AGL Electric Vehicle Orchestration Trial

Lessons Learnt Report 3

March 2022

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This Project received funding from ARENA as part of ARENA's Advancing Renewables Program.

1. Executive Summary

AGL's Electric Vehicle Orchestration Trial has received funding from ARENA as part of ARENA's Advancing Renewables Program. The trial comprises three streams:

- A trial of orchestrated residential EV smart charging comprising 200 participants who will have their charging controlled via a smart charger installed in their homes.
- A trial of two emerging charging technologies – vehicle API charging control and Vehicle to Grid (V2G).
- A control group of 100 customers on a time-of-use (TOU) tariff to assess the effectiveness of a tariffication incentive against that of firm charging control.

Installation of charging equipment for the 200 smart charging participants has been completed and controlled charging has been in progress for this group since January 2022. Detailed charging data is being collected from this group for analysis. Customer research involving this group is presented in this report and has been very positive.

By agreement with ARENA, the original number of participants in the vehicle API stream has been increased from the original 50 to 100, and a second vehicle API platform provider has been included in the trial. Recruitment of customers is complete with detailed charging data being collected. Controlled charging is now taking place through the first platform provider (Flexcharging) and will shortly be implemented with the second platform provider (ev.energy).

Metering data is continuing to be accumulated for the TOU control group.

The V2G stream of the trial has been significantly delayed due to technical compliance issues with the chargers and other concerns with the technical solution required to achieve the trial objectives.

2. Introduction

The AGL Electric Vehicle Orchestration Trial project commenced in November 2020 and has received funding from ARENA as part of ARENA's Advancing Renewables Program.

The trial comprises three streams:

- A trial of orchestrated residential EV smart charging to assess the value of controlled charging as a distributed energy resource – 200 participants who will have their charging controlled via a smart charger installed in their homes.
- A trial of two emerging charging technologies:
    - Vehicle API charging control – 100 participants (expanded from the origin 50) who will have their vehicle charging controlled remotely via an API provided by the vehicle manufacturer.
    - Vehicle to grid charging – 50 participants who will have vehicle charging and discharging controlled via a V2G charger installed in their homes.
- A control group of 100 customers on a time-of-use (TOU) tariff whose performance will be compared with the participants on controlled charging to assess the effectiveness of a tariffication incentive against that of firm charging control.

In reflection of the encouraging early results from the vehicle API charging control stream, and by agreement with ARENA, AGL is now extending this stream of the trial to include a total of 100 customers and a second vehicle API platform provider.

There are three phases to the trial:

Phase 1: Recruit and Build – recruitment of all trial participants, installation of charging hardware in homes and development of an aggregation platform to manage and control charging. This phase took place during calendar year 2021 (extended to early 2022 for the second group of vehicle API participants).

Phase 2: Operate – test and trial the various solutions in the field, collate charging data for detailed analysis and carry out customer research. This phase takes place during calendar year 2022 and is now in progress.

Phase 3: Close-out – transition customers from the trial, analyse any remaining data and publish the final project report. This phase takes place in the first half of 2023.

3. Recruit and Build

The recruit and build phase of the project has been the focus throughout 2021 and is now complete, other than for the V2G component of the trial.

3.1. Smart Charging Platform

To control the smart chargers installed in participant's homes and to give participants visibility and control of what is happening with their charging, a charging aggregation platform has been developed for the smart charging stream. The platform comprises three elements:

- A smartphone app that allows customers to:
    - see their current charging status
    - see what charging control is planned over the next few days
    - be notified of up-coming ad-hoc charging control events
    - opt out of controlled charging when needed.
- EV charger aggregation software that:
    - manages the database of individual chargers in the field
    - sends control and programming commands to the chargers
    - manages the data behind the customer app, including notifications
    - groups chargers into blocks of controlled load that can be dispatched individually or together
    - manages the collection of data from the chargers
    - provides an interface for setting up charging schedules and ad-hoc charging control.
- A second software platform, known as NEO, that collects data from the charger aggregation software and provides visibility and analysis tools to allow EV charging to be viewed together with other distributed energy resources (DER) being operated by AGL.

The aggregation software and smartphone app, together with the interface to NEO, have been developed by our project partner Chargefox specifically for this trial. The remainder of the work in NEO required to ingest and process this data has been developed in-house by AGL's DER platform development team.

The development is now complete and in full operation, and we have been actively controlling chargers since January 2022. Detailed charging data from the smart chargers is now available in dashboards for day-to-day monitoring and is being accumulated in a high-resolution time-based database for full analysis.

3.2. Smart Charger Supply and Installation

The installation program for smart chargers was completed in December 2021, other than for a couple of customers who had been difficult to contact to arrange the installation visit. (These customers had their installation completed in early 2022.) Charger supply and installation was undertaken by AGL's field services partner for the trial, JETCharge.

The charging station used in the project was the Schneider EVLink Wallbox. This charger has proven to be reliable in the field with very few failures during installation or since.

Charger supply remained continuous throughout the installation phase and was not significantly affected by supply chain disturbances due to Covid or other factors. To some extent this may be because the project elected to use a relatively mature product with an established supply chain from a manufacturing partner of significant size and capability, together with an install partner who uses this charger day-to-day and maintains sufficient stock of the devices in Australia.

JETCharge proved to be a very good installation partner and the teams at JETCharge and AGL established an early rapport. Day-to-day communication between the AGL field services team and the JETCharge installation team occurred through email and phone calls, with the individual installations being managed and monitored using the Emvisage field workflow software, which both AGL and JETCharge were already using before the trial and were familiar with. Some modifications were made to the Emvisage instance being utilised to cover specific trial requirements.

These processes were augmented by a monthly contract management meeting between AGL and JETCharge to monitor and discuss overall project performance and HSE compliance.

Due to issues AGL has experienced with internet connections for other DER devices made through customers' Wi-Fi, the project elected to use a hardwired ethernet connection between the customer's router and the charger wherever possible. Where this wasn't possible, an ethernet-over-powerline solution was used. Ethernet is a little more expensive to install, but the extra cost is quickly made up with savings from not having to deal with ongoing communications issues caused by circumstances such as the customer's Wi-Fi password changing.

3.3. Lessons Learnt – Smart Chargers

3.3.1. Charger maximum load limits

Not all residential chargers can be installed with the full charging capacity enabled due to house wiring, switchboard and service fuse limitations. Further to this, there are current limits imposed by Distribution Network Service Provider service connection rules in Queensland (20A if the charger is not connected to a DNSP controlled switched circuit[1]) and South Australia (20A).

[1] Refer section 3.3.4 for further discussion of the implications of this rule.

Whilst AGL expected that we would see some installations with charge rate limitations for these reasons, the relatively high percentage of installations affected has been a surprise.

The breakdown of maximum charge rates for the single-phase[2] trial installations is:

Maximum Power (kW)	Current (A)	Percentage of installations
7.4 (nominal)	32	52%
6.0 (limited)	26	12%
5.8 (limited)	25	9%
4.6 (limited)	20	27%

48% of the installed single-phase chargers have had their charge rate limited to less than the nominal 7.4kW (32A). Taking this into account, the average maximum charge rate per charger in the trial is 6.3kW, compared to 7.4kW if there were no limitations.

Of the 48% of chargers that were current limited, 14% were due to DNSP service and installation rules and 34% were due to household wiring, switchboard or service fuse constraints.

3.3.2. Customers not downloading the app or using a different email address

In common with many other residential distributed energy resources connected to an online platform, it's necessary for the customer to complete a login procedure when a charger is first installed in order to correctly identify the device and allow the customer to see and control it via the smartphone app. In the trial, the customer email address is used as the customer identifier and the charger station number is used as the charger identifier during the login process.

There was a small percentage of customers who used a different email address to the one that they'd previously given to AGL when logging into the app for the first time. In these cases, Chargefox is unable to identify the customer as belonging to the AGL trial.

There was also a small percentage of customers who didn't download the app and install it on their phones or didn't attempt to login to it at all. In these cases, the correct linkage between customer and charger won't be made and customer won't have any visibility of controlled charging events.

AGL becomes aware of these situations when a charger is installed but doesn't appear in the aggregation platform as a connected device. When this happens, customers are contacted by AGL's customer service team to understand what has gone wrong, and either obtain the new email address

[2] There are a small number of three-phase chargers on the trial but not enough to draw statistically significant conclusions from.

from the customer or talk them through the app download and login procedure. This process is successful in resolving the issue.

This aspect of system configuration and the related customer communication needs careful consideration at an early stage of project design to minimise the overhead required to manage these exceptions. While not an overwhelming problem with 200 chargers, it has the potential to become more significant issue with a rollout of many thousands of chargers.

3.3.3. Chargers being turned off by the customer

There are a small number of customers who regularly turn off power to the charger using the isolator that is on the wall beside the charger. Some customers have told us they do this because they are concerned about the weather proofness of the charger. This should not be a concern, as the chargers are designed for outdoor use.

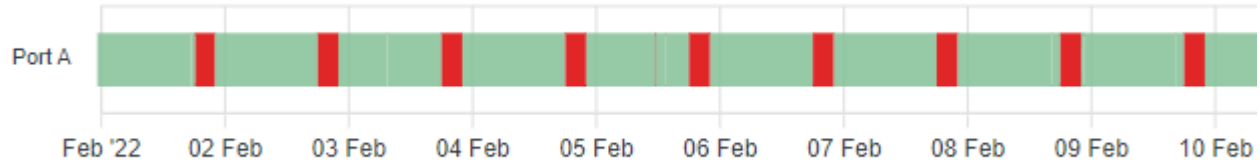
Turning the charger off means, however, that the aggregation platform cannot communicate with the charger. This leads to the possibility that a charger may miss certain communication messages and then take some time to "catch up" with its correct status when supply is restored.

Improved communication with the customer before installation of the charger should be considered to prevent this situation.

3.3.4. Chargers being turned off by the local DNSP

Chargers installed in Queensland with a maximum current over 20A are required to be connected to a DNSP controlled switched circuit, normally a ripple control receiver, by the Queensland Service and Installation Rules (also known as the Queensland Electricity Connection Manual). The charger then becomes part of a load control system that the local DNSP will use to disconnect the charger from supply for a number of hours each day, usually during the evening peak.

The following snapshot from the charger aggregation platform shows the offline (red) and online (green) status of an individual trial charger connected to a controlled circuit at a house in Queensland:



Whilst this type of load control works well for electric hot water systems, which are non-sophisticated devices containing a simple heating element, it does introduce some issues with internet connected smart devices like chargers which are designed to remain connected to power and the internet more or less continually.

While the charger is off supply, it may miss important communication messages sent from the aggregation platform. This can lead to the charger being in an incorrect state at the time power is

restored, potentially affecting customers' vehicle charging. Whilst it will catch up with its correct status eventually, this problem may persist for a period of time.

After turning on charging control in January 2022, AGL had several calls to our customer service line arising from this issue. Chargefox rapidly implemented an improvement to the communications process to return the charger to the correct state more quickly. Nevertheless, routinely disconnecting devices of this type from power is not recommended, and there is a higher probability of problems bringing the charger back online the more often it is disconnected.

A charger that is off supply will also not be visible in the customer app. While this may be acceptable for occasional power outages caused by weather etc, having the charger not visible in the app for some hours every day, in the late afternoon/early evening when people are most likely to be looking at it, is a significant drawback in terms of customer service.

It should be noted that this will be an issue with any smart charger that a customer has purchased, whether or not it is connected to an aggregation platform for orchestration.

3.4. Vehicle API Platform

The software to manage the control of charging via the vehicle API is similar in concept to that being used for smart charging except that the software communicates directly with individual vehicles via an API provided by the vehicle manufacturer for this purpose. The vehicle then manages its own charging no matter what charger it is connected to, be it a smart charger, a "dumb" charger or even just an extension lead plugged into a general purpose outlet.

The overall architecture of the vehicle API platform is similar to that of the smart charging platform:

1) A smart phone app to allow the customer visibility and control of their charging.

2) An aggregation platform that manages the data and control aspects of the trial and communicates with the vehicles via the vehicle manufacturer API. AGL is using Tesla vehicles for this part of the project as Tesla have a well-developed API in operation globally, including in Australia.

3) A data interface to the AGL NEO software for data management and analytics.

AGL has completed the above development work with our main vehicle API aggregation platform partner for the trial, Flexcharging (USA). This system has been collecting data from trial participants since mid-2021, and controlled charging functionality was turned on in early February 2022.

Due to the level of information being gleaned about vehicle charging behaviour from this cohort of participants, and with the agreement of ARENA, AGL has now extended this part of the trial to increase the number of participants from 50 to 100 and include a second aggregation platform provider, ev.energy (UK).

Platform development work with ev.energy is also now complete, with the interface to AGL's systems now in operation. Controlled charging on the ev.energy platform will be turned on shortly.

3.5. Lessons Learnt – Vehicle API

The vehicle API trial is limited to Tesla vehicles only, and some of the issues noted relate to the way Tesla vehicles in particular respond to events. This may or may not be representative of the behaviour of other vehicles, or even Teslas in the longer term.

3.5.1. Vehicle power drain

The vehicle API platform communicates with the vehicle regularly to obtain data about its location, charging behaviour and battery status. The frequency of this communication varies depending on what the vehicle is doing – if the vehicle is driving or charging the platform communicates more often, if the vehicle is doing very little or nothing the platform communicates less often.

For this communication to happen, the vehicle must be in a mode in which its communication circuits are active. In this mode there is a small power drain on the vehicle battery. Vehicle API platform operators go to considerable lengths to minimise the number of communication sessions with the vehicle to ensure that this power drain remains negligible, and have made further improvements in this area since the trial started.

Nevertheless, some customers may perceive this "waking up" of the vehicle as an issue and one participant elected to withdraw from the trial for this reason.

3.6. Vehicle-to-Grid Platform

AGL and Chargefox have undertaken a design project to scope and specify the platform requirements to vehicle-to-grid aggregation software for the trial.

However, due to delays with other elements of the V2G trial solution, development of this platform has not commenced.

3.6.1. Vehicle to Grid

Technology Readiness

Work undertaken by the project has found that V2G technology is still at a very early stage globally, with small scale trials using pre-production hardware and rudimentary software systems. V2G chargers are not generally being sold as commercially available product.

The integration/interfacing of V2G chargers with control and aggregation software is not yet standardised – OCPP promises to do this in the future, but this is not yet a reality. This, together with a long delay on the availability of chargers approved for use in Australia, has presented a number of hurdles to the project schedule and scope, the implications of which are currently being discussed with ARENA.

4. Operation

Control of the smart chargers in the trial was turned on in January 2022. The control methodology being trialled comprises two elements – a fixed time-based charging schedule, together with the capability to augment this with ad-hoc charging control events to meet specific wholesale, market operator or network requirements on particular days.

4.1.1. Routine Operation

The fixed time schedule implemented for the first stage of the trial is as follows:

State	Time reference	Morning		Evening	
		Off	On	Off	On
Qld	Summer	-	-	16:30	20:30
	NEM	-	-	16:30	20:30
NSW	Summer	-	-	17:30	21:30
	NEM	-	-	16:30	20:30
Vic	Summer	-	-	17:30	21:30
	NEM	-	-	16:30	20:30
SA	Summer	-	-	17:30	21:30
	NEM	-	-	17:00	21:00

These times were chosen based on an analysis of NEM wholesale prices over time, and represent the period that prices have a greater likelihood of being high, particularly during summer. High prices in the NEM are generally caused by one or more of the following:

- A low percentage of renewables generation
- The use of peaking gas or volume-constrained hydro generation
- Generation shortages or transmission constraints in or between NEM regions.

Another consideration in selecting the scheduled charging times was to keep them clear of TOU tariff rate changes that typically occur around 11:00pm. While in the longer term, post-trial, it may make sense to align charger control with TOU rate changes, for the trial it's important that we are able to identify load changes that occur due to controlled charging within the trial separate to other action that customers may undertake to move their charging to off-peak times.

This time schedule will be modified to test other charging scenarios as the trial progresses.

4.1.2. Ad-hoc events

AGL ran a number of ad-hoc events in January and February 2022 in addition to the routine charge schedule.

There were five events run for United Energy/Powercor/Citypower covering all of the chargers installed within that area on specific days requested by the DNSP, generally in the late afternoon/early evening on days of hot weather when network constraints may occur. AGL had set up a "day-before" activation process with the DNSP for this purpose.

AGL also ran a wholesale market event on 1 February 2022 in NSW and Queensland around the time that AEMO activated RERT capacity in Queensland due to system constraints and very high demand.

In all of these cases, the requested time period for the event included the period that chargers would be off anyway due to the routine charge schedule, but required an earlier start time. This was achieved by programming an ad-hoc event into the aggregation platform to cover the time from requested event start up until the start of routine scheduled event. Customers received an app notification of this ad-hoc event and could opt out if desired.

Detailed analysis of the fleet response to these events is currently being undertaken.

4.1.3. Results of controlled charging

Given the relatively short time frame that controlled charging has been in place, it's too early to draw any meaningful results from the data. AGL will commence detailed analysis of the data in the coming months and will provide commentary on this in the next report.

5. Customer Research

As a condition of joining the trial, customers agreed to be contacted regarding participating in surveys and research over the duration of the program. Despite participation in research and surveys remaining voluntary, we've continued to observe high levels of participation in our survey responses, which highlights the high level of engagement of this trial group.

5.1. Research scope

The research detailed in this report focuses on our trial participants experience with installation of smart chargers in their homes. Although we have now commenced charging orchestration, at the time this research was conducted many respondents had not yet experienced orchestration events, and those respondents who had experienced them would have only participated in a handful. As such, we felt that it would be premature to conduct research on orchestration events as our trial participants have not had sufficient lived experience with smart charging to provide informed insights into it.

We will be undertaking further qualitative and quantitative research with the trial cohort during May 2022 and will communicate these findings in a future report.

5.2. Survey questions

The survey focused on the installation experience of our trial participants, who were asked the following questions:

- On a scale of 0 to 10, where 0 is 'very poor' and 10 is 'very good', how do you rate the charger install experience?
- Tell us why you gave that answer. (freeform text)
- Is there anything we could do next time to improve the experience? (freeform text)
- Based on your charger installation experience, on a scale from 0 to 10 where 0 is 'Very unlikely' and 10 is 'Extremely likely', how likely are you to recommend AGL to your friends and family?

5.3. Online survey participation

Online surveys were sent to all 200 trial participants in the smart charger stream. 112 completions were received, a completion rate of 56%. Participants were not directly incentivised to complete the survey.

5.4. Survey results

5.4.1. High-level findings of the installation experience

Broadly speaking our customers have had a positive charger installation experience, as evidenced by the great results in the Net Promoter Score (NPS) and the relatively high average rating for the installation experience.

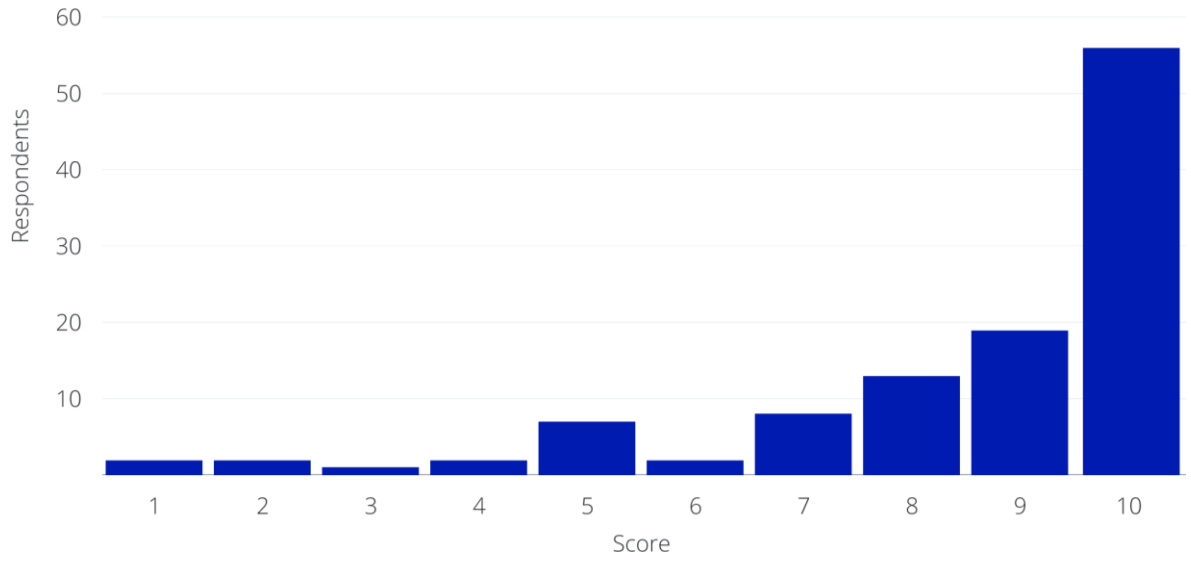
The NPS result of +36.1 for the installation experience is especially strong, almost twenty points higher than AGL's current weighted year-to-date NPS of +16.6.

Net Promoter Score (NPS) breakdown

+36.1	52.1%	31.9%	16.0%
NPS	Promoters	Passives	Detractors

The overall ratings of the installation experience were very positive too, with an average score of 8.5. Of the 112 respondents, 75 (67%) rated their installation 9 or higher.

On a scale of 0-10, where 0 is 'very poor' and 10 is 'very good', how would you rate the charger install experience?



5.4.2. Insights on the installation process

To supplement the 0-10 rating of the installation experience, we asked our participants to provide further detail explaining the rating they provided. These responses were individually synthesised and uncovered the following themes and insights around our trial participants' installation experience.

The positives – what made a good install experience

There are many components that come together to make a great charger installation experience, however these three themes emerged as the most common denominators in our survey responses.

Knowledgeable and professional installers

Our trial participants are invested in their EVs and appreciated the professional knowledge sharing that the installers could provide them during their install process. It builds confidence and trust that the charger will work for them. On the flip side, there was one reported instance where the installer wasn't aware of distributor specific requirements for the install, which created a negative experience.

"He (the installer) was very knowledgeable and gave us a lot of confidence that the job would be done well"

- Yolinda

Quality and finish of installation job

Unsurprisingly, the quality of the finish on the installation job is important to EV owners. Over a quarter of our respondents calling this out as a reason for why they gave their score. Keeping cabling and conduit neat and/or out of sight were frequently mentioned. This included not only the finish of the install job, but also leaving the site clean and tidy afterwards.

"Neat, tidy install, taking care to align conduits and clips. Even turned the conduit labelling to face the wall."

- Amanda

Consultation & flexibility of charger location

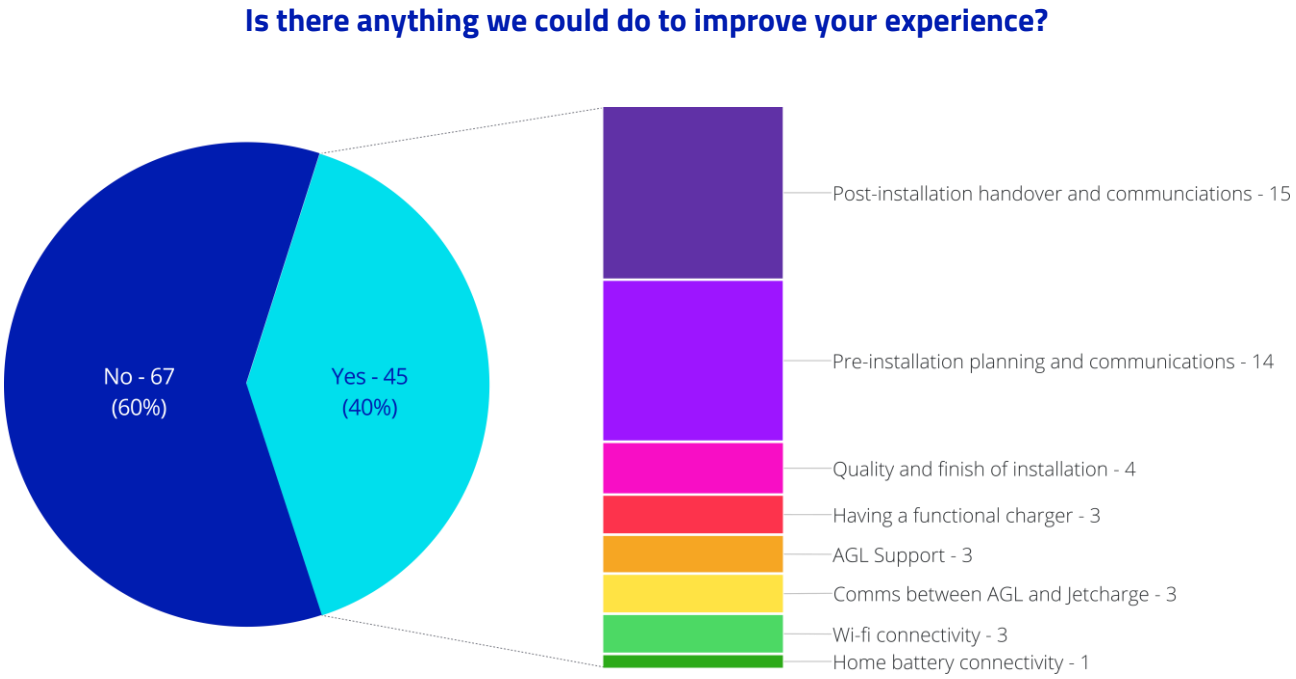
The last major theme that emereged for our respondents was consultation and flexibility in the charger location. Involvement in planning shone through as a positive for many for our respondents. Providing customers the opportunity for input and feedback into the process creates a positive experience and ensures that the charger is installed in the location that best suits their home and parking/charging arrangements.

"The installer spoke with me and was open to opinions on my preferred spot to place charger. Allowed me to provide feedback before fitment."

- Kevin

The opportunities – what could be improved

In addition to asking our participants to provide free-form verbatim explaining their 0-10 rating of their installation, we explicitly asked what could be done to improve the process; again, this was obtained via free-form text. The responses were individually analysed and categorised, with a visualisation of the suggested areas for improvement below.



In line with the strong overall customer satisfaction with the installation process, the majority of respondents saw no opportunity for improving the installation process. For those who suggested improvements, there were two key areas that made up over two thirds of their recommendations.

Post-installation handover and communications

The most frequently suggested area for improvement was post installation handover and communications. Once the charger was installed, some felt that they didn't have a clear picture of what happens next. This covered the handover of the charger hardware, the charging software, and what would be happening next in terms of the trial itself. An ideal smart charger installation experience should leave the owner clear on how the charger will operate and what's required to get the most out of it.

> *"The biggest room for improvement is to provide information on how to use the charger. It took 2 - 3 weeks after install for the "welcome pack" instructions to reach us."*
>
> - Richard

Pre-installation communications & planning

The second key cited area for improvement was pre-installation communications and planning. There were a variety of specific causes for breakdowns here, such as understanding house layouts, precise charger installation locations, charger cable length, and meeting the expectations around install timing, but the theme remained clear: communicate with customers to help plan and set the right expectations for what will happen both leading up to and on the day of installation.

> *"The only issue is the communication of the house layout - access issues. Hard to explain via the phone but we got there in the end on site."*
>
> - Dan

5.5. Closing thoughts on the research

Whilst the findings that have come from the surveys may not seem overly ground-breaking, the results are a testament to the professionalism and expertise of the parties involved in the installation process. To improve the customer experience even further, planning, communications, and handover processes could be further refined to ensure that customers feel fully informed of what they should expect before, during and after the installation.

In the next round of research, AGL will be exploring our trial participants smart charging experiences to provide us with in-depth and meaningful insights into our participants attitudes towards smart charging and how these may have changed during the trial.

6. DNSP Engagement

The Distribution Network Service Providers (DNSPs) that have elected to participate in the trial are:

United Energy

AusNet Services

Jemena

SA Power Networks

Ausgrid

Endeavour Energy

Energy Queensland (Energex and Ergon)

The DNSP Technical Reference Group has met once during the reporting period, on 10 December 2021. Apart from a status update on the trial, the key agenda items were a presentation and discussion from JETCharge on network connection approval issues surrounding V2G chargers, and a discussion around the initial controlled charging schedule being implemented in the trial.

The next Technical Reference Group meeting is planned for June 2022.

Throughout January and February 2022, AGL successfully executed five demand response events using the trial chargers at the request of United Energy/Powercor/Citypower in Victoria, on hot afternoons where high demand was expected. Results from these events are still being analysed.

7. Knowledge Sharing Activities

AGL presented on the trial and the integration of EVs into the Australian energy market to the Australian Energy Market Commission (AEMC) on 13 December 2021.