



Battery Storage and
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Lessons Learnt

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

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Introduction

Purpose

The Realising Electric Vehicle-to-grid Services (REVS) trial is implementing vehicle-to-grid technology in a fleet of 51 Nissan Leafs in Canberra.¹ The project commenced in June 2020 and this report documents key lessons learnt in the first eight months.

The REVS Consortium held a Lessons Learnt Workshop on 17 February 2021, from which most of the insights in this report are drawn. This was conducted as a retrospective workshop, focusing on how the team would go about the project if it could be done again with the full benefit of hindsight. In this report, pronouns such as “we” and “our” refer to the Consortium.

As a trial project, a learning process is not just expected, it is essential to the development of new technologies. This implies a certain level of accepted risk that cannot be mitigated by more early investigations or design work, and to attempt to do so could strain credibility in setting the original project timelines and funding levels.

Having said that, there is a strong argument for considering up front whether it is preferable to pack contingency into the project scope, or to structure for progressive review and variation as the detail of delivering a project like REVS become clear through the doing.

Instead, our aim is to shine a light on a number of “unknown unknowns” that the team have encountered in delivering REVS to date so that those who might follow us can benefit from the experience and focus on the right issues at the right time.

Progress to date

At time of writing, the REVS trial is at the point of taking delivery of vehicles, installing chargers on site and carrying out the required hardware and software integrations across multiple sites and platforms. The bulk of lessons learnt at this stage in the project have related to designing and installing chargers and obtaining the necessary approvals to do so.

Figure 1 shows the generalised project process. At time of writing, the project is certifying chargers (2), developing the technical V2G integration (3) and preparing to install (4).



Figure 1: Generalised project stages showing the current phase

¹ For more information, refer to the ARENA website <https://arena.gov.au/news/world-leading-electric-vehicle-to-grid-trial-in-act/>

Lessons Learnt

Intersecting Issues

Many of the issues encountered are intersectional – that is they cut across all the more specific lessons described later. These issues are important to recognise at the early stages of projects like REVS so that strategies can be put in place to manage them or soften their impact. They are noted in this first section and expanded upon in the following section looking at more specific lessons.

Making decisions with imperfect information

A good deal of effort was invested in the early planning phase of REVS (the “discovery” phase) to set budgets and timelines and identify and manage risks. Given the project is a trial of a new technology, these were necessarily done based on imperfect information. Furthermore, our reliance on imperfect information was exacerbated because the discovery phase needed to be undertaken in parallel with the ARENA application process, which had defined timelines. Strategies that could have improved the quality of information and improved project discovery are included below.

#	What	When	Key parties
1	More rigorous stress testing of budget assumptions feeding into project planning and risk assessments	Discovery	REVS Consortium
2	Earlier site selection decisions	Discovery	ACT Government
3	Earlier engineering input to installation requirements	Discovery, linked to site selection	JET Charge

Underestimating complexity

Similarly, we found that we tended to underestimate the complexity of the project arising from multiple emergent issues, many of which are described in detail below. These could be generalised as focusing on the wrong things; for example, charger installation in part involves the physical installation, but far more effort is involved in compliance and approval processes with regard to the installation sites. The below strategy should be in tandem with strategy #3.

#	What	When	Key parties
4	Earlier consultation with site managers regarding compliance requirements and approvals	Discovery, following site selection	JET Charge consulting with ACT Government

Sufficient influence over obstacles

We reflected on the project governance with regard to its ability to effectively deal with project difficulties. REVS is overseen by a Steering Committee (SC) on which each Consortium member is represented. The roles of the SC are:

- To oversee the direction of the project toward the objectives;
- Provide general oversight and support to the collective work of REVS; and
- Ensure obstacles to the project are cleared in a timely manner.

In general, it was felt that REVS enjoys a high quality of governance, particularly with regard to guiding the project. The weak point has been the ability of the SC to exert influence over project obstacles. The root cause of this was treating the ACT Government as a single entity, when it is functionally made up of several entities, each with their own decision-making processes. As a result, some key decisions have been outside the SC's control, requiring more time and effort to be able to move the project forward. It may have been better to include all ACT Government stakeholders in the consortium SC.

#	What	When	Key parties
5	Identify key decision makers outside the project	Pre-Discovery	ACT Government
6	Ensuring clear line of sight and influence over major decisions or commitments, via Steering Committee membership, splitting out as separate parties in the contract, or memoranda of understanding (or other appropriate mechanisms)	Pre-Discovery	REVS Steering Committee Participating ACT Government Directorates

Specific Issues

Identifying and accommodating timeline dependencies and risks

The original project timelines have proven to be optimistic so far. The lesson to be learnt from this relates to the visibility of dependencies and risks at different points in time, and the efficacy of steps taken to accommodate those dependencies and risks as they become apparent. We could summarise this as failing to always see the forest for the trees – or vice versa.

In hindsight we did not sufficiently explore and identify risk dependencies, nor explored a reasonable extent of back-up plans should our assumptions prove wrong. This meant that one delay could cause unforeseen roll-on effects.

To provide one example, fleets require business continuity and therefore the sites need to receive their vehicles and chargers at the same time. A delay in charger installation meant that the delivery of vehicles also needed to be held back by Nissan. Incremental delays of one to two months were not sufficiently long to justify Nissan ordering fresh replacement vehicles, allowing the original vehicles to be released for other customers, partly due to supply bottlenecks caused by Covid-19. In addition, delays were notified at the eleventh hour, such that the vehicles had already been fitted out for the trial, so couldn't be sold to another customer. As a result, as an interim measure Nissan were forced to hold the vehicles, which incurred additional holding, preservation and depreciation costs.

On a different note, a risk that was not explicitly identified and discussed was the different operating environments of the consortium members, ranging at one extreme from JET Charge, a small and flexible business, to at the other extreme a government consortium member and government end-users – much larger organisations with complex governance, low risk appetite, and many stakeholders. Likewise, the newness of the project varied between consortium members – for some it resembles business-as-usual activities, whereas others faced a learning curve. As a result, different members of the consortium operate at very different speeds. The impact of this has been a tendency to underestimate timing.



*Figure 2: It can be challenging to see the forest for the trees. Or the trees for the forest.
Image: "Coastal eucalypt forest" by Tim J. Keegan is licenced under CC BY-SA 2.0*

We believe that it would be constructive to consider REVS not as a single project, but as a portfolio of several small interdependent projects across different organisations, managed by one central project management office. This approach would support a more staged approach, emphasise detail, and allow the project plan to be revised as new information comes to light.

Site selection and fleet selection are not the same thing

A seemingly innocuous assumption made early on was that, while the chargers would be installed at multiple sites, they would be, in corporate terms, servicing the same fleet. This was not the case; indeed, in retrospect the ACT Government should not have been treated as a single entity when multiple Directorates are involved. While vehicles are going to the ACT government fleet, it is not managed as a single unit. Sections of the government (Directorates) have individual fleet managers, requirements, and locations. The scale of the trial exceeded the capacity of any individual Directorate to take on. Working with multiple fleets resulted in significant unexpected effort due to multiple negotiations and decision makers, and made the project structure fundamentally different.

Site selection, rather than being an early decision, was a negotiation process. This led to site selection being settled relatively late in the process even though it has proven to be a significant driver of complexity. The features of the site, including electrical switchboard locations and layouts, site tenure (owner or lessee), and specific requirements of different sites has meant that technical requirements and approvals processes have emerged late in the piece and haven't always been replicable between sites.

#	What	When	Key parties
7	Asking the right questions about corporate fleet arrangements	Discovery	Participating ACT Government Directorates

The right people doing the right things at the right time

The consortium has a broad range of skills collectively. During the project there has been no need to source external skills. However, in some cases we found that planning and decision making could have been improved by utilising that in-house knowledge earlier – operational knowledge in particular.

Firstly, in terms of technical expertise we would have benefited from delving more deeply into technical specifications during planning. A good example of this was the communications requirements of V2G. Put simply, a hard-wired internet connection will achieve the needed response speed, whereas a wireless connection, which is typically used in EV chargers, will not. The need to provide a hard-wired connection was unexpected because the communication speeds were not given scrutiny early enough. This meant a more complex installation both in terms of reticulation and site internet security.

Secondly, while operational staff are integral to the consortium, they did not have a major role in the project's early formulation, which was led by their policy colleagues. Leveraging more on-the-ground experience at an earlier stage could have weighted discussions more towards the practicalities.

#	What	When	Key parties
8	Technical and operational staff to engage more deeply and earlier in order to test assumptions and reveal potential challenges earlier	Pre-Discovery and Discovery	ACT Government operational staff REVS Consortium technical staff

The ultimate dream team

The team also reflected on our own approach to project management and consequent accountability. The project is managed using a hybrid of Agile and Waterfall and in retrospect we have found a gap in accountability that could have been narrowed had we weighted it more towards Agile.

While REVS does have a dedicated project manager, we feel that increased resourcing of project management could have improved accountability to tasks. Likewise, it would have been worth interrogating our own expectations of, and responsibilities to, project management.

Having said that, we consider project management to be a strength of REVS and the above could be thought of as fine-tuning a (V2G-enabled) Ferrari. While we are fine-tuning our dream team, we did identify skills and experience gaps that would have been beneficial. These are:

#	What	When	Key parties
9	Seek a “unicorn” – someone with overseas experience of V2G trials – to help focus the team and uncover unknown-unknowns	Discovery	N/A
10	In-house experience with AS/NZS 4777 certification, to rely less heavily on vendor advice	Procure Certify	JET Charge



Figure 3: It would have been great to find a V2G unicorn to advise the project.
Image: "Unicorn" by Valerie Everett is licenced under [CC BY-SA 2.0](#)

Rethinking equipment vendor relationships

The model of V2G charger was selected early on as we were given confidence it would be available and certified quickly. At the time, only one vendor appeared ready, and indeed this is still the case. However, this dependence on a single vendor created risks that have unfortunately been realised.

The first issue was that supply of the charger was severely impacted by the Covid-19 pandemic, as lockdowns overseas meant the vendor's staff were unable to access their own work premises, which caused delays. Secondly, the vendor underestimated the rigours of AS/NZS 4777 certification due to differences from the European equivalent standard.

The local vagaries of AS/NZS 4777 in part arise from its pedigree as a standard developed for solar and stationary battery inverters, which deal with earth-connected loads. V2G is effectively a grid-connected battery, but it is not necessarily earth-connected because it is mobile. The new 2020 version of the standard, under which REVS is testing, categorises V2G chargers as multiple mode inverters (those which can operate grid-interactive or stand-alone) rather than having a dedicated standard for V2G. Therefore, an early recommendation from REVS (which will be documented in future reports) is that AS/NZS 4777 include test standards specifically for V2G chargers.

In terms of project timelines, we felt the key determinant of risk was the extent of control system development included in the project. REVS was not scoped as a technology development project, and expected to use off-the-shelf charging hardware. Thus for REVS as scoped, the main learning is to work with more than one manufacturer. However, we also considered whether having a local manufacturer with AS/NZS 4777 experience as a consortium member – even if this meant expanding the scope of REVS into product development – would have made a difference. It might have.



Figure 4: Should the charging manufacturer be inside the tent?

Image: "[The tent roof](#)" by [Dave Herholz](#) is licenced under [CC BY-SA 2.0](#)

In hindsight, if REVS had included local, experienced product development within the consortium, the delivery of certified chargers may have gone better. In addition, it would have been an opportunity to grow manufacturing presence and expertise in Australia. In originally conceiving of the project, this was not considered and would have significantly expanded the project scope.

Having said that, a clear strength of REVS has been that the consortium includes a local technology integrator: JET Charge provided the technical competence to develop the necessary workarounds and solve problems in conjunction with the charger manufacturer.

A further issue was, similar to the other lessons, we discovered fairly late that additional steps would be needed in the software side of V2G integration to solve a hardware issue. Specifically, the charging plug cannot be disconnected while the charger is engaged. This has resulted in some workarounds between software platforms which may compromise the user experience of drivers (though the solution is still under discussion). This situation could have been averted had more time been spent thinking through the customer journey, or if charging equipment product development was part of the project.

Therefore, we offer alternative strategies for future projects.

#	What	When	Key parties
11/1	Bring the vendor “inside the tent” as a consortium partner, so they bear greater risk and effort. This may be best achieved by working with a local manufacturer with AS/NZS 4777 experience, and if necessary expanding the scope of the project to include product development	Pre-Discovery	REVS Consortium
11/2	Spread the risk by engaging multiple vendors as suppliers	Procure Certify	JET Charge

Reflections

V2G challenges, or just challenges?

Finally, we reflected on whether the issues documented here are specific to V2G or applicable to any complex technology-related project, and agreed that, well, it depends.

In some cases, the fact that REVS is a V2G project is significant. For example, we have discussed the different installation requirements of V2G chargers as compared with other types of chargers and the implications of not accounting for those differences, and the specialised task of AS/NZS 4777 certification.

In other cases, the lessons regarding project planning, governance and resourcing could be considered relevant to any complex technology project.

However, our key take-out was that EV charging itself is a new technology that occupies a space between electricity and transport for which there does not yet exist a common language. This means that consortium members are continually acting as a translator, possibly mistranslating, and/or not realising the significance of different issues at the pertinent time. While all of this gives rise to valuable learning, it is not always timely.

A final note

Had all of the original assumptions of the project proved correct enough, the project may have been deliverable within the original budget and timeline. They were not, and so it wasn't, and this is not unusual for real-world trials of innovative technologies. This is not to mention the wide-ranging and ongoing impacts of Covid-19 as well as other unforeseeable delays.

Responses fall into two over-arching categories: pack contingency into the project scope, increasing cost compared to the ideal, but avoiding rework and variation; or plan for a progressive review and variation process to deal with the expected emergence of unknown-unknowns in a managed way.