel it's – it doesn't sit well with me, the money we're getting back for it.

> Well to me it's this. If they charge me let's say 35 cents, right, fair is fair. When I export, I also expect to be paid 35.

The risk for aggregators is that as one of the energy entities most closely situated to customers, they may become the targets of any ill will generated by the perceived unfairness of feed-in tariffs, even if the value of those tariffs is largely set by upstream stakeholders. As another customer noted:

> I do think there should be some equity between exported and imported prices. I'm not expecting to make cent for cent, but I'm expecting to see at least 50%, every day of the week, for every kilowatt we put in. If they can't make – that's 100% mark up when they get it. If they can't meet that, that's ridiculous. That's ridiculous.

While attention was particularly focused on feed-in tariff rates, some customers also commented on the financial value associated with VPP activity. One interviewee, for instance, believed that most of the financial returns generated through VPP activity should be delivered to the customer in recognition of the substantial value of the DER assets that customers were bringing to the table.

> But I think the majority of the trading revenue should come back to the customer. I mean, after all, we're supplying the, albeit small scale infrastructure, to be able to make that contribution. We've paid for the installation of that equipment. So what they're doing in managing, there's obviously some sort of recourses required to manage the trading. What sort of commission should they be taking? I don't know. Maybe they should be taking five percent, three percent.

Another customer believed that relative to the financial benefits of self-consumption, the financial case for participating in a VPP was non-existent.

> If I'm thinking about the VPP side specifically rather than energy self-sufficiency, well, the business model is broken.

3.2.2 Insufficient stored energy to cover self-consumption needs

By relinquishing control over their DER assets, customers recognised that they may not always be able to utilise their own stored power to cover their household's power consumption needs. For some customers, this was seen as a barrier to joining a VPP, not least because it would require them to purchase power from the grid rather than using the power they had generated and stored through their own DER assets.

> Potentially exporting more power than what I'll need to store for my own use, that could be a potential downside.

> …if the company that had access to our battery took six kilowatts of electricity from our battery and put it into the grid on a Monday morning, and the weather was fairly ordinary, then we mightn't be able to top our battery up before the peak period at 3:00 pm, and if that was the case, then… the financial return for sending energy, selling energy into the grid might be reduced because we have to import electricity during the peak period.

As another customer noted, however, this issue was potentially a shorter-term growing pain that would likely be resolved over time as better analytics and technologies became available.

> Well, the downside is potentially, "Oh shit, I need more power, and they sucked it all right out of my battery, therefore now I have to buy it at retail prices from the grid, but if there is the technology there that can manage grid stability, grid distribution, predictive analytics and all of that stuff […], if they use the right tech, it's do-able. […] So my expectation is yes, there will be some issues, but at the end of the day they'll be managed".

3.2.3 Data security

Data security would likely have been top of mind for many consumers around the time the interviews were conducted, given the then-recent announcements of largescale data breaches at several well-known organisations, including Optus and Medibank. Thus, it is perhaps unsurprising that several customers raised concerns about data breaches and their potential to violate household's privacy, particularly when considering the data that needed to be shared with the aggregator to support VPP activity.

> I would say data security. I mean you can't help it, right? The hacking with Medibank and Optus. You really can't help it, like a lot of people are thinking because we're impacted by it. It's like "Okay, now they have our health data." We weren't with Optus. It's like "My god, it's so easy for a good hacker to join the dot. They live in this street. They have this level of consumption in terms of energy. They're seeing this doctor and they're calling internationally quite a lot." Profiling it is not that difficult.

A second data security concern related to the fear that hackers could exploit hardware or software vulnerabilities to cause widespread power outages among VPP customers. As one customer noted, this risk is only likely to increase as more customers participate in VPP offerings, increasing the attractiveness of VPPs to hackers.

> As they took control, the concern that I had was, how good's their software? Potentially, once you open up that channel, could they get hacked? Could they get hacked and someone just shut you down through that controller? Because I've given them open access to that controller. One of the things if the program tries to go wider, then what controls are in place? What firewalls, what security provisions are there to stop some hacker saying, "Bang, I'm going to shut everyone down, I'm going to cause disruption"?

Key takeaway: Insufficient financial returns were a persistent concern of customers, and one that may pose reputational risks for aggregators.

Consistent with other research[9] and a common thread throughout this report (e.g., Sections 3.2.1, 4.3.2.1, 4.3.4.1, 4.4.2), dissatisfaction with the financial returns associated with adopting DER, and even more so joining a VPP, were commonly expressed. At one level, this dissatisfaction had not been sufficient to prevent customers from joining the Project EDGE trial, and customers were generally cognisant that the financial benefit of DER adoption stems particularly from self-consumption (vs. feed-in tariffs for energy exports to the grid). Whether a similar motivational calculus will be observed among other consumer cohorts remains to be seen.

The nature of customers' perceptions about receiving insufficient financial returns also point to a more subtle risk. By virtue of sitting at the interface between customers and the energy market, aggregators may be held responsible for low (and, in the future, potentially decreasing) feed-in tariffs, even if their ability to influence the size of the feed-in tariffs available to customers is small. Customers, for example, compare their consumption usage rates with their feed-in tariffs, and any marked discrepancy between the two is deemed to be the responsibility of greedy energy companies. How aggregators manage customers' expectations around the size of feed-in or export tariffs is therefore likely to be key.

Key takeaway: In joining a VPP, customers were symbolically giving aggregators access to the heart of their home, and they wanted assurances that this wouldn't leave them vulnerable to hackers.

Recent, well-publicised data breaches had left customers increasingly cognisant of data safety and security. Given the centrality of DER to a household's energy consumption, some customers consequently expressed a wariness about allowing an aggregator to directly manage their DER, at least without assurances that the aggregator was protecting their DER access from unscrupulous third parties.

[9] Newton, J., Jacob John, J., Weber, V., & Rotman, J. (2022). Project EDGE: General community perceptions of distributed energy resources. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/community-perceptions-of-der-and-aggregation-services.pdf?la=en; Zenkić, J., Newton, J., Rotman, J., & Weber, G. (2021). Project EDGE: Public customer insight and engagement study interim report. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/public-customer-insights-and-engagement-study-interim-report.pdf?la=en

4. Customer touchpoints with their DER and VPP

Interviewees were asked to reflect on the major customer touchpoints associated with their aggregator's offering, including:

- Sales process.
- Installation process.
- VPP process.
- App interactions.

Summaries of the elements examined through this exploration of the major customer touchpoints are presented in Figures 2 and 3.

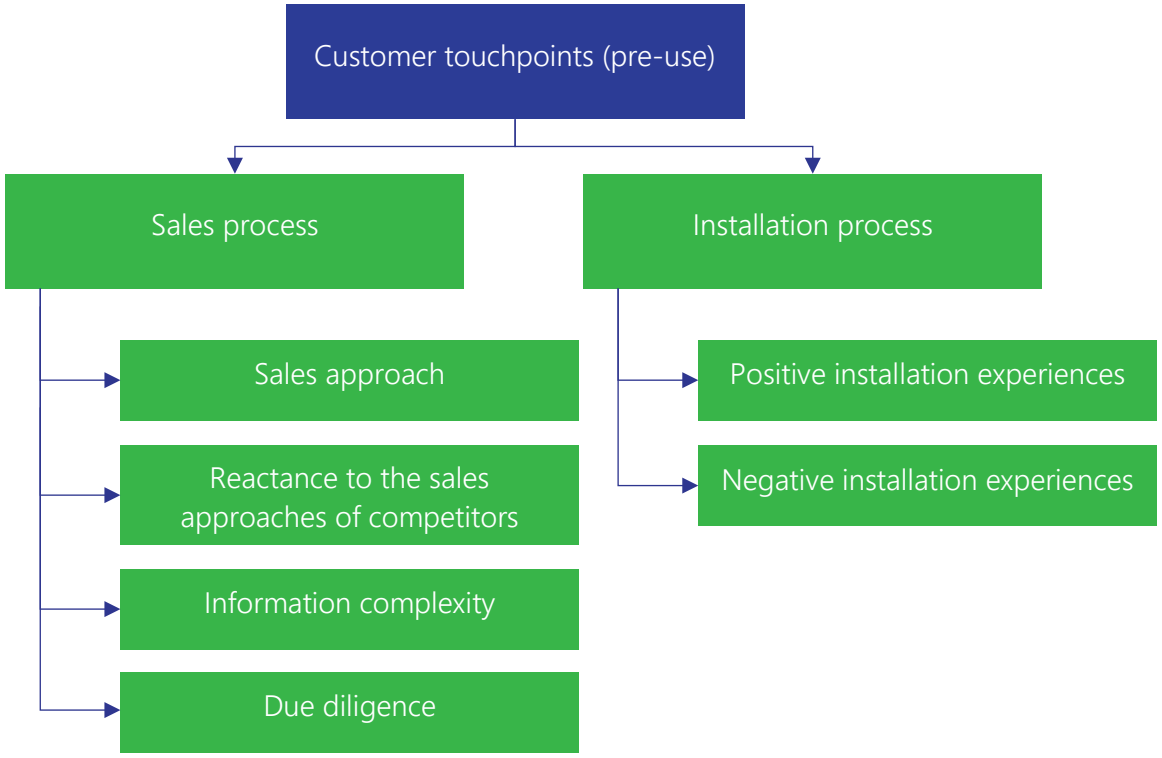

Figure 2 Components of the pre-use customer touchpoints examined with interviewees.

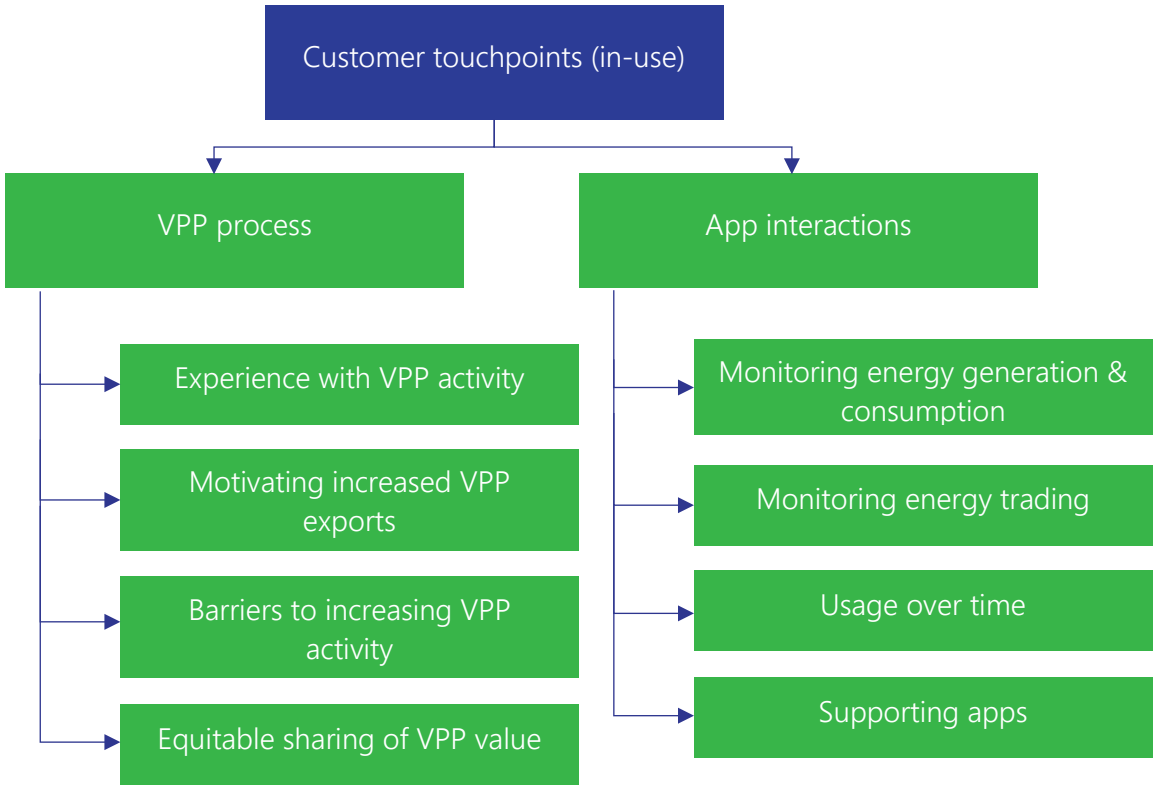

Figure 3 Components of the in-use customer touchpoints examined with interviewees.

4.1 Sales process

The sales process is often the first touchpoint that a potential customer has with an aggregator, and how this interaction proceeds can have an important influence on their perceptions of the aggregator. As one customer noted:

> “I think it all stems back to the salesman that arrived here on day one. I was able to build great working rapport with him, and I don't know. I guess I've a believer of if you cooperate with people and you deal with people fairly, they will deal with you fairly. I got the sense that this was a company that did care. It just built trust.

4.1.1 Sales approach

Although the aggregators often used third-party sales teams, customers generally spoke positively about their interactions with the sales teams they encountered. Special mention was made of their knowledge of the aggregator's product offer, ability to clearly explain technical details, openness to answering questions, and aptitude in building rapport.

> The salesman, the initial contact, if you like, he explained things that everyone could understand, and it was just a smooth transition, transaction.

> [Aggregator] salesman, I was very impressed by him. He was incredibly knowledgeable, and I connected with him at a technical level very easily. We ended up having a great rapport, and he was able to answer or get an answer for any question that I asked. I asked lots of questions and I put different alternatives to him.

Some customers did, however, wish that the aggregator had exerted greater oversight of the sales teams working on their behalf, particularly in ensuring that customers were receiving an honest appraisal of their energy needs (and by extension, the DER they would need to purchase).

> The part that I think where it falls down, from people who initiate these projects, is that they then outsource the installation and quotes to a third party. […] I would have much preferred if [aggregator] were there on the journey with me to sort of say, "We have a group of preferred installers." Cool. But again, a bit of that oversight of, "Well, [customer] hasn't bought solar before, so he looks at a quote and doesn't know if it's high, low, good, bad or indifferent." […] You know, they are in a position of expertise, where I don't have that knowledge.

4.1.2 Reactance to the sales approaches used by competitors

The sales processes used by the aggregators were (favourably) compared with those of their competitors. One customer, for example, recounted how a salesperson from a competitor estimated their DER requirements remotely, which led to an overestimation of how many solar PV panels could be situated on their roof. This negative experience only served to underscore the more hands-on approach that their aggregator adopted, where one of their salespersons made a site visit to directly evaluate how many rooftop PVs could be placed on their roof.

> Well, he didn't come to the house. Everything was estimated through drawing and only the [aggregator's] people and the local company came and they look at the roof structure, they said, "No way can we put 13.5 kilowatt panels". And when they both came and I go, "My goodness. Your quote is grossly inaccurate." Because if they can only put seven, that's like 40% less. And why am I buying more panels that basically don't generate solar, right?

A similar experience was mentioned by another customer, who spoke of having difficulty engaging with several other companies before ultimately purchasing solar PVs through their aggregator.

> I had tried to go solar previously, but the complexities and lack of transparency in the industry, and stupidity of people that I was sent out by power companies such as [competitor], meant that I had been thwarted in my aims to go, effectively, fully solar if I could, but not off grid… So I've had maybe three different people to come out to look at solar, but they just don't seem to - either there's a communication problem, or they don't seem to understand what I need.

Another customer reflected on how the sales process used by their aggregator favourably compared with the sales techniques they had encountered from other competitors in the sector, including approaches made through cold calling and door-to-door selling.

> We did have a cold call here, but look, straight up, they were only offering a small system, not really what I wanted, and maybe after this cold call, they were – what do you call them? Door to door. Then after that, and I looked at some of their numbers and I thought, no. Then, one of the neighbours said, "I've got this [aggregator]. Can you come around?" She's on her own and she thought, "I won't understand everything that he tells me." I said, "Well, that's more information for me," and yeah, that same day, when they'd finished round with the neighbour, [friend] came around and we had a look here and we ended up doing the deal.

4.1.3 Information complexity

While in-person interactions with each aggregator's sales teams were generally viewed favourably, customers nevertheless perceived two interrelated areas where opportunities for improvement existed. Several customers, for instance, considered the information available on their aggregator's website to be unnecessarily technical and wished that information about the VPP had been presented using plain language and in a more engaging manner.

> Their website doesn't have as much information as it should, which I pointed out to them. No, I think they are a bit light on information and also I think their approach in terms of the way they present what they do, they may have improved it since, but it comes across more as a technically driven approach rather than thinking about, "Well, what does Mr and Mrs Average Australian need to know and how do we make their choices as easy as possible in term of providing the information in a clear manner?" I think there's a little bit of weakness there.

> So, all this use of jargon: what is DER aggregation? There's no YouTube videos. Facebook, I don't know. You know what I mean? It's not as engaging.

Customers also struggled to comprehend the meaning of the financial information they were presented with, such as the rates they would be charged for importing or exporting energy.

> I've always found that the rates that the people quote, the import/export, all that sort of stuff, it's just hard for people to understand it, so it's difficult to be able to comprehend the figures and things like that. Yeah. Look, to be honest, I didn't know what rate I was paying for the tariffs and all that sort of stuff, just – yeah, very confusing, it's just difficult.

> I find it really, really hard to work in concrete, mathematical formulae and stuff. I had it explained to me, but unless you're actually working with it my retention of facts and figures is not great. I've got this great wad of information here I could refer to, but I was really, in some ways, trusting the company, basically, that they would do the right thing.

Contributing to this comprehension issue was the fact that the financial information they were presented with had not been contextualised to their household's regular energy consumption patterns. Put differently, customers had not received personalised analytics to help them understand what the financial impacts of joining a VPP would be for their household. In the absence of such analytics, joining a VPP constituted a financial unknown for customers; although customers hoped that joining would provide them with financial benefits, there was a risk that they might end up being financially disadvantaged by joining.

> A lot of people are struggling to pay their bloody mortgages and put food on the table at the moment, so it's a real issue, and electricity prices keep going up. The last thing anyone wants to do is know that they're participating in a program that's actually costing their household more money. I did it knowing that it could because there was, actually, really no guarantee. There was no guarantee, there's no feedback as to what it costs you extra, so I could be getting ripped off and I don't know.

4.1.4 Due diligence

While the sales approaches used by the aggregators were generally perceived favourably, there was also a recognition that the role of sales teams is to sell, which introduced doubt as to whether the information being provided by those teams could be completely trusted.

> I wanted to be able to trust them. I assumed I could, but salespeople are sharks. They're just wanting to sell you things and you just – I wanted to make sure that they were giving me the best deal and the best – But, no, they seemed legit, but you just don't know whether – They're selling a product, so of course they're going to rave about it.

Many customers consequently spoke of undertaking their own due diligence to test the claims being made. As the following sampling of quotes suggests, a range of due diligence strategies were used, including comparing offers from competitors, searching for information from trusted or independent sources, and seeking the views of friends and family.

> I got quotes from other companies and the difference that I perceived was that a lot of companies are essentially sales companies that do installation of solar equipment. The company that I went with seemed to be genuinely committed to solar energy and they were engineers first and salespeople second.

> Through Peacock [Finn Peacock, a social media influencer on energy], through the Whirlpool [a technology-focused online forum]. I talked to a couple of agents. I had two people tendering for business.

> So, we needed new panels and then the batteries, so I again went to SolarQuotes and I found out about battery technology and so on, which was really good.

> Victorian Government website perhaps because they're non-biased. Obviously [aggregator's] staff. Look, I might look at AGL or Origin just to see how those stories match what I'm looking at but I would tend to stick to well-known sources of information e.g. governments, the electricity Ombudsman maybe, that sort of thing.

> My next door neighbour is an electrical engineer who'd just gone through this process so I picked his brains and I was very happy with the decisions I made.

Notwithstanding their concerns about trust, customers spoke of the time-consuming nature of searching for information from different sources, and of their associated desire for having a single source of information that they could consult.

> Having one place for all the information would be really handy instead of having to go through a whole heap of different places.

Key takeaway: Customers appreciated sales teams that treated them with respect.

The aggregators' sales teams were generally seen as being courteous, knowledgeable, and happy to answer questions, and these positive experiences lay the foundation for establishing trust in the aggregator. (See Section 5.1 for further discussion on trust). This respectful and personalised approach to selling was contrasted with the experiences that some customers had had with sales teams from other energy companies, many of whom adopted a more transactional or non-personalised approach to the selling process. The fact that interviewees noted the superior sales approach of their chosen aggregator as a key differentiator is suggestive of the role that the sales process can have in influencing decisions to adopt DERs and join a VPP.

Key takeaway: For some customers, joining a VPP was a leap of faith.

Many customers reported struggling to understand the charges and terminology used to describe the aggregator's product offering or else wanted (and failed to find) information that could tangibly describe what the net financial implications would be if they were to join the VPP. Due diligence activities undertaken by some customers – such as seeking out information from independent third parties – helped to address some of these informational requirements. Nevertheless, joining a VPP was still often seen as a leap of faith, particularly in terms of understanding the net financial implications for doing so. Reducing the complexity of the information presented to consumers and providing them with tools to better estimate the financial implications of joining a VPP may be potential strategies for addressing this issue.

4.2 Installation process

Although there were differences in the DERs and VPPs offered by the aggregators, what was deemed to be a good installation experience did not differ across the aggregators.

4.2.1 Positive installation experiences

From the perspective of customers, a positive installation experience was characterised by competency and respect, with installers displaying technical proficiency, showing politeness, and being responsive to customers' needs.

> Look, their people were technically competent, so never did they give the impression, "Oh gee, I hope I've got this right." They gave a level of competency that was very high. They were polite, respectful, just gave a real feeling of, "We know what we're doing. We're here to do a job and we're going to do it and it's going to all work and then we'll wave you goodbye and it's done."

> So, they actually tried, as much as they could, to bring those panels into a better alignment, which we were really appreciative of. They didn't have to do that, which was great. They've always been incredibly professional. When they put the battery in and all the cords and wires and everything were just perfectly neatly packaged and they did such a great job.

Clarity was also appreciated, with customers valuing interactions that allowed them to understand where they were at in the installation process and what would happen next. This was deemed important for ensuring that there were no "hidden surprises".

> Very thorough, very in-depth, informative, there was no hidden surprises, it was all pretty, yeah, pretty straightforward and that was there at the time.

> There was a chap on the phone I could […] who I would badger when the installation was going in, and get that sort of information, and he was very helpful… It was fantastic.

4.2.2 Negative installation experiences

Although most customers experienced a positive installation process, several issues were encountered.

4.2.2.1. Aesthetics

DER are not just energy technologies; some – such as solar PV – can leave a large visible footprint, which can have aesthetic implications for the homes on which they are situated. This was a point of contention for some homeowners. Exemplifying this broader issue, one customer noted that a reason they decided to forego a quote from a competitor was because of how the quoted solar PV location would have looked.

> It's not a big house but the other quotes were also putting extra panels on the framework on top of the carport and making the house as ugly as hell.

Not all customers were satisfied with the aesthetic outcomes of DER installations organised through the aggregator. Some, for example, voiced annoyance when the visual appearance of their home was deemed to have been substantially altered by the installation.

> There was no consideration given to aesthetics. It was like blanked out the house and then pushed on it was – yeah, like putting a stamp on the side of the house. And I just thought, "well, we could maybe trim the piece of – the bit down there, just a little bit, so we can minimise the impact of the look of it."

4.2.2.2. Installation delays

Installation delays were also encountered, although many of these were perceived by customers as being beyond the control of their aggregator or its suppliers. COVID and its attendant effects on global supply chains, for instance, delayed the installation process for some customers.

> …we signed up last year some time, but it took some months to install it. […] I can't remember the exact date, but it took quite some months to get in, which was a bit frustrating, but I understood there's a lot of demand for them.

> COVID, so a very difficult start. They weren't able to come out for absolutely ages.

Similarly, delays in receiving the necessary post-installation signoffs from regulatory authorities were also encountered.

> Apparently because regional inspectors drive so far they basically – they cherry pick which jobs they have, so if they haven't got a close one – it took us over a month to get the inspection because basically nobody wanted to come.

4.2.2.3. Lack of proactive communication

As outlined in Section 4.2.1, customers appreciated being kept appraised of next steps in the installation process. Customers consequently became frustrated when this was deemed lacking, and especially so when they needed to follow-up with the installer to determine what needed to happen next.

> I was annoyed that I had to wait and I had to ring them, I guess that was a bit annoying. Because once you put your deposit down there was no follow-up to say – They gave me a timeframe, but then it got to the end of the timeframe and I had to ring them. So, that was a bit annoying.

> I think it was fine but basically, they didn't tell me what the next steps were about installing and turning it on and things like that. They basically did their job and left and they didn't tell me that someone needed to come and inspect it and then when it wasn't working you would call and you would find out, you know, speak to someone and they would say this and then they would say that and then we're a bit unsure and then eventually they said, "Oh, it needs to be inspected", okay, and then, yeah, had issues around that.

4.2.2.4. Human error

Human error resulted in several installation issues, with customers often being the first to notice these issues.

> Before the system was installed, a chap came to view the house. He viewed it. I was at pains to point out that the house had vinyl cladding on the walls and zinc cladding tiles on the roof. And zinc tiles were over corrugated iron. And that seems to have got lost in the translation somewhere, and it was only because I picked up, at the last minute, on the invoicing on the quotes, they were billing me for tile clamps. And I said, "We haven't got tiles. That's wrong; they shouldn't be billing me for tile clamps." ... And even for the guy that came and did the initial inspection and didn't pass this information on.

> …one of our arrays wasn't producing power, but the other array was. So, you look at the inverter and it says it's producing power, but – And we're getting some power and all that…And because the other array was producing power, the inverter was generating, but it wasn't generating what I expected. So, someone with less knowledge of solar power and the like wouldn't have picked that up. And so, I think from an installer's point of view, they weren't careful enough in commissioning the system properly.

4.2.2.5. Service recovery

As the previous sub-sections suggest, installations sometimes go awry. While this can be a cause for customer frustration, it can also provide an opportunity for organisations to show their true colours. This was the case for one customer, who gained a newfound appreciation for their aggregator after they quickly rectified damage incurred during the installation process.

> I trusted them before. I trusted them more after this installation. They actually broke several of – they damaged my roof and they realigned the tiles. So they are very responsible. And with technology as well, it's been overall very, very stable, surprise, surprise…

Key takeaway: Proactive communication and coordination were key to ensuring a positive installation experience.

Customers expected the aggregator to coordinate the various third parties required to finalise the installation process. Customers also expected the aggregator to proactively keep them appraised of where the installation process was up to, and to inform them of next steps, particularly if any of those steps required the involvement of the customer. Anything that disrupted these expectations ran the risk of being perceived by customers as a negative installation experience. However, promptly solving these problems and correcting or compensating for issues that arose provided the aggregator with an opportunity to regain trust and rebuild customer satisfaction.

4.3 VPP process

This section details customers' experiences with and perceptions of the VPP.

4.3.1 Experience with VPP activity

4.3.1.1. Preference for automated VPP activity

One of the aggregators gave their customers the ability to customise their VPP settings and manually initiate VPP activity, such as exporting stored power to the grid. Some customers had engaged with this process, whether from necessity or out of interest.

> I have, yes. When they initially had it set it wasn't doing any export or doing any usage from the battery over night-time. So, I've had to adjust that to meet my own needs.

When a choice existed, however, most customers expressed a preference for using the default VPP settings and for VPP activity to be automated by the aggregator. Indeed, one customer, who had manually initiated stored power exports through their VPP, found they had mistimed some of those exports, resulting in their battery running out of stored power in the evening. For this customer at least, that experience had highlighted the value of relying on the automated exporting process managed by the aggregator.

> What we do is we sort of leave it up to them. When we joined with them, they told us about the VPP, and they said that we could use an app to participate in the energy trading, or we could just leave it up to them and they'd do it for us. To be honest, I haven't got time to be sitting there, trading our electricity in half-an-hour blocks. I just said, 'You do it.' So I haven't really done any of that, I've relied on them to manage that side.

This sentiment was echoed by others, who preferred VPP activity to be automated because of the level of expertise involved.

> I think I'd probably prefer having a company like [aggregator], as long as I had confidence in them which, at the moment, I have no reason not to. But to do it yourself, it could be disastrous; you know, if we don't know - you could say, "Oh, I'm going to feed it in because we're getting a big tariff now," and then you find that you haven't got enough power, and another time - there's a lot of balance and a lot of knowledge, I think. A bit of a gamble, some of it.

> So trading's just the mechanism to the benefit, right? I would actually prefer it to be automated and that I didn't have to play a part in it. Do I want to be sitting there waiting for a notification, and then go in there and sell my battery? Because the situation I've actually ended up in at times, and this is going to require – it's not something that you can instantly get right, it's going to have to be a learning process over time. Whether there's AI systems involved, I'm not sure. But I've been in situations where I've sold power and then run out in the evening, and I'm thinking hang on, that wasn't a good trade-off.

Contributing to this reliance on default VPP settings and/or automated VPP activity was a perception that the financial returns associated with VPP activity were insufficient to warrant the attention required to customise or control when that activity occurred. One customer, for instance, indicated that they no longer looked at their VPP settings because the amount of money being generated through the VPP did not warrant this level of optimisation.

> Well, you can be given manual - sorry, automated reminders of when the charge reaches a certain point and indeed I've done that, but you still actually have to go in and physically manually do it, unless you can have it set-up to be automated, and I must admit I haven't done it for ages because it never really makes any money.

4.3.1.2. Uncertainty about VPP activity

While customers generally expressed a desire for automated VPP activity, the corollary of this desire was that they were not always sure when the aggregator was actively managing their DER asset. Some customers, for instance, spoke of looking at their electricity generation and usage statistics to try and infer whether DER management was actively occurring.

> So there's been a few times I've wondered whether I'm being controlled or not, whether it's saying, "No, we can't take in the grid", but I haven't had a definite moment yet where I've said, "They're controlling my system." I haven't found it yet. It's really had no impact on me that I've noticed.

> Sometimes you'll look in the middle of the day and your solar generation will be turned off. And then basically you'll think, well, okay, basically I'll wait and then they'll turn it back on again. And it's obviously some interface they're doing with the grid.

This uncertainty also extended to what the financial benefits of this (presumed) active DER management might mean for households.

> I don't really know when they take energy from us, how much they take and I can't really tell whether the money we get from them in the end will actually cover our losses. I'm not sure yet.

Key takeaway: A delicate balance exists in how much customers want to know about the VPP 'black box'.

Customers differed in their approach to VPP activity. While some were happy to get 'under the hood' and customise how or when VPP activity took place, most appeared to prefer for VPP activities to occur in an automated fashion. However, one consequence of this preference for automation was that the VPP remained a 'black box' for many customers in that they were not always aware of when – or even if – active management of their DER asset was occurring. The challenge for aggregators will be in finding the delicate and customer-specific balance between facilitating automation and providing the level of information that customers desire about how their DER asset is being used. (See Section 4.4.2 for further discussion on optimising how the trading process is presented to customers).

4.3.2 Motivating increased VPP exports

Customers identified a range of strategies for motivating a specific form of VPP activity: increased exporting of stored power to the grid.

4.3.2.1. Increased financial returns

Given the findings discussed elsewhere in this report (Sections 3.2.1, 4.3.4.1, 4.4.2), it is unsurprising that many customers saw increased financial rewards as being essential for motivating greater exporting activity.

> I don't worry about exporting energy too much, because basically, I think I worked it out and to fully discharge the battery and stuff like that, it's only a few dollars or something like that, so I can't be bothered doing that every day.

> I think they'd need to provide good financial incentives or a good rate when you're feeding back to the grid. And that's what I'll be looking for, definitely. It's like, who will – who will give me the most money for doing that because helping generate power.

Two approaches for increasing the perceived financial value of exporting were suggested by customers. The first suggestion was to provide a flat increase to the rates that customers received for exporting their power to the grid so that the discrepancy between feed-in tariffs and consumption usage rates was perceived as being less extreme.

> That's a good one because to me, like my short answer is this. If they're really fair about the market dynamics, if I buy per kilowatt at 35 cents – I understand margin, right? Let's just say you at least give me 25 cents and you make that ten cents difference, I understand it. And I probably would be more motivated. But when you're giving me five cents, that's more like an insult to my intelligence.

The second suggestion was for dynamic tariff structures to be implemented that better reflected spot prices on the energy market. For example, if stored power was going to be exported during periods of high demand/low supply, then households should receive discounted energy rates during periods of low demand/high supply.

> Yeah, it's not so much - there needs to be a preferential recharge in the times overnight where it's obviously the power is cheap, that makes sense, that's how the whole VPP is supposed to work. So if they want to drain on a 40-degree day, everyone's air conditions are going and I'm pumping power into the grid, well, I expect a bit of a payback in the quiet times.

4.3.2.2. Receiving prompts about underutilised capacity

As discussed in Section 3.1.5, providing energy resilience to the community – one of the stated motivators for joining a VPP – was often framed in moralistic terms. That is, why hold on to unused stored energy if it could provide benefit to others? Consistent with this finding, some customers spoke of the motivating impact of receiving a message that: (i) highlighted the proportion of their DER asset that was not regularly being used for self-consumption; and (ii) prompted them to export this underutilised capacity for the benefit of the community.

> Anything that was surplus to our needs. I don't have a reason – I don't believe to holding onto something just for the sake of holding onto it. If it can be put to better use.

> If I'm knowing that I didn't need the energy myself and then I was going to generate it the next day, yeah, I'd export. And if it was easier to figure out how to do the export. Or if I didn't need to do it manually or if I could set something on an app somewhere to say I can export 50% or 60%. That would be good.

4.3.2.3. Assisting others in an emergency

Customers also spoke of responding to one-off messages highlighting how a short-term increase in exports could assist vulnerable communities, such as disaster-affected households or those who may be struggling to cool their homes during a period of hot weather.

> Oh, if they notify me… look, let me donate 30% a day of your battery it's going to help these affected communities or flood affected, yeah, I'd be happy to do it.

> Just obviously on the fly, if there's something that happens and notifications and yeah, so an app notification saying, "There's people having trouble, will you help out?" Yeah.

The caveat is that customers were not willing to put themselves in a position where increasing their exports might put their own households at risk of being without power or incurring substantial additional costs.

> So does that mean that I'm going without – so if it means that I'm going to be then relying more on grid power to help out someone that has no power, sure, that's no problem. If it means that I'm not going to have any power either, I don't know about that.

> You've got to protect yourself, too, so you've got to know that you're comfortable in your own situation, that you just haven't given away your protection to help others. Be nothing worse than realising that all of a sudden you've found yourself not able to protect your own home and your own family.

4.3.2.4. Multiple approaches may have a motivating effect, but the impact of any additional exports should be clearly stated

Ultimately, and as the following quote suggests, many of the strategies identified in Sections 4.3.2.1 – 4.3.2.3 may have a motivating effect on customers.

> If I felt there was a social benefit for those who were less fortunate than me, absolutely. If I thought there was a greater environmental benefit without there being a significant economic impost to me, again I'd be interested. And if I thought I'd actually get a little bit more for what I was exporting in terms of the remuneration, I would also consider it then. So they're the three things that I think would make it obvious to consider it.

What was important across all these strategies was that the benefits associated with any voluntary increase in exporting activity were clearly enumerated. As several other customers indicated, people want to see the impact of their activities in ways that can be clearly understood.

> Well, if I was part of that project and they were exporting power that I'd produced or stored, I'd like some sort of app that's telling me what's happening. Mainly just so that, the satisfaction of knowing that you're actually contributing something and that something's actually happening versus being left in the dark and not knowing. But I just want an app to give me some information about what exactly had been generated, what had been exported, what I contributed.

> One of the ones that I do find easy to understand is the equivalent of taking so many cars off the road… Yeah, it's a bit tricky. Maybe it's about so many houses, your power will power enough – power 10 homes for six months or something… But I think it needs to be something that you can quantify that's not tonnes of greenhouse gases, because no one knows what that looks like…. And I think too incorporating communities, so maybe within your community of VPP you save the equivalent of so many kilowatt hours and then maybe – most people can get their head around kilowatt hours. So maybe it's a case of saying, "Hey, this much free power went in, that might be equivalent to half a day's reduction at the power station", or something like that. Just something easy, quantifiable. Look, the reality probably is that I'm not a marketing guru but something that a 12- or 14-year-old could look at and go, "Yep, I get that."

4.3.3 Barriers to increasing VPP activity

Customers also identified a set of barriers to any efforts aimed at motivating enhanced exporting activity.

4.3.3.1. Protecting capacity for self-consumption

Any export of stored power to the grid means that less stored power is available for households to use in periods when they are not generating any energy. As flagged in Section 4.3.2.3, many customers would therefore only countenance an increase in exporting activity if they could be assured that sufficient stored power remained in their battery to meet their household's self-consumption requirements.

> Not really any potential downside, only that it needed to be managed in such a way that we're not exporting power to the grid and leaving our battery empty at night, then we have to rebuy it at, potentially, a higher price. So it's more about the management of exporting the power to the grid to ensure that we retain enough for our own use.

> Obviously, I don't mind, as long as they're not exporting my whole battery and then I've got no battery to rely on and I have to export back from the grid.

Complicating the task for aggregators is that the desire for sufficient stored power to be available for self-consumption purposes was deemed particularly important in periods when demand for the exporting of power through a VPP was likely to be greatest.

> I think I'd like to have input to the control. Not necessarily control it on an hour-by-hour or day-by-day basis, but be able to have the option to – if I know that we're in a fire season or whatever, to keep my batteries fully charged, or some such scenario where I wonder, 'Have the batteries' – Like today, we had a scheduled power outage with [distribution network] here, and I wanted to be able to ensure that the batteries were charged before the power went out. And so, that's what it – That sort of thing, that I'd want to be able to have some sort of input into how the power's going to be used or exported.

4.3.3.2. Longevity of DER assets

Some customers were concerned that increased exporting activity could adversely affect the longevity of their DER assets, particularly by unnecessarily increasing the number of battery discharge/recharge cycles. Given that DER assets are both expensive and paid for by customers, customers were conscious of trying to preserve the value of their investment.

> So longevity of the battery. How long it would do. The deep cycle of it, about where it empties, how many cycles you could get out of it. I suppose the efficiency level – how long that would last. A lot was towards longevity of the system. Because you're going to spend that kind of money. "Is this good for a season? Is it good for 10 seasons? Is it good for 20?" And certainly what I was getting was it was going to be long enough to – for us to get 10-15 years down the track and see what other – where we'd moved to then, as we're going to reassess where our battery systems are, or where we look at next.

> So, all these things – we're doing things now in the short term, but I guess we're not really fully aware of how these impacts will manifest themselves in 10, 15, 20 years' time when all these batteries start to lose their storage capacities and the solar panels start – stop functioning the way that they should at their optimum.

4.3.3.3. Social loafing

Also contributing to a potential reluctance to further increasing exports of stored energy was a fear of what has been termed in the psychological literature as social loafing[10]. Social loafing refers to situations where group members put in less effort to achieve a goal than if they were pursuing that goal on their own. Perceptions of social loafing can, ironically, increase social loafing, and this dynamic was alluded to by one customer, who indicated a reticence to further contribute through exporting if others in the community were not reciprocating such effort.

> My neighbour doesn't do it so why should I contribute when my neighbour doesn't because he's going to get the benefit later of no line upgrade. So it'd be very hard. It'd be very hard unless you put money on the table to see people pour money back into the grid.

By extension, minimising the potential for social loafing by developing a system that encouraged reciprocity in the exporting of energy across households was seen as motivating additional export activity.

> I wouldn't mind sharing my energy with everybody else, as long as there was some system in place where they would share it with me as well.

Key takeaway: Efforts to motivate additional VPP activity should pass a 'better off overall test'.

Customers were not averse to increasing the amount of energy they traded through a VPP, so long as it passed something akin to a 'better off overall test'. For example, customers wanted assurances that the value of their DER asset would not depreciate more quickly from engaging in additional exporting activity. Similarly, customers wanted certainty about the implications of additional VPP exporting activity for energy self-consumption, whether directly (e.g., having sufficient stored power to meet their household's regular energy consumption requirements) or indirectly (e.g., receiving cheaper consumption rates during periods of high supply/low demand to offset any losses incurred when exporting results in insufficient stored power to meet their household's energy requirements).

[10] Kerr, N., & Bruun, E. (1981). Ringelmann revisited: Alternative explanations for the social loafing effect. *Personality and Social Psychology Bulletin, 7*(2), 224-231.

Key takeaway: Highlighting unused stored energy that is regularly going to waste could motivate additional exporting activity.

While customers wanted to ensure they had sufficient stored energy to meet their household's evening consumption requirements, they also didn't want any regularly underutilised stored energy going to waste. Personalised messages that highlight the amount of underutilised stored energy each household has, and which then offers the account holder an opportunity to export this energy through a VPP, may therefore provide one means of motivating additional export activity.

Key takeaway: Additional exports through a VPP could be positioned as a form of philanthropy, although customers would want to know the impact of their philanthropically focused exports.

Customers indicated that they would be open to one-off or short-term requests for additional exports if the beneficiaries of those exports were vulnerable communities or those affected by a disaster. There were two provisos, however. First, customers did not want to be personally disadvantaged by their philanthropically focused exports. Second, customers want to know what impact these philanthropically focused exports were having on vulnerable communities. (See Section 5.2.4 for further discussion on the assurances that customers were seeking for VPP community benefits).

4.3.4 Equitable sharing of VPP value

Customers were asked to reflect on how they would like the value of their VPP activity to be recognised by three potential beneficiaries: aggregators/energy retailers, the community, and government.

4.3.4.1. Recognition of VPP activity by aggregators/energy retailers

Consistent with Section 3.2.1, customers routinely expressed a desire for their VPP activity to be more tangibly recognised by aggregators/energy retailers. A range of suggestions were elicited in this regard.

Clearer payment structures

Customers of one Project EDGE DER aggregator received monthly $50 vouchers in return for their participation in the Project EDGE trial. Preference was expressed for financial benefits that could be more easily used by customers, whether in terms of direct payments or bill discounts.

> Direct payments is probably easier for me. You know, by buying my system I was given some vouchers to spend at these companies, and I had a look through the various things, and I thought, this is ridiculous. I've now got to find a company and go and spend this degree of vouchers. I downloaded it, because I thought everybody else does. But I thought, I could actually do with the money rather than the voucher, do you know what I'm saying? Instead of vouchers and stuff, if there was going to be some sort of recompense or discount for doing this or that, I'd prefer it just be a monetary thing, because it's more useful.

Alternative tariff structures

As outlined in Section 3.2.1, many customers struggled to reconcile the difference between electricity usage charges and the feed-in tariffs they were receiving for exporting their power to the grid. Many customers were consequently desirous of having their contributions more directly recognised through increased feed-in tariffs.

> Because they're the ones who are making money off you, the company. Not your neighbours; it's helping to stabilise their energy, I guess, but it's not helping them cost-wise. But definitely the company. And I don't think 10 cents is enough, considering what it was when solar panels were first introduced. That was really good amounts.

> The stored power should be – it should be a reasonable percentage of what we will pay for it… If we are going to be part of the actual system, which we should be, it needs to be worthwhile.

Upgrading systems

As co-creators of value, customers considered themselves to be an increasingly critical part of the grid. Developing long-term relationships with aggregators – such as aggregators committing to upgrading their customers' systems over time – was seen by some customers as one way to formally recognise this co-creation of value.

> Well, obviously we're part of their infrastructure as well so, I mean, obviously we're generating capacity so we're part of their decentralised energy supply. Maybe they could – we could work together and maybe they could look at upgrading people's systems and things like that from time to time or we could work together.

Asset maintenance and updates

Other customers looked for potential 'win-win' solutions that would mutually benefit both aggregators and customers. One suggestion was for aggregators to undertake routine maintenance of DER assets, such as cleaning rooftop PVs or installing software updates, so that these assets could continue operating at peak performance for longer periods of time.

> They can come out and say, "Hey, we're going to look at it, inspect your system, make sure there's no updates we can do or recommend anything to you." And do that as a service then that comes with it. Because ultimately, they're the ones who are going to get benefit from it as well. And I think there has to be more of a cooperative [approach].

> Maybe they could offer a free performance assessment and discount on a cleaning service or something. Maybe they could come out and they could say – because that's one thing that's in my mind, is I know I've got 11 kilowatt of potential sitting up there, but how much – actually due to weathering and cover, what's my performance now? I don't know how I can go and measure my performance, but I tell you, [aggregator] would know how to come and measure the performance. What's the degradation? Is it cleanliness? Is it a lifecycle drop? Because we know we do degrade in our panel performance.

Key takeaway: Customers wanted to be treated by aggregators as a more equal partner in recognition of the value of the DER hardware they were bringing to aggregators.

Given the value of the hardware they were bringing to the table, customers were seeking to be recognised as more equal partners in any agreement they entered into with aggregators. While customers were often pleasantly surprised with the relational style of service they received from aggregators (Section 5.2.5), they were generally less impressed with the financial returns they were receiving, with many believing that they were putting more into their relationship with aggregators than they were getting out. Financial remedies that recognised the upfront costs being borne by customers were often advanced as a way for aggregators to form a more equal partnership with customers, but non-financial remedies – such as aggregators supporting the ongoing maintenance of DER assets – were also suggested.

4.3.4.2. Recognition of VPP activity by the community

Although the community collectively benefits from households joining VPPs, customers believed that direct community recognition was not necessary because customers had elected to voluntarily purchase DERs and join a VPP.

> I don't know whether the community – They wouldn't want to pay you. Because you've made that choice to put the panels on. It would be nice, but they're not going to do that. I couldn't see how or why they would want to pay. Unless there was a financial benefit to them as well.

> It's a bit nerdy. I don't want - I don't want letters and flyers saying I've done this. It's more recognition from probably [aggregator].

4.3.4.3. Recognition of VPP activity by government

Government recognition – particularly in the form of rebates and other adoption incentives – was seen by some customers as an important way to recognise the benefits arising from households joining VPPs.

> I think the best proactive solution is for the government to provide more rebates to encourage more homeowners to install more power so that we've reduced that inequity, and we have a broader scale of solar installation so that it can provide a lot more support and reliability to the grid.

> It's obviously pretty costly, but I think it's a high priority. I think there should be maximum available rebate. I mean, I'd like to see, in a utopian society, I'd like to see the government saying, 'Hey, anybody who wants it, we'll install solar panels and a battery on your house for free.' That would be the perfect solution. That would obviously be very costly. We did get a small rebate when we installed the power. Maybe a couple of thousand, two or three thousand maybe, in rebates, I don't know. There was still a fairly high residual cost. So I think they should be increased as far as possible. I think it should be high priority.

Indirect investment, such as by providing grants to improve the technology underpinning VPPs, was also seen as an important lever that governments could use to better recognise the value of household energy exports.

> There probably are grants that might be relevant on a state or federal government level that will possibly assist them in better developing that technology, and the truth is it does need to be developed better. So that's probably where I would sit it, I would sit it at the level of infrastructure spending in technology and development around the delivery of those services because it is a little clunky and flawed, and if they get the model right, it can actually do a lot of social good.

Key takeaway: Customers wanted government to continue recognising the value of their VPP participation by maintaining support for DER acquisition and VPP development.

Although customers were not looking for direct recognition from government for the value being generated through the VPP, they were keen for existing rebates to be maintained, particularly given the large upfront costs associated with purchasing DER. Customers were also looking for government to continue funding R&D into the systems underpinning VPPs.

4.4 App interactions

Customers typically interacted with their VPP via an app, so their perceptions and use of these apps shaped how they viewed the VPP.

4.4.1 Monitoring energy generation and consumption

While by no means universal (see Section 4.4.3), some customers were active users of the energy generation and consumption statistics displayed through their VPP app. These customers spoke of the heightened energy awareness they had gained as a result, and of how they had used this new-found awareness to optimise their energy consumption patterns, such as by aligning their use of certain household appliances with periods when their solar PVs were generating power.

> I reckon my wife would check it a couple of times during the day. She's using that as a bit of an indicator of when we should switch things on. I think that's a significant feature of the system that we've got.

> Oh, I look at the information daily, at least. I also look at it, at times, to make a decision on what we - you know, if we're going to wash or put the dishwasher on or all those kinds of things. I mean, I don't have to; often you can tell, the sun's shining brightly and it'll be fine. But if it's not so clear I'll look at it and, "Yep, the battery's fully charged, that's okay." So I use that as input.

4.4.2 Monitoring energy trading

Apps from one of the aggregators also provided customers with information about the trading of stored energy. For many customers, while the information displayed about energy generation and consumption was relatively easy to understand, a much steeper learning curve existed with respect to understanding what was being displayed with respect to energy trading.

> There are two sides to the application. One is to look at current generation on our side. I find that very easy. On the side of managing the exportation of power to the grid, I find that very confusing. I don't know - I have no idea what to do with it.

> It's not that I've got too much information, it's a lack of clarity. But just dealing with how the app works, yes, there was definitely a ramp-up. I had to learn how that behaved, and this delay of 24 hours and things like that. So they're things that you don't notice when you first look at something and you have to actually go through the process a few times till you fully understand how it's working.

What made it harder to overcome this learning curve was the perceived lack of explanatory material to guide customers through the app's trading functions and information displays.

> There could have been a document that they sent out. There was like an agreement letter that said, 'We will pay this feed-in credit, this feed-in credit', but that was sort of all. They didn't really explain the trading at all in documentation form, it was just what you saw through the app.

> Maybe they do, I haven't looked. But I would imagine that they should have some videos on their website that would explain the trading process, and how to use it on their app. Some tutorial videos on their website. I wouldn't imagine they're going to run a live one-on-one training course just for me. But I would imagine if I asked, that they should be able to direct me to their website and say, 'Yeah, hey, go here, we've got some videos on how to do it.'

At the same time, however, many customers had not attached much weight to completely understanding the ins and outs of the app's trading functions, perceiving that other day-to-day concerns and pressures took priority. Potentially contributing to the limited weight attached to understanding this trading function was the limited financial returns represented by each trade (see Section 4.3.1.1).

> I haven't been losing sleep over it. Honestly, I haven't followed up with them in order to do that. It's one of those things in the back of my mind, if I'm ever sitting around one day and I have nothing else to do, maybe I'll ask them. But to be honest, I just get carried away with day-to-day, with work, whatever, you just get side-tracked.

4.4.3 Usage over time

While some customers reported regular use of the app's energy generation and consumption statistics (see Section 4.4.1), others indicated that utilisation of the app quickly fell away after an initial burst of interest. This drop-off in app usage often arose because interest faded or there wasn't seen to be a sufficient need to be continually checking the app to gauge generation and consumption data.

> I'd tell you, when we first had the system installed it checked a number of times a day, because we were just fascinated with it, to understand and learn how it all works. These days, I don't check it that often.

> I do look at it probably at least once a week and for a while I was watching it every day. I was looking at it every day.

4.4.4 Supporting apps

Some customers reported using multiple apps to monitor their energy generation and consumption. Even though these apps were often drawing on similar sources of data, idiosyncratic preferences for how information was displayed meant that customers often used other apps – such as those that came bundled with their DER assets – in addition to the one supplied by the aggregator.

> The [aggregator's app] has more information, like carbon offset, amount of trees or plants saved. Where the other one, it's graphs are a little bit different. So, I'll probably look at that one more than the other. The [aggregator's] one's good for bragging rights to friends.

> I've got a Powerpal app too. And the Powerpal app actually tells you how much electricity you're using in monetary terms. So it'll say, "you've used $4 worth of electricity today," or something like that. So maybe that's something that that app could improve on as well.

Some customers also reported using multiple apps to help troubleshoot specific issues with their DER.

> Every now and then, as far as my usage of the app, every now and then - I actually have two apps. I have an app from the battery manufacturer. The app from the battery manufacturer lets me see statistics of my generation. Then, basically what's happened is the app from [aggregator] just links into that data that comes out of the battery, and it shows you the same data. So I have two apps, I have an app from the battery manufacturer, and then the [aggregator] app, which draws data from the battery's app. Every now and then I open the app to just say, basically to check if the system's working. Because there was actually a time when - a period of a couple of months early this year when the wi-fi module on the battery system, which connects it to the internet to report the power generation, the wi-fi module actually became faulty. So what that meant was for a couple of months I was unaware. When I eventually looked at the app it just said zero. Then I had a look at the historical generation and it said zero, zero, zero. So according to the company - the solar panels had been working, but I hadn't been feeding anything in because the system was offline. So that was a couple of months of feed-in that I missed out on, and so since then, we had the wi-fi module replaced, which was through warranty. That was very easy, no problem. But since then, I'm a little bit more vigilant to, at least check the app regularly to make sure that the system's online and that it's generating something.

Key takeaway: For some customers, the value proposition for manually engaging in VPP trading wasn't enough to justify overcoming the learning curve for understanding the VPP trading process.

Some customers spoke of their difficulty in understanding how the trading function worked within their VPP app. At one level, these customers highlighted how training or explanatory material would have been useful so that they had greater awareness for what the trading process entailed and how to engage with it. At another level, however, customers also indicated that the financial pay-off to overcoming this learning curve wasn't sufficient to do so, particularly against a backdrop of competing life priorities.

5. Customer evaluations of their DER and VPP

Two broader customer evaluations were also examined through the interviews:

- Trust in the aggregator.
- Potential discrepancies between customers' expectations and experiences.

Findings emerging from this exploration of customer evaluations are summarised in Figure 4.

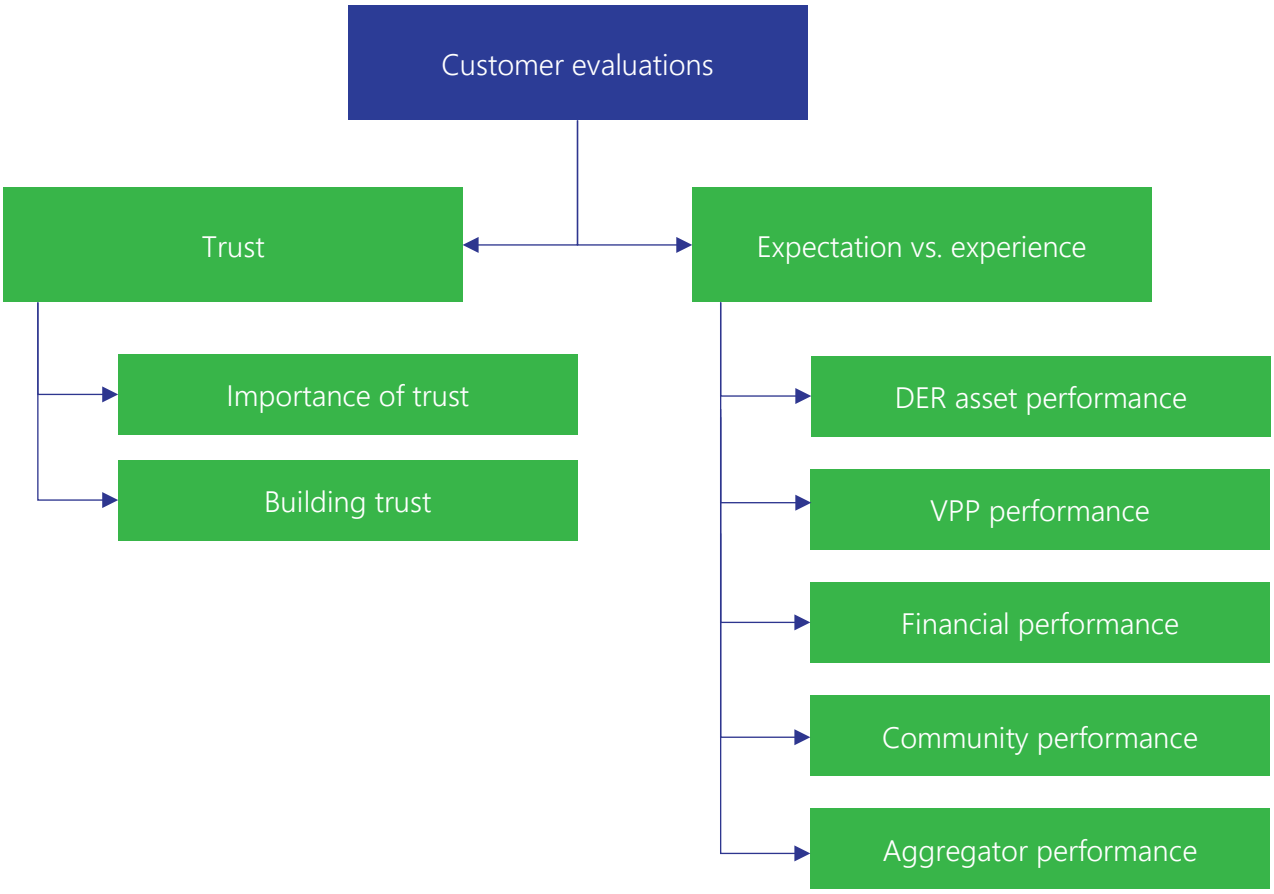

Figure 4 Components of trust and differences in expectations vs. experience identified by interviewees.

5.1 Trust

5.1.1 Importance of trust

Customers alluded to the importance of trust, not only when determining which aggregator to select but also in deciding whether to remain with that aggregator. As one customer noted, the importance of trust stemmed from the fact that in ceding management of a DER asset to an aggregator, they weren't just losing some degree of control over that asset; they were also ceding a certain degree of control over the devices in their household that were dependent on energy.

> "At the end of the day, we're kind of handing over control of the house to [aggregator]. Like I said, if their security's not good enough, if someone hacks the system or someone at their end fails, they can stuff me around, they can shut me down, they can cost me a lot of money. I did, I had to feel comfortable with that company.

Several other features of the customer-aggregator experience further accentuated the importance of trust. Customers reflected on the information asymmetry that existed in the customer-aggregator relationship, with aggregators having access to highly technical data or data that could not easily be verified by customers. In both respects, customers had to trust that the aggregator was being honest in their interactions.

> "You have to trust them, because I haven't got - to be honest, I haven't got time to verify everything that they do. It's like any provider. Our water bill, do I trust that the water meter reading is accurate? Do I have time to check it? No. I have to trust it. Our gas bill, do I trust when we receive a gas bill that our consumption is what they state on the bill? I kind of have to trust it, because I don't have time to check myself. So with all of these utilities, my phone bill, my data usage for my mobile phone plan. If my provider tells me yesterday I used two gig of data, do I have time to go and check every site and every download that I did and add it all up and see whether or not it matches what they say I used? No, I have to trust them. I think with all these utilities there's a degree of trust.

> "Well, basically, the most important thing was that if I trusted them to install it, I had to trust them that it was working. Because how am I supposed to know if it's working, or how much power I'm using, all of that sort of thing.

Trust was also required with respect to the ongoing management of VPP activity, particularly in terms of whether sufficient stored power would be available for households to maintain continuity of power supply during periods of power outages. For one customer at least, there was almost a sense of resignation in this regard; now that they had joined the VPP, there was only so much they could do to influence how their DER asset was utilised.

> I presume they don't cut me short by giving it back to the grid, so they would see what I wasn't using at that time. Particularly if it's very, very hot days and it looks like there could be power failures in various places because they don't have enough. Again, it's a matter of trust for me. I mean, what can I do about it anyway? It's like, you buy the package, you've got the package, and that's what you've got; do you know what I mean?

While the aggregators had generally been successful in securing the trust of interviewed customers, customers were quick to point out that this trust was not absolute. As one customer indicated, all businesses – whether they're an aggregator or not – will serve their own interests first, providing a tension in the extent to which they are able to also serve the interests of their customers.

> I suppose you can trust them to an extent, but trust – At the end of the day they're a company and they look after themselves. And we look after ourselves. So, they're there to make money, so I guess that would be a factor for me. Like, would you trust them? They're trustworthy to an extent, but at the end of the day they're a business. And they have to live and feed their families and stuff and we have to do the same.

5.1.2 Building trust

Trust in the aggregators was built through a variety of ways.

5.1.2.1. Local company

Some customers appreciated that the aggregators were Australian-owned, Australia-based, and/or had an extensive presence in their local community. This was seen as providing several advantages, including their perceived heightened responsiveness to changes in the Australian marketplace and their ability to authentically connect with customers.

> And the fact that they're Australian-owned – Australian-based, I feel that they could be a lot more reactive, because they're here – to the market. Rather than if they were based elsewhere. And I think that really helps.

> [Aggregator's] not only local, but they've certainly got people on-the-ground here. So yeah, I think we just trust the local kind of aspect.

5.1.2.2. Brand reputation

Brand reputation was identified by customers as another key driver of trust. Having a reputation for providing good quality service was deemed especially important. So too was company size, particularly in a sector characterised by lots of small businesses. As one customer noted, these reputational benefits meant that they were happy to pay a price premium so that they could be assured of receiving better quality service.

> They [aggregator] have a halo. The brand is there.

> I was very happy with [aggregator] because it's a reasonably big company compared to many other solar installers which are private individuals. I always expected them to look after me. I was happy to pay a higher price because I believe in, you get what you paid for, and I've got to say, I'm very pleased with my experience with [aggregator].

This reputational standing was contrasted with less well-established competitors that were offering potentially cheaper solutions but without the same level of credibility or history. For one customer at least, these competitors could not be trusted to manage such a sensitive and integral element of their home's energy setup.

> If I had gone with some company that was just a fly-by-night company that was doing really cheap panels that had a poor reputation, but I went with them anyway because they were cheap, I don't think I'd participate in a program. I wouldn't give them control of my system.

> The other part of that is that the brands that [aggregator] were recommending are all vetted brands. For the equipment that I needed in order to participate in [Project EDGE trial], [Project EDGE trial] has minimum requirements around what brands they will accept so they won't just accept any cheaply made, back-alley solar panels or inverters or whatever.

5.1.2.3. Interactions with company representatives

As has been discussed in other sections, interactions with company representatives were deemed important for developing or maintaining trust in the aggregator. This included during two critical periods: the sales process (Section 4.1) and the installation process (Section 4.2). For example, having an informative representative available to reach out to during the sales and installation process was seen as directly responsible for building trust.

> The other part of that is that [installer's representative] himself did the quote, was always available on the phone, talked me through the quote and was really quite helpful in terms of always being informative, knowing everything about and being able to explain why he recommended particular options. That also helped with my trust.

5.1.2.4. Third-party information and endorsements

As highlighted in Section 4.1.4, third-party endorsements or information provided by independent sources were also seen as helping to verify the bona fides of the aggregator, particularly in a sector characterised by complex product offerings and dubious selling techniques employed by competitors. Such content was deemed especially helpful while customers were going through the sales process.

5.1.2.5. No lock-in contract

While trust was developed through a variety of means, one other element was deemed important: having no lock-in contract. As several customers noted, this provided them with some degree of assurance that should the aggregator no longer be deemed as trustworthy, they could easily transition to an alternative provider of aggregation services.

> Although the reality is, I could leave [aggregator], I can even leave them now and it's very easy to be set up with an alternative provider.

> Once again, you've got – we've put some trust in that company, more for the research benefits of it, is the way I see it, not the control side of it there. I'm – well, I'm under the assumption I can just go, "I don't want to play this game anymore" but it's not a great concern to me.

On the other hand, the late discovery that certain incentives would be forfeit if the customer left early resulted in a perception of being locked-in with the aggregator.

> I said, "What happens if I don't accept a four-year contract? What happens if I don't sign this four-year contract?" And he said, "Well, you lose all the incentives, and you'll have to pay for everything." I felt railroaded into signing a four-year contract, because everything had been installed.

Key takeaway: Aggregators with strong brands and an ability to maintain expectations through strong, proactive interactions with customers are likely to build and maintain trust.

Aggregators with a strong brand and a reputation for delivering good service that is validated by independent third parties and reinforced by personal experiences are well-positioned to build and maintain the trust of their customers.

5.2 Expectation vs. experience

Pre-adoption expectations do not always align with post-adoption experiences, and such discrepancies can have an important influence on satisfaction with the company[11]. Customers were consequently asked to reflect upon whether their pre-adoption expectations aligned with the reality of their post-adoption experiences.

[11] Santos, J., & Boote, J. (2003). A theoretical exploration and model of consumer expectations, post-purchase affective states and affective behaviour. *Journal of Consumer Behaviour*, *3*(2), 142-156.

5.2.1 DER asset performance

Perceptions about the performance of their purchased DER assets varied across customers. For some, asset performance vastly exceeded their initial expectations, with the functioning of the technology causing one customer to simply say "wow".

> Yeah, my expectation was low I guess. Yeah, I just want carbon emission reduction. That was – which obviously being met, and this piece of technology is like "Wow".

> So, really satisfied with how we've set up and placed our solar PV systems on our roofs; they give us maximums of generation from as soon as the sun comes up to when the sun goes down…it means I've actually tailored my energy consumption that I'm actually using - all I need - and that's a good thing that I actually have excess to give back.

For others, however, it was only after they had purchased the DER asset that certain limitations became apparent. One customer, for example, was disappointed that certain household devices couldn't be used during a blackout because the energy requirements of those devices exceeded what the battery could discharge at any moment in time.

> If there's one issue I have, basically if there is a blackout, we do get blackouts here occasionally, and basically the battery only works the lights. It doesn't work the power. Obviously because – they say some devices use too much power to – and they can't function off the battery. Well, anyway but – that's something that's annoying when you have a lot of energy stored up and you can't use it, that's annoying.

5.2.2 VPP performance

How the VPP interacted with their DER assets was seen by some customers as not aligning with their expectations. One customer queried why the recharging of their battery was not prioritised before energy generated by their rooftop PVs was exported to the grid. Similarly, another customer initially believed that their battery would be recharged using energy from the grid during periods of high supply/low demand and was surprised when this did not appear to be occurring.

> I do know that basically sometimes the solar system tends to export to the grid rather than fill up the battery first. It does a bit of filling the battery up but it also exports on to the grid before the battery is full. Yeah, I would have thought you fill up the battery first and then export to the grid but it doesn't seem to be doing that. Even – yeah.

> It was supposed to be, yeah, they can take it out in - what do you call it, high demand times during the day, that they would recharge the battery during the cheaper periods during the night, but yeah, I haven't seen that as of yet, and I don't know if that's a state government - because the tariffs were too high. Yeah, whether it's a state government thing or just a grid issue.

One customer also believed that the aggregator was responsible for ensuring that their battery did not become 'flat', even if the battery had been used to maintain power to household appliances during a power outage.

> During one of the storms, we had I think the power went off for quite a long time and we didn't realise of course because we had the battery and then the battery went flat because I'm not sure of the issue, I think it was because [aggregator] is meant to be – I don't really know this, I'm just guessing this. I think that [aggregator] is meant to have a look and make sure it doesn't go flat or something.

5.2.3 Financial performance

Some customers had not yet had a chance to evaluate what impact their DER assets had had on their energy bills.

> I really haven't got a good baseline yet to – well, to really – a datum line if you like, because we're away, I think, for five months over this winter. The previous one we were in – in '21, I think, we were in lockdown as well as '20, so they weren't what we would expect normal years to be. Maybe one or two months we're away, but this time we're away for five, so yeah. I can't really say that the last bill was extraordinary or made me think there was anything different.

Others, in contrast, found that their energy bills had declined following the purchase of their DER. Indeed, one customer, who brought a previously purchased battery asset to their aggregator, praised the turnaround in their bills that had occurred from making this shift.

> Because when I had the battery fitted, I hadn't joined the VPP program. And I was still with my original provider, who were offering me bad returns into the grid, who were still charging me an arm and a leg to actually import electricity when I needed it, and I was running at a loss on it. As soon as I moved to [aggregator] with the VPP program, that turned around. I think it was in the next month I had a $45 credit on my account, where the previous month they had charged me $120.

> I am very satisfied right now with my household's current energy solution, with the solar, with the battery, and the reason is because - my house, I'm not very often here but when I am use the power. But because I've got the solar pumping into the battery but also pumping back to the grid, my electricity costs are significantly negative at the moment.

5.2.4 Community performance

Some customers mentioned that one of their motivations for joining the VPP was to benefit their local community, particularly by making subsidised energy available to those in need or to support those who did not have access to rooftop PVs. Such customers were consequently disappointed to

learn that their participation in the VPP had not led to these community benefits, at least as they had originally envisaged them.

> Again, I think from what I said there, was the idea of community – of people that didn't have solar panels being able to benefit from people who did have solar panels…. Yeah. Now, that wasn't the reality of what was happening. It was – yeah. But that, in my head, that's what I was hoping…. Because I don't think that people who – I was expecting them to get a direct benefit of it. And what was happening was it was just getting channelled back into the grid, but not at a reduced cost. Not – the 6c they were charging me; this was getting pulled in and passed out at full price to whoever needed it. And that's what – I would have loved to have seen.

> There is no proactive communication by [aggregator] telling me how the energy is used, when it is used and for whom it is used. So I was sucked in a little bit by this idea of community energy because I was into community energy.

5.2.5 Aggregator performance

Before joining, some customers were expecting to have a transactional relationship with their selected aggregator, believing that any interactions between themselves and the aggregator would mirror the types of interactions that would typically occur during and after the purchase of a product. These customers were therefore pleasantly surprised to find that the aggregator was interested in developing a more relational and longer-term partnership with them; a partnership built on ongoing communication and value exchange.

> So having that ongoing relationship with the company that you bought it from, I didn't expect that. I thought I'd buy it, pay the money, they'd install it, and that'd be it, I'd never talk to them again. But I've found that – now I've got an ongoing relationship with them, and I'd be talking to them regularly. I've become more active in power consumption.

> And then only one other time they've been in touch, and they were letting me know that there was a likelihood of there being a power outage due to storms and would I like to set the battery – for them to reset the battery to draw from the grid so I had a full battery that I could use if the power had gone out. So, I really liked that they're actually thinking and monitoring and hoping to help in situations such as that. I was very impressed with that.

This view was not universal, however. Other customers held the expectation of a partnership but believed that the aggregator had not been sufficiently proactive in their communications to maintain that partnership. Another customer also found the contribution of the aggregator to be somewhat opaque, querying the value-add that they were providing over and above the provision of trading functionality through the aggregator's app.

> So yeah, my expectation is I'm entering into a partnership, if you like, with [aggregator], and I would like them to be accessible and perhaps a bit more proactive, particularly in this early stage, where at the end of the day, [with] the people who participate in this […] You know, just being a little bit more proactive along the way would be useful.

> If I go to the trading tab of the app, I really see - I see the ability to sell in a particular trading window. So, I get the ability to select a trading window, and then to manually sell if I want to, but apart from that, I have no insight into what they're doing on our behalf. I have no idea.

Key takeaway: Aggregators must actively manage customers' expectations about what DERs and VPPs can and cannot achieve.

While customers were generally satisfied with their aggregator, several consistent gaps were identified between what customers expected and what they experienced. Some customers, for example, had heightened expectations about what their battery could achieve or how it would interact with the VPP, while others had hoped that joining a VPP would deliver greater direct benefits to their community. Actively managing customers' expectations so that their expectations are better aligned with their eventual experiences will likely be key to maintaining longer-term customer satisfaction.

6. Conclusion

Thirty-five semi-structured interviews were conducted with customers of three Project EDGE DER aggregators: Discover Energy, Mondo, and Rheem. Although customers attached value to many of the benefits associated with DER aggregation and were generally complimentary of the levels of service they received from their aggregator, they also questioned the financial benefits associated with their participation.

While previous research has discussed at length the importance of delivering clear financial benefits to customers to accelerate DER and VPP adoption[12], several interesting financially focused insights emerged from this study:

- Customers were not always cognisant of how their consumption and export rates were set, instead attributing any marked difference between these rates to profit-taking actions by aggregators and retailers. Further education may therefore be required to better align the expectations of customers with the market realities of the National Electricity Market, particularly as a means of averting potential reputational damage for aggregators that set and provide export rates to their customers.
- Customers were wanting a more equal partnership with aggregators in recognition of the substantial value of the DER assets they were bringing to the table, with suggestions for establishing a more equal partnership including obtaining better financial returns for their export activity or receiving ongoing support to maintain the value of their DER assets.
- Many customers had joined their aggregator in a leap of faith, hoping (rather than knowing) that this decision would not leave them worse off financially. These customers rationalised their decision to join as a means of supporting the development of an emergent technology that would benefit their community and the climate more broadly, but as other research has found, these factors tend to be less influential in driving the adoption intentions of households in the broader community[13]. Providing prospective customers with clearer information about the potential financial returns they are likely to receive from joining a VPP is therefore likely to be key, particularly as broader segments of the community are encouraged to join a VPP.

Against this backdrop, swiftly increasing the uptake of VPPs in Australia – and relatedly, encouraging members of a VPP to allow greater exports of stored energy – will likely require either:

- VPPs that, when positioned as a standalone product offering, offer tangible and discernible financial value to customers, particularly given the large upfront costs that customers incur to purchase the DER assets needed to join a VPP.
- Bundling VPPs as part of a broader package of energy services that are deemed to be attractive by customers.

Irrespective of the strategy that aggregators adopt, VPPs are a complex product offering, and while some customers may relish this complexity, many will not. A challenge for aggregators will therefore

[12] Rotman, J., Newton, J., Weber, V., & Jacob John, J. (2022). Project EDGE: Gaps in existing DER customer insights research. Available from: https://aemo.com.au/-/media/files/initiatives/der/2022/project-edge-lit-review-der-customer-insights-research.pdf?la=en

[13] Newton, J., Jacob John, J., Weber, V., & Rotman, J. (2022). Project EDGE: General community perceptions of distributed energy resources. Available form: https://aemo.com.au/-/media/files/initiatives/der/2022/community-perceptions-of-der-and-aggregation-services.pdf?la=en

be balancing the level and frequency of information that customers require to understand how their DER assets are being used while also respecting the desire that many customers have for VPP activity to be automated. In this regard, customers' informational requirements for automated VPP activity identified in this study were relatively modest: understanding when their DER asset was being utilised, receiving clear information about the financial benefits they were receiving, and, for those with a more technical bent, understanding how to manually change VPP settings or initiate trading.

Additional learnings were obtained with respect to motivating additional VPP export activity. As a general principle, customers were looking for any request to increase their VPP export activity to pass a 'better off overall test', with either sufficient financial rewards for exports to offset any short-term losses associated with decreased self-consumption or for sufficient charge to be left in their battery to ensure that households could continue to meet their self-consumption needs. Customers were also seeking assurances that the value of their asset would not experience accelerated depreciation – such as reduced battery performance – from increasing their export activity.

Finally, this study identified a set of pathways for building and maintaining the trust of customers. Being transparent, responsive, and available for customers to reach out to during the sales and installation process were activities that helped to develop a foundation of trust between aggregators and customers. Building a reputation for providing good quality service, and having this reputation validated by third-party endorsements or independent sources, also helped to verify an aggregator's bona fides.