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Interim Social Report

From the Realising Electric Vehicle-to-grid Services (REVS) trial

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Executive Summary

The social research stream of the Realising Electric Vehicle-to-grid Services (REVS) trial examines sociotechnical dynamics in the advancement of vehicle-to-grid (V2G), considering the views of technology developers and different user groups. The work takes a broad approach to V2G analysis that includes different implementations of bidirectional charging as well as both private and fleet electric vehicle (EV) users.

This report presents early results from interviews conducted in late 2020 and early 2021 with the REVS consortium, REVS trial end-users, future private and fleet end-users, and industry specialists. It is an interim report of work in progress: it does not include the full suite of results collected to date, and data collection is still underway.

As a trial project, REVS is application-oriented in the sense that trial end-users are staff of a consortium member (albeit within a different organisational unit) and the technical concept design has an intentionally limited scope. Hence the V2G concept being trialled is not a complete offering ready to compete on the market. The social research stream therefore aims to broaden the impact of REVS by looking to the future, informed by the multi-level perspective of sociotechnical transitions. Anticipating future risks and benefits associated with a technology in the design phase is a critical element of responsible research and innovation.

To date, the consortium has been preoccupied with the task of making V2G work. Consortium members have been extending and applying their existing knowledge and problem-solving heuristics gained from previous work deploying standard EV chargers and distributed energy resources (DER). V2G can hence be understood as a sub-niche of EVs and DERs and part of the same sociotechnical trajectories. At the time of the interviews, the consortium was yet to seek end-user feedback on what they were proposing, and were very keen to understand user experience, economic viability and future market offerings. There is currently a knowledge gap between making V2G technically work, and making V2G work within a societal context.

The end-users of the REVS trial—in this case, the fleet, facilities and sustainability managers who are coordinating the installation—were anxious about maintaining business continuity while the vehicles and chargers were deployed, and concerned that changes to procedures and parking arrangements will negatively impact drivers. They emphasised that drivers should not have to change their routines to accommodate the trial and called for transparency, noting they wanted to understand the trial's activities and outcomes beyond its immediate relevance to their daily work.

The research also extended to future fleet and private end-users, none of whom are involved in the REVS trial, but all of whom are interested in, and in some cases already using, EVs. Future fleet end-users generally interpreted the potential interest in V2G through the lens of their organisation's climate change targets. An important implication of our research findings is that V2G proponents will need to focus attention on organisations' specific goals and tailor the V2G offerings accordingly. Participants also raised a risk that the timing and form of V2G's commercialisation might not align with investments in EVs, particularly with regard to different vehicle classes. V2G could be seen as compromising core business activities, such as providing bus services or fitting in with existing salary packaging arrangements. Despite their reservations, the future fleet end-users saw V2G as potentially beneficial and worthwhile.

Private fleet end-users were motivated by self-imposed goals to reduce their personal environmental impact, and were keen to be legitimising early adopters of technology. While

they saw V2G as a positive concept, barriers to participation included distrust of V2G providers, distrust in software, concern over battery degradation, the need for flexibility, and a preference to have their battery present and connected to their house at all times. They expected to be compensated accordingly for doing the grid a favour, but were most interested in the vehicle to building (V2B) configuration, in effect having a home battery much larger than a stationary battery.

Industry participants identified the need for both early use cases that appeal to legitimising end-users and seamless, user-friendly implementations for future mainstream users. While they believed the EV transition was inevitable, the future of V2G was uncertain. Industry participants emphasised the need for V2G business models to be consumer led.

Key highlights

- **Key stakeholders are still uncertain about the likely users (and beneficiaries) of V2G technology.**
- **The social science research is already informing consortium members of key gaps and issues in the technology roll-out.**
- **There are many practical issues in the installation of bi-directional charging which require consideration and incorporation into the ultimate design and installation of charging stations.**
- **Fleet managers are not a homogenous group – their varied motivations mean it is unlikely there will be a ‘one size fits all’ V2G offering even for fleets**
- **Private EV users believe V2G may work for them but only under specific conditions. Their perceptions are mediated by a (lack of) trust that energy providers and the technology align with their own interests and expectations.**

Introduction

The REVS trial

In an Australian first, the REVS project demonstrates how commercially available EVs and chargers can contribute to energy stability by transferring power back and forth into the grid. EVs will inject power back into the grid during rare events (to avoid possibility of blackouts) and the fleet owner will be paid when their vehicles are used for this service.

Employing 51 Nissan LEAF EVs in ACT Government and ActewAGL fleets, the REVS project seeks to support the reliability and resilience of the electricity grid, unlocking economic benefits and making electric vehicles a more viable and appealing transport option for fleet operators. The REVS consortium covers the whole electricity and transport supply chains and includes ActewAGL, Evoenergy, Nissan, SG Fleet, JET Charge, the ACT Government and the Australian National University. Together the consortium will demonstrate V2G live in the electricity market and produce knowledge sharing materials that aim to accelerate the deployment of V2G nationally.

The project has been endorsed by the Australian Renewable Energy Agency (ARENA) and has received funding as part of ARENA's Advancing Renewables Program. REVS is underway and will publish a final report in 2022.

Purpose

The purpose of this document is to provide an update on early findings from the social research stream of REVS. The social research stream will examine the preconceptions, experiences and priorities of people and organisations involved in providing, facilitating or using V2G, with the aim of growing our understanding of how V2G might develop (or not) in Australia. It will probe different use cases of bidirectional charging in terms of people's values and aspirations, and analyse them in the context of government policy and strategic planning for energy and transport.

This report presents results from 35 interviews with current and potential future stakeholders in V2G, including the consortium, trial end-users, organisations electrifying their fleets, private EV owners or prospective owners, and associated energy and transport industry specialists. As an interim report on work in progress, this is provided as an update for ARENA, consortium members, and the general public.

Scope and timeframe

At time of writing (April 2021), the REVS trial was taking delivery of vehicles, installing chargers on site and carrying out the required hardware and software integrations across 11 ACT Government sites across Canberra and multiple software platforms. End-users are yet to view either vehicles or chargers, nor have they been trained in how to use these new facilities. Accordingly, this report focuses on preconceptions of V2G, rather than use and experience.

The REVS social researcher on the project (based at ANU) conducted the interviews which covered a wide range of issues, not all of which are included in this report. More comprehensive results will be presented in future reports.

Future publications from this stream of work will include contributions to the Scaling Up Report and full documentation of the social research stream in a Final Report, which will be issued at the completion of the REVS trial in 2022.

Approach

Framework

Niche technology development as evolution

For this research, V2G is conceptualised as a 'technological niche' – a space for a new technology to advance, develop and prepare for exposure to the open market. The concept of a 'niche' is drawn from the multi-level perspective¹. Essential to niche development is a process where various possibilities of design expose new technologies to different markets and user preferences. In much the same way we understand evolution, selection of a dominant design relies on there being some variation in that technology – say, different V2G business models – and competition between those variations. As such, it is often not the 'best' design that may end up becoming scaled up – but rather the design that best aligns with key stakeholders' goals and expectations and existing infrastructures (social, economic and technical). In Australia, emerging energy technology designs frequently do not consider the views and capacities of all relevant stakeholders, which may explain why they are not implemented fully or do not become standard features of the energy system.

The REVS trial is implementing one variation of V2G, namely a fleet of EVs that is selling frequency control ancillary services (FCAS) in return for wholesale market value. Many other variations are possible². The social science stream of research aims to address some of the necessary limitations of a trial project and add value to REVS by not just exploring the views of trial end-users, but by also casting a wider net to explore other user preferences and expectations.

It is natural that engineers delivering technology development projects tend to be focused on the task of making something work: combining the components, linkages, skills and infrastructures into an overall working system conceptualised as concentric rings being hardware, software and orgware (Figure 1) [2]. Hardware and software are tools; orgware allows the technology to be installed, operated and managed into the future.

¹ The multi-level perspective [1] is a widely used theory of socio-technical change that combines evolutionary economics and technology studies.

² Refer to our report, *The A to Z of V2G*, for examples.

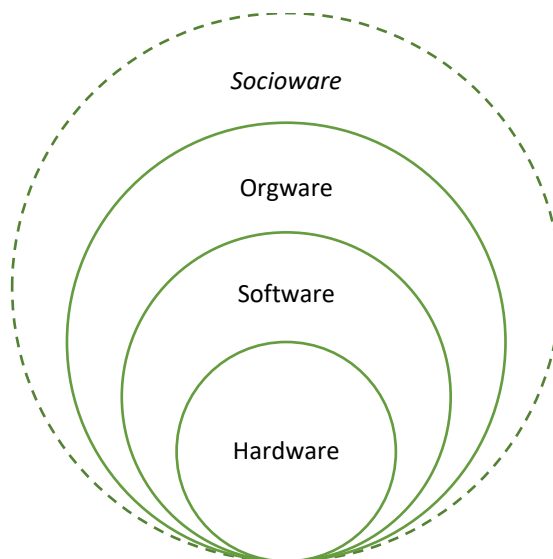


Figure 1: The engineer's perspective of technology development.

The organisation of technology in the concentric model towards a configuration that works is typical of 'the engineer's perspective' [2]. A fourth, outer concentric ring of technology development is socioware, which is the societal embedding of technology into real contexts [2]. In some projects, technology developers view socioware as a niche activity critical to making something work, and include consideration of public acceptability in their design process so as to reduce the risk of rejection or redesign. Yet in other projects, technology developers design their product with little awareness or understanding of the social context in which their technology may be deployed, with attendant challenges in implementation and take-up.

Aside from making the technology work, three processes are crucial to niche development: expectation building, network development, and learning [3]. Expectation building generates a sense of urgency, certainty and belief and is more forceful when shared across stakeholders, and hence also relies on network development. Learning can be limited to first-order learning, which is learning about how to improve the design, what is acceptable to users, and how policy can incentivise the technology. For the niche to develop, second-order learning is required, which does not just test but *questions* and *explores* conceptions about technology, user demands and regulations [4].

The salient point is that development of niche technologies is more likely to be successful if there is variation in design, and if those variations are developed with consideration of the wider environments and contexts in which they must function – not just limited to solving hardware, software and orgware. In addition, technology development must include questioning and reflection so that the technology, users and policies can co-evolve around shared expectations and values.

Situating V2G within EVs and DER

V2G is contextualised as both an EV technology and a DER technology. EVs and DERs, too, are technological niches with their own characteristics and trajectories in Australia. Australia is a global laggard in EV adoption with ownership in 2020 accounting for only 0.6% of market share compared to a global average of 2.5% [5]. On the other hand, DER could be considered a national strength with some of the highest rates of home solar power systems in the world and increasing installation of commercial solar and home batteries [6]–[9].

V2G needs to be seen in the context of EVs and DER as the relevance of V2G relies on there being enough EVs being aggregated together as well as the standards and regulations in which DER is embedded to allow them to be used this way. However, other variations of bidirectional charging might not be so reliant on these factors. For example, using an EV battery to balance energy flows behind the meter involves discharging but not export.

Consequently, this research focuses on the narratives of, and experimentation with, bidirectional charging and hence does not attempt to limit conversations and analysis to just the REVS trial variation of V2G, nor strictly to V2G.

Given this conceptual background and the broader purpose of the REVS trial, the overall research questions are:

- What narratives of V2G are being formed?
- What new collectives and tensions are likely to form around V2G?
- What futures are being extended and which are excluded?
- What are they dependent on (e.g. new collectives), what assumptions are being made?
- How are they aligned or misaligned with the forces and broader transitions of EVs and DER?
- What are the normative judgements—for industry, policy and users—of what should happen next?

While the analysis in this report will not be answering these questions in full, they provide an explanation for the methods used, such as the sampling of participants.

Progress

The results are based on 35 in-depth interviews with participants from five target groups who are all associated with V2G, EVs and/or DER in some way (Table 1). Interviews are ongoing during 2021 and will include follow-up interviews with trial stakeholders after the vehicles and chargers are operational, plus more interviews with the other groups. Overall, they are purposively sampled rather than representative samples of stakeholders. The sampling design is informed by the research questions, stated above. The interviews have been recorded, transcribed and analysed in a qualitative software program (QSR NVivo).

The interviews were semi-structured and included questions regarding:

- How interviewees came to be involved or interested in V2G and similar technologies
- Motives – reason for interest in V2G, hopes for the trial
- Learning and lasting impacts from the trial (REVS participants only)
- Expected and preferred futures
- Different use cases for bidirectional charging, including:³
 - providing grid flexibility via markets (V2G)
 - balancing on-site energy consumption and production (V2B)
 - providing back-up power (V2X during power outages).
- Normative judgements – what should be done about electricity and transport
- Where the interviewee finds information about V2G and associated technologies.

³ These options are not mutually exclusive in reality, but the aim was to explore end-user aspirations that might in future provoke interest in bidirectional charging.

Table 1: Summary of interviews to date.

Group	Description	Trial participant?	Interviews
REVS consortium	Members of the consortium team involved with management and day-to-day project delivery	Yes	11
REVS end users	Fleet, facilities and sustainability managers of participating ACT Government directorates covering the 11 trial sites. At this stage of the trial, they are involved with coordination of the charger installation and vehicle delivery.	Yes	4
Future end users – fleet	Fleet and sustainability managers of organisations transitioning to EVs. All are local or state government organisations covering Queensland, ACT, Victoria, Tasmania and South Australia. No experience with bidirectional charging, but potentially interested in future.	No	7
Future end users – private	Currently or considering using an EV for private transport. Current users include both owners and lessees. All homeowners, including a range of life stages from first home to retiree. Most located in ACT, one each in Queensland and NSW.	No	6
Industry	Industry leaders in EVs and new energy technologies with potential future interest in V2G. Includes energy solutions providers, charger manufacturer/provider, energy retailer, energy strategist and customer experience expert.	No	7
Total interviews			35

Results

This section presents results in five subsections, starting with the consortium and the trial end-users, then the two future end-user groups, concluding with industry specialists. People within these participant groups represent different user types playing different roles in the development of V2G. It should not be assumed that the groups are internally homogenous and variations where necessary will be elaborated. Findings are summarised in Table 2.

Table 2: Summary of findings.

Participant group	Main area(s) of concern	Other viewpoints
REVS consortium	Making V2G work User experience Economic viability and business models	
Trial end-users	Business continuity Minimising impact on drivers Transparency and communication	
Future fleet end-users	Meeting emissions reduction goals (and similar) Availability of suitable EVs Timing and form of V2G offerings Compromising core business activities	V2G is a sensible use of resources and is potentially beneficial, if it is aligned with broader goals
Future private end-users	Lowering environmental impact Being an early adopter of promising technologies (Dis)trust in service providers and technology	Bidirectional charging might be suitable if it is aligned with goals and the deal is fair
Industry	Finding compelling use cases for V2G Putting customer needs first	EVs are inevitable, but V2G is not

The consortium

Focusing on making V2G work

At the time of their interviews (November and December 2020) the REVS consortium members were preoccupied with carrying out the tasks defined in the project plan to deliver the project – the development of hardware, software and orgware shown in Figure 1. Figure 2 depicts the technology development tasks that were identified in the interviews with the

consortium members. These did not include socioware development tasks, consistent with the engineer's perspective and unsurprising given the technical and practical complexity of the project, and the general lack of social science trained experts within these organisations. In the intervening time, however, the consortium has engaged with socioware with feedback from trial end-users and the social science research stream of the trial.

Even with the inclusion of socioware, the consortium activities are currently limited to first-order learning about how to implement and improve the design. This is significant and necessarily, as can be seen in the first results below. As the technology progresses, however, it will be important to expose V2G to different settings in order to push problem-solving into other directions and prompt deeper forms of learning.

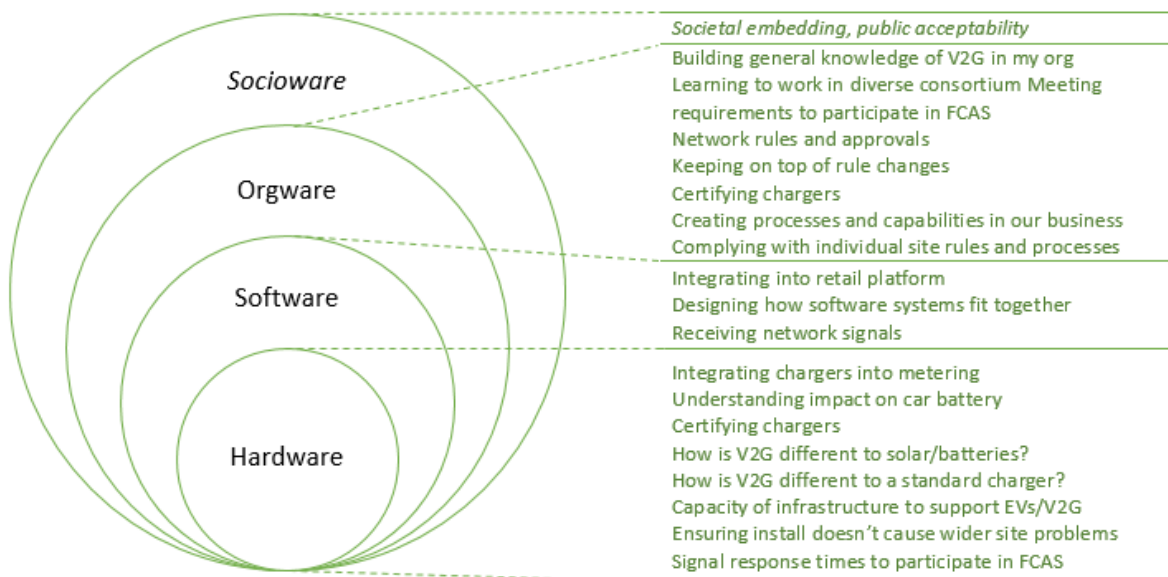


Figure 2: Consortium tasks to date from "the engineer's perspective".

The tasks the consortium is doing (shown in Figure 2) provide insight into the processes of institutional embedding occurring within the V2G niche. Rather than starting with a blank slate, consortium members are assimilating V2G knowledge into what they already understand about other technologies, in particular, solar and batteries (DER) and non-V2G EV chargers.

... for V2G we want to know how different they are to an existing solar panel or a battery and how different they would be if we had to manage that particular asset and manage them in either through third party aggregation or directly – Eddie, network

I suppose the, understanding the differences between vehicle to grid and just a standard charger, and we have learned an awful lot in terms of, you know, the extra considerations that need to be made. - Alex, government

Assimilation of existing knowledge is understandable, as the consortium is made up of organisations that are already working with DER and standard EV chargers as parts of the mainstream electricity system. However, this approach could preclude V2G from finding its own best-fitting use cases. On the one hand, the assimilationist approach could be good for the development of V2G, provided it is accompanied by external pressure (like the mass uptake of EVs, causing pressure on electricity systems that then needs a response), and if V2G proves to be a technology that provides the most appropriate solution at the time it is

needed.⁴ On the other hand, the danger is that V2G does not evolve into a form that end-users prefer over other technologies, and hence it is out-competed by DER and standard chargers [4].

Nonetheless, the orgware development that is happening through REVS—embedding V2G into existing frameworks and processes—is an essential part of any new technology scaling up and is therefore an important process.

Understanding usage patterns and economic viability

Although consortium members are not focused on socioware, they are keen to understand how users interact with V2G and the effect that might have on economic viability. They conceptualised this question quantitatively in terms of vehicle usage patterns and how they align with opportunities to earn revenue from FCAS.

I'd like to learn fleet behaviour so usage of vehicles and how that ties in with periods of grid demand and whether those two things match as in periods of high grid demand equals low fleet usage. - Tim, charging provider

I think we're very much focused on the technical implementation and how do we actually make it all work with the FCAS market and the charging stations but we've got this sort of unknown and, you know, it's working well because the pool vehicle that we're using tends to be back at base at fairly predictable times. - Lincoln, fleet provider

There were varying perspectives of which settings would be best suited to V2G. In some participants' view, complex sites like commercial buildings would be less suitable due to the more technically involved charger installation and the presence of multiple tenants. Following this logic, V2G in fleets might best suit organisations that own both their fleet and their building. Other consortium members felt that only fleets made up of light passenger vehicles would be viable, and some believed the opposite. One interviewee speculated that residential settings might be less suitable, based on the assumption that private EV owners make “emotional” rather than “rational” decisions (it is worth nothing that all forms of decision making implicitly involve both dispassionate calculation of expected utility as well as subtle and sometimes covert emotional processes [11]).

On the other hand, consortium members noted that a good proportion of dwellings in Australia are semi-detached or detached houses possessing off-street parking, drawing parallels with the availability of residential roof space that has helped make solar power so popular in Australia. The following quotes demonstrate the variety of views regarding the most appropriate applications for V2G.

There will be limits within, I guess, from a government perspective, because there's only X amount of vehicles that we have and sites that we can integrate with this and whatnot – Michael, government

... in homes, I think you're always fighting this kind of you know, this is my asset. I need it to support my home and I don't care about the grid, whereas I think for the fleets, it's a much more rational discussion of how much is this going to save my fleet costs and will I have a fully charged vehicle in the morning when I need to use it. - Tim, charging provider

⁴ Researchers describe these possible pathways as ‘transformation’ or ‘reconfiguration’, depending on how it plays out [10].

... we have a high percentage of people who live in detached, semi-detached residences that have off street parking and own their own roof space that can put solar on and therefore have off street parking so they can have a space to charge anyway – Charlie, vehicle manufacturer

... for companies like us where we have heavy machinery, trucks and so on, V2G is not necessarily a thing that we would need to contemplate right now, because the machinery is machinery. – Eddie, network

I suppose if you look at the wider fleet, you might look at vehicles like buses and the opportunity that they might provide, you know, far larger batteries and their transition to zero emissions, maybe, maybe more attractive – Alex, government

I think private, you know, if it's your building, if it's internal, it's probably not too bad. So I can certainly see it in a private fleet being successful – Alex, government

This lack of agreement on suitable applications for V2G is an interesting finding, as it emphasises that even within the consortium there is lack of agreement over where V2G might find its footing and be taken up by end-users. It appears easier to rationalise how it might work for someone else, than for one's own vehicles or premises. This perfectly illustrates the need to understand the embedding of a technology in society before it can be rolled out.

'We just want to see it up and running'

Primarily, though, the consortium is just looking forward to seeing V2G working and earning income as a first step in the development of the technology.

So that's what I'd like to see, is this basically past this trial and basically us proving that it's effective and it works and what the return is as well – Michael, government

The hope is that we see very clear benefits for electric vehicles in participating in FCAS and just creating another revenue stream to bring the price down for EVs, which would just increase the adoption. – Lincoln, fleet provider

Aside from economic concerns, the consortium wants to understand what it is like for people to use V2G. There was also a desire for the REVS trial to participate in real world events so that there would be a story to tell of how the vehicles helped support the grid.

Yeah, so have you had any feedback from people? About what they think of the networks controlling how their cars charge and discharge, like, are they comfortable with something like that? – Justus, charging provider

... basically client acceptance, whether there is any client acceptance, whether, for example, the larger Chademo plug, disincentivises people from plugging in. – Tim, charging provider

Fingers crossed something happens in our trial and then we can respond and then show that these vehicles can do it. – Lahiru, retailer

... for us to actually have this rolled out, it's actually running. And then when push comes to shove and we literally, you know, the grid calls on it. Yeah. It's actually doing exactly what it needs to do. Yeah. And we're actually contributing to that. – Michael, government

These results illustrate that the work of the consortium is consistent with the engineer's perspective being the development of hardware, software and orgware. Regardless, the consortium is looking to the question of socioware. Until V2G is configured to a social context, the technology remains malleable.

The trial end-users

To date, V2G chargers have not yet been installed. As a result, drivers have not yet been exposed to the new vehicles and chargers; the only end-users that have had contact with the trial are the fleet, facilities and sustainability managers who are coordinating the installation of V2G at their sites and the operation of V2G within their fleets. Even at this early stage, however, we have learnt a lot about the priorities and perspectives of end-users.

Installing chargers in existing facilities

There are many challenging aspects of installing chargers in existing facilities that were designed, built and entered operation before EVs and V2G were envisaged. One example was that some facilities need to shut down site power in order to safely build a new connection point for the chargers, which is particularly challenging for 24-hour sites and those with swipe card access. In these cases, security guards need to be stationed to control building access while the power is out. Facilities managers reported that building shut downs in the past have resulted in “blown fuses” and the like, and as a result shut downs are always cause for some anxiety.

As another example, buildings with multiple tenants or are not owned by the party installing the chargers require extra coordination and solutions for metering and billing, depending on where the chargers are installed in the electrical topology.

Considering these types of challenges, the trial end-users are very focused on ensuring the installation and transition to new vehicles and chargers goes smoothly.

... the challenge is we don't own the buildings. When we need to install EV chargers, especially this one is the bidirectional EV chargers, it's a little bit more complex and also involves the shutdown of the power. So we need to have a little bit more approval process to hook up to the base building that is also providing the power to other tenants, not only to the ACT government.
- Jane, sustainability, facilities and fleet manager

There are also approvals and processes for installing charging infrastructure that vary between end-user organisations and buildings. For example, some organisations actively maintain an up to date set of plans for their building, so any new chargers, cables and connections need to be added to plans as part of the process. On the other hand, some buildings might not have an up to date set of as-built drawings that installers can rely on for information. In any case, the trial end-users need reassurance that the works are being done according to the normal processes that would apply to any type of works.

The two three components of V2G

From the perspective of the consortium, V2G involves only two components: a V2G-enabled and warranted vehicle and a V2G-enabled charger. However, from the perspective of the end-users, another component is just as important: the parking space. This applies to EVs more generally, but V2G creates a new type of EV parking bay that only some EVs can use. Parking spaces can be difficult to manage under basic circumstances and some sites were already experiencing challenges trying to prevent petrol fleet vehicles and members of the public from parking in EV bays:

At the hospital we have an area which all of our fleet but also public can access at the moment. So it's mainly educating people that they can't be parking in those spots, that that would then impact the business unit if they're running low on battery power but they've got to go out quickly across Canberra – Grace, fleet manager

... we as a team kind of sat down and worked out where would be the best spaces to make sure because they're only going to be able to charge the Nissan Leafs, we have to make sure that we've got enough space for things, making sure they're clearly marked so that staff aren't accidentally going to try and a vehicle that's not going to work – Grace, fleet manager

These issues raise further questions – how will drivers know which are the V2G vehicles? The V2G parking bays? The V2G chargers? These components are not easily discernible, so the fleet managers have flagged that they will need to be identified somehow. However, if some vehicles have been assigned parking bays and not others, this can create perceptions of unfairness among staff.

Ensuring business continuity

While the consortium has been getting the technology in place and working, the trial end-users were focused on business continuity – they don't have the luxury of going without vehicles, even for a short period. Delays in charger installation, which have forced delays in vehicle delivery, have caused anxiety for the end-users. It is essential that the vehicles are available when needed, including for unscheduled use, such as urgent late night client visits by mental health nurses.

The biggest thing at the moment is organizing delivery to meet the time for the charge stations. So we haven't got a second date for when our infrastructure will be installed, so it's more I guess with time and how long it's going to take, because we've got areas waiting that've been told that they're now getting an electric vehicle. So that timing I suppose is biggest concern with delays across Christmas shut down and that kind of thing. But, yeah, probably that that would be our major concern just making sure that it's all a seamless transition. – Grace, fleet manager

The managers are not expecting anything to change for the drivers compared to the other EVs in their fleet once the trial is up and running. At all sites, drivers are already in the habit of leaving vehicles plugged in when parked, so that is not expected to be an issue.

... we're currently looking at how it's going to suit the staff and making sure that there's nothing extra that they need to do – Grace, fleet manager

So we ask that as people drive them, they're just put back on onto the charge. So as people are using them they just remain on the charge. We've set one of them, one of them has a capacity to set it to 80%. That's the Kona. I'm not quite sure whether the Nissan Leafs have the same ability to set a certain charge or not. – Alma, facilities officer

In the past, the process of adding EVs was subject to some minor usability challenges for drivers, such as using pushbutton ignitions or foot brakes. Those managing the fleets reported that drivers seemed to like EVs (though not universally), however it should be noted that this has not yet been discussed with the drivers themselves.

The biggest problem we have with them though is, is because it's so quiet, sometimes occasionally, very occasionally, they don't actually get turned off. – Bill, fleet manager

... some people love them. Some people hate them. – Bill, fleet manager

I did speak to some of the community nurses that said they love driving the car. They have no issues. I think, again, it was a bit of a learning curve to make sure that you are keeping an eye on the power gauge and learning things like having the heater or air conditioning going full bore will obviously decrease the power. – Grace, fleet manager

But overall, speaking for users who used to use the EV, yeah, they enjoy using the EVs. I think they are proud that our agency or the government is transitioning to the electric vehicles. – Jane, sustainability, facilities and fleet manager

Given the importance of continuity and the expectation of fleet managers that driver workflow will not be changing, there is a potential issue that is now being given attention. A constraint of the charger hardware is that the charging plug cannot be disconnected while the charger is engaged, which could cause an issue if a V2G session is underway at the same time as a vehicle needs to be used. To solve this, additional actions were proposed at the software side: specifically, drivers would need to follow new steps in SG Fleet's Bookingintelligence system, such as having to book cars when previously they did not need to. The visibility and indexing of the trial vehicles in the pool vehicle booking systems also needed to change, which could make it harder for drivers to find them.⁵

Factors will change end-user workflow (while not also changing the workflow for other EVs and non-EVs in the fleet) could affect the utilisation rate of the trial vehicles, which could in turn impact the viability of V2G. Eventually the consortium (and other market proponents of V2G) will need to create solutions that will more seamlessly embed V2G in the daily lives of fleet managers and drivers. When a technology is an accepted part of the landscape, its complexities tend to be concealed [2].

No such things as too much communication

Trial end-users were clear that they would appreciate visibility of the project beyond the immediate steps (like charger installation and vehicle delivery) as well as finer detail about how it will work (as opposed to general information about V2G). This included the behind-the-scenes details of the trial – it might not be obvious to the consortium that the managers are interested in more than merely the operational details.

The managers emphasised the need for greater communication in general, and to adjust the pace at which details of the project are revealed. Otherwise it's difficult for them to know the right questions to ask at any given time.

I don't have a lot of understanding as to how that [V2G] actually works because we haven't had that actually rolled out to us yet, so we haven't actually seen it and how it's going to work. – Alma, facilities officer

... up until now, it's been fine, everything's good, but we haven't we're not participating in the REVS trial yet. So I don't know what it actually entails. So I don't know what sort of reporting is going to be needed, whether it's done by computers or whether it's done automatically or whether I've got to put some input into it. – Bill, fleet manager

As other recent Australian technology trials have found [12], without a dedicated resource to communicate and engage end users, participants can end up frustrated and confused. In REVS, steps have been taken to address this desire for more communication: since receiving feedback about the level of communication, consortium members have hosted a Q&A session with the managers. The session was particularly useful in making clear the significance of workflow changes in Bookingintelligence, as mentioned in the previous section.

Finally, the managers stressed the need for training of both themselves and the drivers. This would need to include the vehicles, using the chargers and using the booking system. The managers emphasised that drivers regularly make simple errors, even with non-EV fleet vehicles, and that drivers should be expected to do the wrong thing sometimes.

Really, I think it's training, training, how to charge the cars, if it's different to what we normally do. Which I assume it's not going to be, or not too different. No doubt that SG Fleet, because

⁵ Following end-user feedback, a more acceptable solution is now proposed.

we lease them off SG Fleet, no doubt they will have a training process, on driving the car, because I haven't driven one yet. – Bill, fleet manager

Care should be taken not to mischaracterise the need to conceal complexity and a desire for broader and more detailed communication as contradictory. These results are typical of different phases of technology development. V2G is a niche technology in the experimentation phase that still needs to be fully developed for end-users through trial and error with a higher degree of uncertainty [13]. Whilst in these early stages of development, end-users require transparency so they can understand the risks they are taking on. Later, V2G should stabilise into a shared and socially embedded vision of what the technology is, at which point black-boxing is more possible [2]. This also illustrates the different roles of users at different stages of sociotechnical change.

Future fleet end-users

The future fleet end-users are, like the trial end-users, fleet and sustainability managers within organisations. The key difference is they are not part of the REVS or any other V2G trial. The trial end-users are implementing V2G because their organisation has agreed to take part in a trial; the future fleet end-users are not part of the trial, but might implement V2G in future if there is a compelling case to do so. They therefore represent a different category of user more illustrative of the potential future of V2G.

Understanding the bigger picture

All of the organisations represented by this group of interviewees were already transitioning to low or zero emissions fleets as a result of higher-up decisions and announcements. They also all happened to be state, territory or local government organisations from the ACT, Victoria, South Australia, Queensland and Tasmania. Their decisions and announcements took the form of transport emissions targets, economy-wide zero net emissions targets, renewable energy targets, or similar.

... our premier announced that we're going to be, the Tasmanian government to be, 100 percent electric by 2030, which really is only three cycles of our vehicles because we run them for three years, sixty thousand k's – Michael, state government

So basically that encompasses more than just electric vehicle charging stations. It actually predominately looks at how the city can achieve a 50 per cent renewable energy target by 2030. Now, 2031, because we've basically killed off 2020. – Pamela, local government

In addition, many of these organisations were already reporting and reducing greenhouse gas emissions in line with a standard system⁶. They already understood their operational emissions, and in many cases their fleet was a major contributor and therefore a key part of meeting their targets.

... transitioning transport fleets to zero emissions will have biggest impact of any measure to reduce emissions – Kim, state government

These factors framed the fleet transition process as not a question of if or when, but a question of how. Depending on the organisation's roles, fleets are made up of a variety of vehicles – not just light passenger but also light commercial, heavy vehicles and others. The narrow range of EVs currently available in Australia, coupled with organisations' ambitious and

⁶ For example, the National Greenhouse and Energy Reporting (NGER) program, the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) or the Climate Active Carbon Neutral standard.

pressing transition targets, meant that electrification of the light passenger fleet is currently seen as low-hanging fruit that can be transitioned now. This has implications for V2G, because the time at which it becomes commercially available might be too late to factor into light passenger vehicle transition plans. This may be especially the case if V2G availability coincides with heavy EV availability, as the heavy vehicle transition is likely to be of much higher impact in meeting targets and hence could dominate the organisation's attention and funding.

... it's a relatively easy path for councils at the moment to transition the light vehicle fleet to electric vehicles. There's enough variety now in Australia that they can do it. – Stuart, local government

... of course, small vehicles are easy to transition as we start upgrading and switching our fleet, but it's those heavy vehicles where most of our fuel use comes from. – Ethan, local government

In one case, an issue of timing had already occurred:

... people like me who are trying to advise large groups of people, including our own organisation with all the hype around bidirectional vehicle to grid, I haven't heard any outward conversation around the fact that it's not really even here yet. – Ethan, local government

This becomes more significant when organisations are facing the challenges of installing any type of EV charger in existing facilities. As the REVS consortium well knows, this is universally difficult in terms of physical practicalities, organisational processes, and finding a way to fund it. This makes timing very important.

But as well we've just put in cabling for another 16 stations. But I haven't got the money to actually put the charge stations in as yet. And we have to upgrade our circuit boards and all that as well to be able to do that – Michael, state government

The key takeout from these results is that due to competition for fleet transition solutions over time, V2G must be viewed as not just supporting EV uptake, but competing with other zero emissions transport options, and needs to present a particularly powerful value proposition. It also depends on whether end-users see themselves as legitimisers of V2G—not merely consumers—and therefore interested in testing, shaping and interpreting the technology, and sharing their interpretations with others [3].

Fleets in the context of a larger transition

Depending on each organisation's targets and approach, their fleet transition was situated differently – for some, the fleet transition was approached as a stand-alone piece of work that was not part of a larger program. For others, fleet transition was very much seen within the context of larger electrification or emissions goals involving much more than transport.

Responses were in part dependent on location, which dictated the broader infrastructural context. For example, organisations in Tasmania had less need to consider the scope 2 emissions⁷ from charging EVs, as they are already very low due to a mostly renewable state electricity grid. In other parts of Australia, however, switching to EVs without also installing or purchasing renewable energy was seen as shifting the problem elsewhere, which tended to expand the scope of their transition program.

⁷ Scope 2 emissions are greenhouse gas emissions arising from the indirect consumption of an energy commodity, such as the emissions from the consumption of grid electricity.

... from a Tassie point of view, as our power is predominantly renewable, there's not as much emphasis on solar and whatever else – Michael, state government

So if you're going electric drivetrains powered by coal, you're shifting the problem elsewhere. You're making slight improvements somewhere, but you're shifting a problem elsewhere. So that journey has to be taken along with renewable energy – Stuart, local government

Likewise, if an organisation had a strong mandate for locally-sited renewable energy or carbon neutrality, transition efforts and decision frameworks were built around achieving those particular objectives.

So our whole premise is to not offset, it is to use onsite renewable technology for our assets and then see if we can turn that into something that is more useful for the community. So that's kind of what we're looking at when it comes to EV charging – Pamela, local government

Though organisations had oversight of their emissions, fleet transitioning brought different expenditure on liquid fossil fuels or electricity for charging vehicles into or out of view, depending on the person's perspective and the infrastructures in place to collect information. This was constrained or enabled by the existing electrical topology of their facilities as well as accounting processes.

We're, so with that as part of the cabling, we're also doing a new you-beaut – I think it's a couple of hundred grand – not a substation, but basically it's a switchboard that will allow us to basically go off each one and work out how much it's actually costing us. But at the moment, we don't. [Q: But you have oversight of how much you're spending on petrol?] Yes, yes. A lot of money. – Michael, state government

The organisations were also grappling with issues broader than just energy or emissions. For example, some were facing new revenue challenges since the Covid-19 pandemic, were very focused on job creation through energy projects, or felt it important to address the life-cycle impacts of lithium batteries as part of decisions. The future role of hydrogen in transport was also a significant part of their planning, particularly with regard to heavy vehicle fleets.

Does V2G make sense?

We asked participants what they thought of V2G as a concept in and of itself. Universally, they saw the technology as positive, being an efficient use of existing battery assets for good.

I think it's a good idea from a global perspective and especially for fleets where the numbers can justify the investment and benefits – Ethan, local government

Because it provides a decentralised way of guaranteeing electric supply and balance the networks. And yeah, and the vehicles seen as batteries and operating as such in a broader way, it makes all the sense. – Con, local government

... why wouldn't we try and utilize it as much as possible? It's just sitting idle when it could be doing so much more. – Pamela, local government

One participant saw V2G as particularly relevant to their organisation's objectives:

We're looking at, there's a strong opportunity for vehicle to grid as well that lends itself to other opportunities to support what we're doing – Pamela, local government

However, others envisaged practical barriers to its adoption, particularly if it was seen to clash with core business.

It would be very difficult to convince managers to agree to this, as buses are often required at short notice for breakdowns and service changes. – Kim, state government

And the flipside of that as well is that with the push for electric vehicles, too, is that a lot of our private plated contract vehicles. So when a doctor or something starts and gets a vehicle attached to their package, if it's pure electric, will also, oh, they'll make us pay for their electricity bills. So we're probably in in the deep end a bit there. – Michael, state government

... we're still trying to get them over range anxiety. All of a sudden we're saying, oh, we're going to actually do something else with this vehicle. – Pamela, local government

Similar to the REVS consortium, some future fleet end-users considered V2G quantitatively in terms of vehicle usage patterns and alignment with the most lucrative times of day to earn revenue. Framing the use case in this way prompted both doubt and interest in the suitability of V2G for their organisation, depending on the characteristics of the fleet.

Look, to be brutally honest with you, no, I don't. Because I think the usage patterns of vehicles are so sparsely different that it's kind of like, you know, when you need the power, the car's being used on the road, it's not plugged in. – Stuart, local government

Well, I mean, I think in certain situations that could work. I mean, for instance, if you've got vehicles, for instance, with your blue collar workers, you know, in local government, quite often the vehicles that are used in those operations apart from, say, three or four o'clock in the afternoon. – Stuart, local government

Again like the consortium, for some future fleet end-users it was easier to see someone else using V2G than it was their own organisation.

But certainly it makes sense from a private car point of view or a private person point of view. It just does make sense. If you can either go back to grid or get off grid totally and have enough battery or car battery available to run your house, then you're actually decreasing the costs so it makes sense. – Michael, local government

These results emphasise that the socioware of V2G remains an open question, and as a result there is an outstanding need to articulate the viability and significance of V2G, both in application and in vision, so these interpretations can then be shared. REVS can contribute to this, but the project cannot achieve it in isolation.

Exploring potential use cases

Based on the mixed responses, it appears that the prospect of V2G being used in fleets is a firm 'maybe'. To understand this better, the interviews explored what sort of configurations or objectives the fleet participants envisaged for bidirectional charging more generally in order to articulate possible use cases.

The two organisations that had already considered the concept of bidirectional charging were primarily interested in using it to optimise on-site renewable energy, envisaging a bank of EV batteries acting as a 'solar sponge' and/or reducing energy costs with arbitrage. Note that the former does not actually require bidirectional charging – controlled charging (or V1G) would suffice. One organisation was interested in offering V2G in public car parking.

... these vehicles sit in our car parks doing absolutely nothing during peak hours. And if we are able to support our building infrastructure or different infrastructures that we have utilising those vehicles and then charging when it's not when it's not peak, there are opportunities to play those games within the demand curve. – Pamela, local government

... we just wanted something that essentially did the same thing in terms of being a sponge in the middle of the day and avoiding peak, which we thought we could achieve with a unidirectional control module that spoke to spot prices and things. – Ethan, local government

Participants were open to either V2G or V2B if it saved their organisation money as long as it did not get in the way of using the vehicles but, as mentioned above, felt it was peripheral to their core business or not a primary goal. Some did not envisage there would be much value in providing grid services, especially when they already had organisation-wide power purchase agreements in place which meant the potential to earn income was relatively low.

And again, from a power perspective, it makes sense to balance up your power. But from a Health point of view, it probably doesn't make any difference to me how that actually occurs, because, again, Transend [TasNetworks], they need to keep the grid up and running. So it's more a Transend type of thing to do that balancing act. – Michael, state government

You support the NEM, there's opportunities for revenue. So they kind of go hand in hand. So it's - supporting the NEM is not our primary driver, nor is revenue. I think it's more about how do we actually move away, move our reliance from the grid to our own self-sufficiency so that way we can generate revenue or provide opportunities for our community members. – Pamela, local government

... so feeding like the frequency control or something? Yeah, we did the numbers and compared to the revenue from a fleet, car park and the electricity costs and things, it's a nice co-benefit, but it wasn't a base for a business case. – Ethan, local government

None of the organisations found the back-up power features of bidirectional charging to be compelling, though some imagined it would be of great interest to those with an existing remit to provide back-up power, such as electricity networks or emergency responders.

Each organisation was different in terms of fleet composition, goals, drivers and scope of their transition process. This suggests that a future for V2G in fleets is unlikely to be a 'one size fits all' proposition, and that it may be fruitful to approach this challenge through collaboration and aligning V2G offerings with the goals that are driving change in the organisation. The development of V2G past the experimentation and legitimating phases into a stabilised, black boxed commercial offering appears most difficult to identify.

Future private end-users

The future private end-user group comprised people who either owned or leased an EV, or intended to buy an EV in the near future. In all cases the vehicle was for private use. All were homeowners in metropolitan areas and ranged from millennials to retirees (by their own descriptions). Most were located in the ACT, with one each in Queensland and New South Wales.

Working through a to-do list

The interviews included discussion of EVs, as well as other aspects of energy production or consumption in their daily life, with a focus on aspect they were actively changing. All of the future private end-users were doing (or planning to do) more than switch to EVs, such as upgrading their home for energy efficiency, installing solar and/or a battery, and home automation. In many cases, installing solar was seen as part of preparing for an EV, so that it could be charged with renewable energy.

Well, I'm interested in energy efficiency, have been for some time.

I suppose what motivated me is I've got quite an old car and I thought, oh, you know, next time I get a car, I'd really like to be prepared to buy an electric car. So I've recently got solar.

– Anne

So we bought the Leaf in August 2019, a month before the solar panels were installed. – Joan

We've got two solar systems, one is the older one that has the feed in tariff, then we got an electric car and we wanted to take care of the electric car with solar, but there wasn't enough, the original system wasn't big enough

... we did over the insulation, we replaced probably 90 percent of the windows and doors with double glazed, we provided external shading. We've got a nifty little device called Ecoheat, which I could explain if you want to hear about it.

– Seth

So we have one system and that is not sufficient it's under 2 kW. So we recently invested in a new system, started in June, July this year. So it's been running for six months. And it's a 4.9 kW. Much more efficient and has a 12 kW Tesla battery connected to it.

So I guess I've had a long interest in solar energy and energy efficiency and our whole house has been gradually modified to improve its efficiency, increased insulation in ceilings and floors and double glazing windows and the like

Yeah, also our goal is to purchase an electric car within the next 12 to 18 months, if a suitable model comes at a price we can afford.

– Dan

I'm trying to figure out in my mind I haven't written anything down, like is it worthwhile for our household to get solar, get a stationary battery, or do we hold out, wait for that next generation vehicle, the Kona or whatever we get, and that will serve as our household battery. – Farah

We're planning to put in PV system and battery.

I'm still driving around a standard car, but I'm hoping when we need to replace this one in the next year or so, we will be able to buy an electric vehicle.

– George

Participants also associated their actions with other forms of energy, or other issues entirely. For example, some were in the process of transitioning gas-powered services like cooking and hot water to electric, using water more sustainably, growing food at home, reducing waste, divestment from fossil fuels, and planning for aging in place. In general, the participants interviewed were interested in sustainability across multiple dimensions.

So we've sold both our motorbikes, so we have no petrol in the house now.

And I guess the next step is converting our, we have gas cooking and gas hot water.

Finances are fossil free.

– Farah

I live in a townhouse, but grow a bit of food and that sort of stuff. – Anne

In terms of how we live, I mean, we do the recycling as best we can, with North Sydney Council's recycling program.

... we've now switched to Diamond Energy. So I'm not sure if you're familiar with them. So they may be only New South Wales. They don't own any coal assets, any fossil fuel assets, and they're actively involved in building renewable energy generation as well as retailing.

– Joan

We've got solar hot water; we've got a grey water system. We've got water tanks. – Seth

These results indicate that V2G and technologies like it are ascribed meaning that sits within a broader context and will be interpreted and assessed as such. This means, for example, it is not only important what the V2G offering is, but who is offering it and what their goals are.⁸

A clear destination

If these actions were a journey, participants had clear destinations in mind. They were all motivated by environmental values and a desire to consume net zero energy.⁹ In many cases, environmental sustainability was a long-standing passion. Some were inspired by sustainability organisations such as Renew, and some also noted that the financial benefits of their actions were secondary considerations at best.

You know, to me, it's just getting away from, it's just decarbonising the community. That's all the energy system, I should tell you, that's my motivator. – Anne

... the aim is to be a net zero energy house that we don't need to draw extra energy over a year. We won't need to draw extra energy from the grid, we'll be generating enough so that we can be net zero. That's the plan. – George

So it's really from an environmental focus. I didn't really think of the economics first. So it's really kind of from the what lesser impact can we have in terms of our energy consumption.

Ultimate, ultimate goal, I think, climate. I think what sets us best to address climate change.

- Farah

I'd like to achieve complete energy neutrality or to be able to even export a bit. To offset at least all the energy we consume. – Dan

So I have a very long term committed interest in the climate change topic and enjoy the technical aspects of technology that will help us address the root cause of climate change. – Joan

... to have as low an impact on the earth as possible I guess is what it's all about. – Seth

Again, these results emphasise that interpretations of V2G are important and rationality in decision-making can extend beyond the immediate interests of the individual, to collective concerns such as fairness, accountability and decarbonisation.

Does V2G make sense?

The future private end-users generally saw both private and public benefits in bidirectional charging technology, because it would provide them more utility than having no battery or only having a stationary battery, and because it used an idle asset to provide grid services. Many were open to this idea. They did expect that owners should be compensated fairly, whether they were just making their vehicle available for V2G, or whether their battery was being actively called up to provide services.

So there was an article in the ABC about the project with the EV to grid and the whole concept of not building more power stations, if we could store energy in car batteries. So I really like that

⁸ For more detail on these themes, refer to other social sciences report from the ANU research team:

- [Stakeholder views on the potential role of community scale storage in Australia](#)
- [New energy VOICES \(forthcoming\)](#)

⁹ As the work progresses, efforts to find participants interested in EVs but who do not necessarily identify as 'green' will continue.

idea of having cars, you know, cars running around, and then if there was an emergency that we could all go back to the grid and power the system, that really appealed to me.

You know, to me, it just makes sense that we could be using something that we already effectively have sitting around. And so I wouldn't need a lot of motivation, but yeah, I think there would have to be some sort of financial incentive to make people interested.

– Anne

But now I'm kind of thinking, well, we know we want to upgrade this EV eventually to be bidirectional. – Farah

The Nissan Leaf was at a better price point than the Tesla for us. Obviously, it was cheaper, significantly cheaper, and it had the vehicle to grid capacity. And I went, well, that's perfect, because then we can you've got a 40 kilowatt hour battery sitting in the car that you're only using some of the time. To us, that made perfect sense.

I suppose individually, it was part of a trial, I'd be happy to try it and give feedback. If it was actual, there's a financial incentive, like if it was a commercial contract, it wouldn't have to be to too much money to be to get me over the line in the sense that it's a fairly easy thing to do.

- Joan

The battery on my wall out there is 10 kWh, which will get us through a night where nothing outlandish is happening, you know, not a massive dinner, like a big party with heaps of cooking and it's winter and someone wants a shower at night and needs to put the hot water booster on and all that, then you can easily use more than the ten, you know, and yet the car holds 27 and the car is often sitting out there with a full battery.

If the energy retailer is drawing as seldom as Reposit is now, I would say it would hardly be any change at all. And secondly, if it was allowing me to use the energy strategically at home, it would affect me very positively.

– Seth

Like the future fleet users, there was sometimes a tendency to imagine V2G would suit other users better than it would themselves.

But if it's a vehicle, like a fleet vehicle where it's got it's used to serve whatever organization for X amount of time, and then whatever happens after that vehicle, I think it makes total sense. – Farah

The participants were however not totally convinced about bidirectional charging, particularly the fact that a “battery on wheels” could drive away and not be there to store and discharge energy when needed. A stationary battery, on the other hand, would be there 24/7. Although grid-connected solar and batteries do not provide people with additional end-use services they could not access otherwise, they are perceived as a need.

... the issue for me is the fact that the car's not always going to be at the house. So what do you do if something comes up and your car is not there, you're still going to need a household battery. And also, if your car is plugged into the house, you wouldn't want to drain the car's battery because then that limits your transport options. So to me, I just see it as being more practical to just have two separate systems, not one having to rely on the other. – George

A barrier to participating in V2G was concern about battery degradation. This was an issue that people did not feel they currently understood well, and would require access to trustworthy information.

if I were to kind of translate it personally in our household, if we were to participate in that trial, I think I would have a lot more questions in terms of the impacts of the battery. – Farah

Most did not see major issues with participating in V2G as long as their use of the car was not impeded unreasonably – some flexibility would be required, and the system should not cause a new form of range anxiety. On this note, participants made the point that they would go away with their car for weeks or months at a time, so V2G agreements would need to be very flexible.

Well, as long as it doesn't restrict our ability to use the car when we need it for something, or making sure your car's plugged in overnight, when we'd generally not be using it, then I wouldn't see a problem. But if they started saying, oh, you must plug it in between 12 and 2 every day, that would impact on our travel needs. So if they are reasonable demands, I wouldn't see a problem with that. I mean, I'm expecting that we'd be plugging in our car regularly anyway just to keep topping it up. – George

What I don't understand is if you're selling power, and you're having your battery drained out of the car at night because it's peak demand at night. You wake up in the morning, your car's got no battery, what was the point? How does it work?

We don't all live a life where we eat our lunch and do all the things that we're supposed to do at the same time, and then go to work and go to sleep. And yes, people have all sorts of things that happen in their lives, it changes quite dramatically, you might go away for two months.

– Dan

These results open up interesting questions in the interpretation of V2G. Is it something end-users want to do, or it is something they are doing to help out? Will they have a choice?

Seeing yourself in the adoption curve

Some of the participants self-identified as early adopters, suggesting that they imagined a role for themselves that was greater than the immediate actions they were taking. This suggests they were motivated to take actions – and indeed, to participate in this study – by a desire to be legitimating users that act as intermediaries, building up niches and enabling social networks [3].

[discussing VPPs] So we're trying to find those opportunities to be at the forefront or like to kind of test, and we see the benefits. – Farah

When the Howard government was putting out its solar rebates, the scheme to trigger the solar revolution. And we were early adopters. – Dan

Although they were ahead of the curve, it didn't necessarily mean they saw themselves as particularly technically-minded.

I think in this area I would draw on the expertise of other people. So I probably want support. And certainly my wife is not technically minded at all. So I think we'd be looking at a system that's basically set and forget really that we wouldn't have to be tinkering with it. – George

And it's a bit hard to know what's the best thing to do when you're not really a techo or really knowledgeable in that area. – Anne

The future private end-users interviewed should therefore be viewed as both essential to building momentum for the technology so it may emerge from the niche, but not necessary representative of mainstream user-consumers.

Different implementations of bidirectional charging

As with the future fleet end-users, the interviews with the future private end-users included discussion of different use cases for bidirectional charging. The idea of using EVs as transportable backup power was viewed generally positively – some participants imagined

themselves assisting their own community in the event of a power outage. The participants also expressed a preference for prioritising their home energy needs (V2B) over providing grid services (V2G) or backup power.

I think that's a great idea of being able to help out around the community if power is needed – Seth

... if you signed up like people volunteer for the SES and you can say I'll be on the SES's list as a backup power, mobile power supply, to me, that would be very appealing and dead easy. – Joan

.. as far as my situation goes, if there was a disaster, my car would be home most of the time. So, I mean, it would be very easy for me to plug in if there was a disturbance and a fast response was required to stabilize the grid. – Anne

I think my preference would be on a kind of personal level, vehicle to home would benefit me the most. I definitely see the benefits of backup power and then VPP I'd have questions. – Farah

If government was able to [provide backup power] with its own vehicles, that might be good. But certainly, I want to give my own house the priority for my electricity. Yes, so back up power definitely for my own place. – George

While these results indicate a preference for V2B, it should not be assumed that V2G is of insufficient interest. It could be that people perceive that the needs of the renewable grid are encapsulated by the “solar duck curve” (and hence addressed by V2B) and have lower awareness of other needs such as fast frequency response. Likewise, bidirectional charging for backup power might be of greater interest to, for example, private EV owners in regional locations.

The importance of trust in service providers and in technology itself

The participants emphasised their need to know they were receiving good advice and that the companies they were dealing with were giving them a fair offering in terms of product, price, and terms and conditions. In some cases, they felt that the power imbalance between a service provider (such as a retailer or aggregator) and an individual consumer made it difficult to believe they, or even the public good, would receive a fair deal. Transparency was seen as essential. One participant suggested that a local council-brokered agreement might be preferable to agreements between individuals and large private companies.

Trading services, battery services to make money, I guess my question would be how much of that benefit is passed on to consumers and then what's the impact on my infrastructure, on my equipment that I'm supplying – Farah

... a trial is one thing, but if it was a permanent change, I'd want to feel confident in the organizations I'm contracting with.

... as an individual, you've got no bargaining position. It is one 40 kWh battery, you know, so I can see and also that issue of the level of expertise and how much time am I prepared to spend understanding this contract that I'm signing up for.

- Joan

It really comes down to the flexibility of the kind of deal they are talking about. And what are the real benefits they've got to sell, the idea that, you know, what is it giving benefits to, to humanity or the grid? And my pocket? – Dan

But it would be great if somebody had come along to me offering, you know, a whole package and actually has worked out how much power I'm likely to use here versus there and how much

we could sell and just working out our capacity and then working out the finances of it all. – George

Some participants expressed a lack of confidence in the technology, in terms of it working against their preferred mode of operation, clashing with other ‘good’ practices (like turning off standby power), expecting software to fail, or just receiving confirmation that systems have been sized appropriately for their home. These concerns again point towards the importance of transparency as well as the need align the design of technology with people’s aspirations.

The energy from the panels is being exported to the grid and not going to the battery, and I want the battery. The way it's supposed to be set up and the way, of course, that I want it is that the battery preferentially gets power when it has any capacity to take it right. Apparently, it's related to the fact that I turn off the modem at night usually. And Reposit is set up that you have a permanent modem connection. – Seth

With that technology you could wake up in the morning to drive and it was dead flat because they've taken all your power the night, you know, that kind of thing, because it's something, they'd made a mistake or, you know, technology had had a software error or something like that. – Dan

Then [after my energy needs have been calculated], you know, I might be more comfortable about relying on this sort of technology. For the moment, I just want to make sure the house certainly has the most secure power supply at all times. – George

The results from the future private end-users indicate willingness to play a legitimising role in V2G development and perhaps in future integrate V2G technology into their daily lives. It is important that offerings, in terms of technical design and commercial agreements, are sufficiently weighted towards their aspirations, and that there is transparency throughout.

Industry

Finally, this section presents some brief results from interviews with leaders outside the REVS consortium but in related industries. It is important to understand this group’s views because, as proponents attempt to scale up V2G, other parts of industry have a role in expectation-building and network development, which are essential niche development processes. The results presented here focus on the contributions that the REVS trial should seek to make in order to progress V2G.

V2G still needs a compelling use case

Industry participants highlighted the need to identify use cases that are compelling for end-users, which should then serve as a starting point for V2G offerings. They were not all convinced that V2G would become a mainstream technology, even though they saw the mainstream adoption of EVs in Australia as inevitable.

... what we need is a pivot where the grid suddenly says, OK, all you people out there with your vehicles, you're our resource, you're saving us a lot of money. We don't have to go and buy storage. We don't have to put in extra power lines because we can use you smartly. And so we need to look after you. So what do you want? That's the sort of focus you need to have. – Greg, energy solutions provider

So some vehicles are garaged at home, some are garaged on premise, some are driven all day, some are hardly driven at all. If the project's able to identify potential use cases and scenarios and customer value propositions that might work and then is also able to identify the value that might be available from that, then yeah, great, that would be super. – AI, energy retailer

I have seen some interesting studies that make me wonder how far vehicle to grid is going to go. Is there going to be enough value that you create to the utility to bother cycling an automotive pack? I'm not sure yet. – Francis, charger manufacturer

Some did believe that the V2G configuration being trialled in REVS was the most likely model to progress, at least in the short term. Others noted the particular importance of understanding the motivations of early adopters in putting together offerings.

The ActewAGL trial is going to focus on flexibility services. I guess that's how we see it here in its infancy as well, and whether that progresses into a retail or a tariff type mechanism, we'll see. – Peter, charging provider

Gather the insights from particularly these early adopters and have their stories recognised and, let's say, filter them for the real lessons and learnings that inform where we're going with this thing and don't get bogged down on the little technical bits. – Al, energy retailer

A further point was that it needed to be not just the right solution, but the right solution at the right time, also noting the significance of whether environment or cost was the highest priority.

Delivery of the service [is highest priority for my clients]. So resilience and reliability are number one, I think we could probably wrap safety into that as well. So that's baseline. Then they have a competing cost and environment agenda, and that will depend where they're coming from. They mostly would have a strong environmental agenda now, it's just about timing, cost within the time frame for delivering, and roll out. So it's a case of what's the cost impact and if we wait for six months, is that better or do we do it slowly. So that timetable then becomes the final piece of the puzzle. – Toby, EV and energy solutions provider

Despite the perceived inevitability of EVs, it will be difficult for industry to share visions for V2G in the absence of early and compelling use cases and certainty in timing.

Focus on customer experience

Participants emphasised the need to develop a customer experience that was seamless, easy and positive. Eventual offerings should not assume that end-users are interested in engaging with the technical details of V2G.

One thing I tell everyone is that the user experience is not well documented or understood, and I think from what I understand of your project, that the fleet experience is different again to the everyday user experience. But the fleet experience is also one that must be understood very well. So paying attention to who in the organization is impacted by the trial is probably worthwhile because it's not just the trial manager or the sustainability officer or whomever is the sort of head person.

It's every person that has to use a car and any person that has interacted with the system of, you know, having the parking spaces taken or having all these cords on the ground or, gosh, what's that thing, it's either going to be perceived as cool and exciting and a benefit to the organisation or a bane because it's created inconvenience or difficulty. – Alina, EV customer experience expert

I think the way that it has to be administered and presented needs to be low risk for the user and very, very low friction in terms of the engagement, like if it requires too much signing of forms, too much filling out of apps or anything, it just will not happen. Too much friction. People don't people think about - there's this great statistic, you probably know it. People think about energy for seven minutes on average every year. And most people would consider if it was more than seven minutes, something has gone wrong. And solar people and energy nerds are perhaps an exception to this. – James, energy strategist

These results once again highlight the need to think about different stages of the development of V2G in terms of different user groups. The early stages will involve users taking on a legitimising role which required transparency and malleability in the technology, whereas in later stages more V2G adoptees will be mainstreaming users better suited to a black boxed and seamless version of the technology. Crossing the chasm to reach a mainstream majority of users is a major challenge for V2G and similar technologies (e.g. [14]).

One participant summed up the trajectory of V2G in Australia well:

... think about it through the lens of it being about the road map model, that it's not about what it is right now, it is about what it could be in the future. And I don't think it's going to be the answer to every problem. But if we can figure out what problem it is a unique and compelling answer for, that would be a massive achievement. – AI, energy retailer

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