

Insights from ARENA's Public Charging Projects



Prepared by Energeia for the
Australian Renewable Energy Agency

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Executive Summary

Background

As the third highest source of CO₂ emissions in Australia¹, transport decarbonisation, combined with renewable electricity generation, will be essential to enable Australia to achieve its greenhouse gas (GHG) emissions reduction targets under the Paris Accord. In 2023, the Federal Government published their National Electric Vehicle Strategy, which outlines objectives for electrifying transport. Making EVs easy to charge across Australia is one of these key objectives.²

Convenient access to public DC fast-charging (DCFC) stations for both range extension and everyday charging is essential for the public's adoption of EVs.³

ARENA's Future Fuels Fund launched in 2021 to resolve barriers hindering the transition to zero-emission transport. The key goals of the Future Fuels Fund included supporting development of DCFC, hydrogen and biofuel refuelling stations, and any other co-investment opportunities that could yield national benefits.⁴

A key objective was ensuring the documentation and discussion of lessons learnt in the establishment, implementation, and operation of their public fast-charging programs. Through documentation of key lessons learnt, the wider industry can gain valuable insights to apply in their own fast-charging programs. The eight public fast-charging projects ARENA has funded to date have produced a combined total of 27 lessons learnt reports.

Scope and Approach

Energeia worked alongside ARENA as part of the Future Fuels Fund's knowledge-sharing program and was responsible for reviewing the lessons learnt reports from the Future Fuels Fund Round 1 projects and summarising them into this report.

Findings have been categorised into the following topics:

- **Market Trends** – the key lessons learnt related to demand-side trends, behaviours and patterns identified in the lessons learnt reports
- **Charging Station Infrastructure** – the key lessons learnt with respect to the selection, procurement, installation, and maintenance of EV fast charging equipment
- **Public Charging Commercialisation** – the key lessons learnt pertaining to the go-to-market and pricing strategies, value-adds, and user experience
- **Grid Connections Needs** – the key lessons learnt relating to obtaining permission to connect and energising charging sites
- **Site Selection** – the key lessons learnt regarding the optimal selection of sites, including key siting considerations
- **Charging Bay Configuration** – the key lessons learnt with respect to the physical layout of their charging stations and any related considerations when designing charging sites

¹ Department of Infrastructure, Transport, Regional Development, Communication and the Arts, Towards net zero for transport and infrastructure, 2024, Accessed online from: <https://www.infrastructure.gov.au/infrastructure-transport-vehicles/towards-net-zero-transport-and-infrastructure>

² Department of Climate Change, Energy, the Environment and Water, National Electric Vehicle Strategy, 2023, pg. vi

³ CPRC, The barriers and potential enablers of electric vehicle uptake in Australia, 2022, pg. 3

⁴ ARENA, Future Fuels Fund Round 1: Public Battery Electric Vehicle Fast Charging Infrastructure Guidelines, 2021, pg. 2

All findings and opinions in this compendium can be attributed to the charge point operators (CPOs) who documented them in their lessons learnt reports. The lessons learnt reports contain further details about the findings.

Summary of Key Topics

The 24 key lessons learnt are organised here by topic:

Market Trends

- Despite a widespread assumption of low utilisation, robust growth in utilisation occurred in certain urban and high-traffic locations.
- The majority of EV charging currently occurs at home due to limited public charging availability, with DCFCs primarily used for top-ups rather than full charges, suggesting a behavioural shift from traditional internal combustion engine (ICE) vehicle fuelling practices.
- The CCS2 connector emerged as the dominant standard, significantly outpacing CHAdeMO in both adoption and utilisation.

Charging Station Infrastructure

- Selecting the right charger involves balancing recharge speed and cost not only with long-term reliability but also with compatibility, which simultaneously implies a need for a greater uplift in charging plug type and equipment standards.
- Procuring charging equipment is particularly complex due to extended lead times exacerbated by global supply chain disruptions, emphasising the need for robust planning and the establishment of contingency measures such as sourcing from multiple providers.
- Maintenance also emerged as a crucial ongoing concern, with the availability of skilled technicians and parts of pivotal importance to operational efficiency.
- User experiences and station profitability largely depend on the reliability of chargers, underscoring the importance of choosing reputable equipment manufacturers and proactive maintenance strategies to mitigate downtime and ensure service continuity.

Public Charging Commercialisation

- Balancing economies of scale with prioritising least cost sites is important when developing a go-to-market strategy for a fast-charging station business, rather than committing to installing either the largest possible sites or sites in the best location.
- Pricing strategies should fundamentally reflect the true cost of charging services to consumers, requiring management of user expectations regarding subsidised charging models.
- Value-adding features such as integrating renewable energy sources and storage options at charging sites were found to be effective methods to manage operational costs and enhance service attractiveness.
- Improving the user experience is a critical factor in commercial success, with a focus on ensuring accessibility, reliability, and convenience at charging stations to foster customer retention and consumer loyalty, such as by providing an accompanying mobile app.
- Prevention of energy theft through pre-authorisation of funds is simple and effective, saving lost revenue.

Grid Connection Needs

- Engaging effectively with electricity networks regarding new or upgraded site connections is crucial, often requiring significant time and resources to navigate regulatory hurdles and ensure compliance with local standards.

- Early and proactive communication with network providers is vital to manage expectations and streamline the connection process, while also building a collaborative relationship.
- Load management is critically important, requiring dynamic solutions to efficiently distribute available power and manage demand peaks in order to avoid costly network upgrades.
- Remote commissioning has emerged as a valuable practice because it enables easier setup and troubleshooting of station issues, which saves time, costs and reduces the need for physical presence on site.

Site Selection

- Visibility of the site should be prioritised, ensuring that stations are placed in high-traffic areas to maximise exposure and use, such as the current and future locations of fuel stations, shopping centres, visitor attractions, and urban hubs.
- Site selection and design must consider the safety and accessibility of sites for drivers as well as for maintenance staff, including identifying fire hazards and installing security cameras.
- Access to sufficient grid power is a fundamental consideration, as locations should ideally support current and future energy needs without the need for network upgrades.
- Cooperation with site owners is vital for navigating the complexities of lease agreements and ensuring long-term viability and stability of the charging station sites.

Charging Bay Configuration

- The varying locations of charging ports require flexible cable lengths and charger placements to ensure accessibility for all types and models of EVs.
- The layout of parking bays must enable easy ingress and egress while minimising risk of damage to vehicles and charging equipment to ensure customer satisfaction.
- The charging site environment must be safe and secure for the consuming public, such as through sufficient lighting and pedestrian clearances.
- The risk of "ICEing" – ICE vehicles parking in designated EV charging spaces – must be mitigated with strategies such as clear signage and road markings.

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1. Background

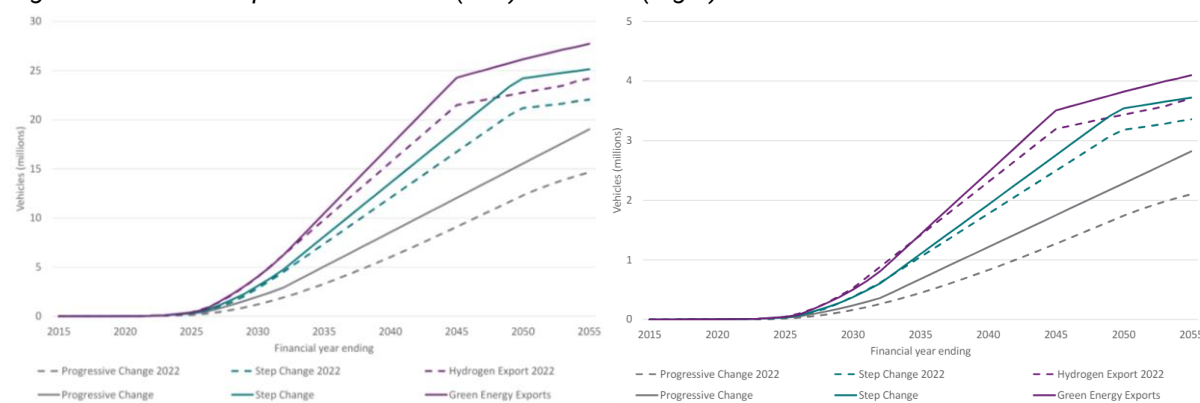
This section discusses the history and forecast of electric vehicle (EV) uptake in Australia, the key barriers to EV uptake, the Australian Renewable Energy Agency's (ARENA's) role in transport electrification, the Future Fuels Fund, and the projects that this compendium has combined.

1.1. EV Uptake in Australia

EV uptake is gaining rapid momentum in Australia. The EV Council reported that as of March 2024, around 180,000 EVs were on the road, over half of which were purchased in 2023.⁵

Figure 1 shows the Commonwealth Scientific and Industrial Research Organisation's (CSIRO's) forecast of EV uptake in the National Energy Market (NEM) and Southwest Interconnected System (SWIS). Their Step Change scenario predicts that EV uptake will continue to increase until around 2035, when the uptake rate will remain stable until 2050 –at which point the total number of EVs in Australia will have reached over 28.5 million.

Figure 1 – Total EV Uptake in the NEM (Left) and SWIS (Right)



Source: CSIRO, Electric Vehicle Projections 2023: Update to the 2022 Projections Report, 2023, pg. 30–31

This level of uptake is supported by the Federal Government's legislated push for national net zero greenhouse gas emissions by 2050 under its Paris Accord commitment. The transport sector is currently the third largest emitting industry in Australia, behind the energy/electricity and agriculture/land industries, contributing to 21% of emissions in 2023.⁶

Therefore, transport electrification will be one of Australia's most significant strategies for reducing emissions. The National Electric Vehicle Strategy that the Federal Government published in 2023 outlines objectives, which include making EVs easy to charge across Australia.⁷

1.2. Key Barriers to EV Adoption

Several existing barriers hinder the adoption of EVs worldwide as well as in Australia. Ultimately, potential buyers' perceptions of these barriers will determine the saleability of EVs. To determine which barriers were most pressing, the Consumer Policy Research Centre (CPRC) conducted a nationwide survey of 2,000 Australians. Table 1 identifies the most significant barriers that these survey participants mentioned.

⁵ EV Council, Australian Electric Vehicle Industry Recap 2023, 2024, pg. 3

⁶ Department of Infrastructure, Transport, Regional Development, Communication and the Arts, Towards net zero for transport and infrastructure, 2024, Accessed online from: <https://www.infrastructure.gov.au/infrastructure-transport-vehicles/towards-net-zero-transport-and-infrastructure>

⁷ Department of Climate Change, Energy, the Environment and Water, National Electric Vehicle Strategy, 2023, pg. vi

Table 1 – CPRC Survey Results on Barriers to EV Uptake

Barrier to EV Uptake	Proportion of Participants Mentioning Barrier
Upfront costs	49%
Limitations in range	34%
Lack of charging infrastructure, both at home and in public	32%
Time to charge	27%
Running costs	25%
Stress in planning trips due to uncertainty in charging availability	21%
Insufficient information about performance and reliability	19%

Source: CPRC, The barriers and potential enablers of electric vehicle uptake in Australia, 2022, pg. 3

The survey highlighted that limitations in range and a lack of charging infrastructure are two of the top three perceived barriers to purchasing an EV.

Enabling access to competitively priced public fast-charging stations is crucial for the adoption of EVs because it directly resolves most of the major barriers to EV uptake. However, private companies may hesitate to invest heavily in EV charging stations before significant numbers of EVs are on the roads, e.g. less populated or low-income areas, where numbers are insufficient to assure immediate returns. This chicken-and-egg problem is a key barrier to EV uptake, and government funding of DCFC infrastructure is therefore essential to enabling the uptake of EVs in Australia.

1.3. ARENA's Role

ARENA is the key Federal Government body providing funding to projects to accelerate Australia's transition to net zero emissions.

Since 2018, ARENA has announced over \$105 million in funding towards the decarbonisation of transport including smart charging trials, EV related studies, rollout of public charging infrastructure, fleet decarbonisation and innovation in charging. The major programs that ARENA created to specifically target transport decarbonisation include the Future Fuels Fund.

1.4. ARENA's Future Fuels Fund

ARENA launched the Future Fuels Fund in 2021 to address the key barriers hindering the transition to zero-emission transport. This includes supporting development of public fast chargers, hydrogen, and biofuel refuelling stations, and any other co-investment opportunities that could yield national benefits.⁸

Round 1 of the program has focused on supporting EV uptake by growing Australia's EV charging network, installing fast chargers throughout Australia at 'blackspots' that have lacked conveniently accessible chargers. Round 1 has allocated \$24.45 million to five projects through which a total of 403 public fast charging stations will be installed. Each of these stations has a capacity of at least 100 kW servicing two charging bays.⁹

1.5. Summary of Projects

Table 2 summarises all the ARENA-funded projects with lessons learnt reports that are compiled in this compendium. These projects produced a combined total of 26 lessons learnt reports. Note that all projects that commenced on 1 June 2021 were part of the Future Fuels Fund Round 1.

⁸ ARENA, Future Fuels Fund Round 1: Public Battery Electric Vehicle Fast Charging Infrastructure Guidelines, 2021, pg. 2

⁹ Ibid.

Table 2 – Summary of ARENA Projects Included in the Compendium

Name	States and Territories	Lead Organisation	Commencement Date	Conclusion Date	ARENA Funding (\$m)	Total Project Cost (\$m)	Description
Ampol Addressing Blackspots Fast Charging	NSW QLD VIC WA		1 June 2021	31 October 2023	\$7.05	\$26.81	Delivering 121 public fast-charging stations in regions lacking convenient access to public charging stations
Chargefox Future Fuels Public Fast Charging	SA WA		1 June 2021	31 October 2023	\$1.40	\$3.77	Delivering 16 public fast charging stations in regions lacking convenient access to public charging stations
Chargefox Electric Vehicle Charging Network Project	NSW QLD SA VIC WA		16 October 2018	26 January 2024	\$6.00	\$15.00	Delivering 21 public ultrafast charging sites along major highways to resolve EV range anxiety
Hobart Electric Highway Tasmania Fast Charger Network	TAS		1 June 2021	31 October 2023	\$0.40	\$1.05	Delivering 5 public fast-charging stations in regions lacking convenient access to public charging stations
ENGIE Future Fuels Public Fast Charging	NSW QLD SA VIC		1 June 2021	31 October 2023	\$6.85	\$22.64	Delivering 103 public fast charging stations in regions lacking convenient access to public charging stations
Evie Networks Future Fuels Public Fast Charging	National		1 June 2021	31 October 2023	\$8.85	\$25.61	Delivering 158 public fast charging stations in regions lacking convenient access to public charging stations
National Ultrafast EV Charging Infrastructure Network	National		28 May 2019	29 August 2037	\$15.00	\$50.20	Delivering 42 public ultrafast charging sites along major highways to resolve EV range anxiety
Metro Advertising Revenue Funded Electric Vehicle Charging Trial	SA		13 December 2020	30 June 2023	\$0.98	\$2.00	Delivering 21 public fast charging and advertising panels to evaluate and refine a business model for advertising-supported charging

Source: ARENA, 2024

2. Scope and Approach

Knowledge sharing improves the competitiveness of renewable energy technologies, thereby increasing renewable resources in Australia. The ARENA Act specifies knowledge sharing as a function of ARENA and requires ARENA to:

- Store and share information and knowledge about renewable energy technologies
- Collect, analyse, interpret, and disseminate information and knowledge relating to renewable energy, technologies, and projects, and
- Promote sharing of information and knowledge about renewable energy technologies.

To fulfill these obligations, ARENA established a knowledge-sharing team to disseminate information among stakeholders through various means, including webinars, workshops, forums, reports, or online banks.

Energeia, working alongside ARENA as part of the knowledge-sharing program, was responsible for reviewing the lessons learnt reports from the Future Fuels Fund Round 1 projects and summarising them in this report.

2.1. Scope

The objective of this compendium is to serve as a ‘one-stop shop’ for any industry participants seeking to develop a public fast-charging site and become a charge point operator (CPO). This compendium highlights the key lessons learnt by existing CPOs who documented their experiences during their projects with ARENA.

This compendium combines the lessons learnt reports from all the projects outlined in Table 2. The Bibliography at the end of this compendium presents the full references for these reports.

This report categorises findings among six topics:

- **Market Trends** – the key lessons learnt related to demand-side trends, behaviours and patterns identified in the lessons learnt reports
- **Charging Station Infrastructure** – the key lessons learnt with respect to the selection, procurement, installation, and maintenance of EV fast charging equipment
- **Public Charging Commercialisation** – the key lessons learnt pertaining to the go-to-market and pricing strategies, value-adds, and user experience
- **Grid Connections Needs** – the key lessons learnt relating to obtaining permission to connect and energising charging sites
- **Site Selection** – the key lessons learnt regarding the optimal selection of sites, including key siting considerations
- **Charging Bay Configuration** – the key lessons learnt with respect to the physical layout of their charging stations and any related considerations when designing charging sites

All findings and opinions in this compendium can be attributed to the CPOs who documented them in their lessons learnt reports. The lessons learnt reports contain further details about the findings.

2.2. Approach

Energeia’s development of this compendium consisted of three key steps:

1. **Review Lessons Learnt Reports** – Energeia reviewed, analysed, and summarised key findings of the lessons learnt reports that the CPOs published as part of their projects with ARENA
2. **Develop Key Insights** – Energeia grouped these key findings by topic and developed a cohesive set of insights, highlighting the similarities and differences between projects
3. **Draft Compendium** – Energeia developed a draft compendium for ARENA’s review, then used that guidance to develop the final compendium.

3. Summary of Key Topics

This section presents a detailed summary of the lessons learnt from the Future Fuels Fund Round 1 projects corresponding to each key topic listed in section 2.1 (Scope).

3.1. Market Trends

This section of the report covers any demand-side trends identified in the lessons learnt reports. Specifically, it relates to the charging load, charging behaviour, and charging plug-type preference of drivers.

The findings reveal that charging demand grew unexpectedly across the timeline of the projects, particularly as impacts from COVID-19 waned, leading to a resurgence in usage. Despite a widespread assumption of low utilisation, robust growth occurred in certain urban and high-traffic locations, necessitating capacity expansions at some sites.

Consumer behaviour indicated that the majority of EV charging still occurs at home, with public charging primarily used for top-ups rather than full charges, suggesting a behavioural shift from the traditional fuelling practices seen for ICE vehicles.

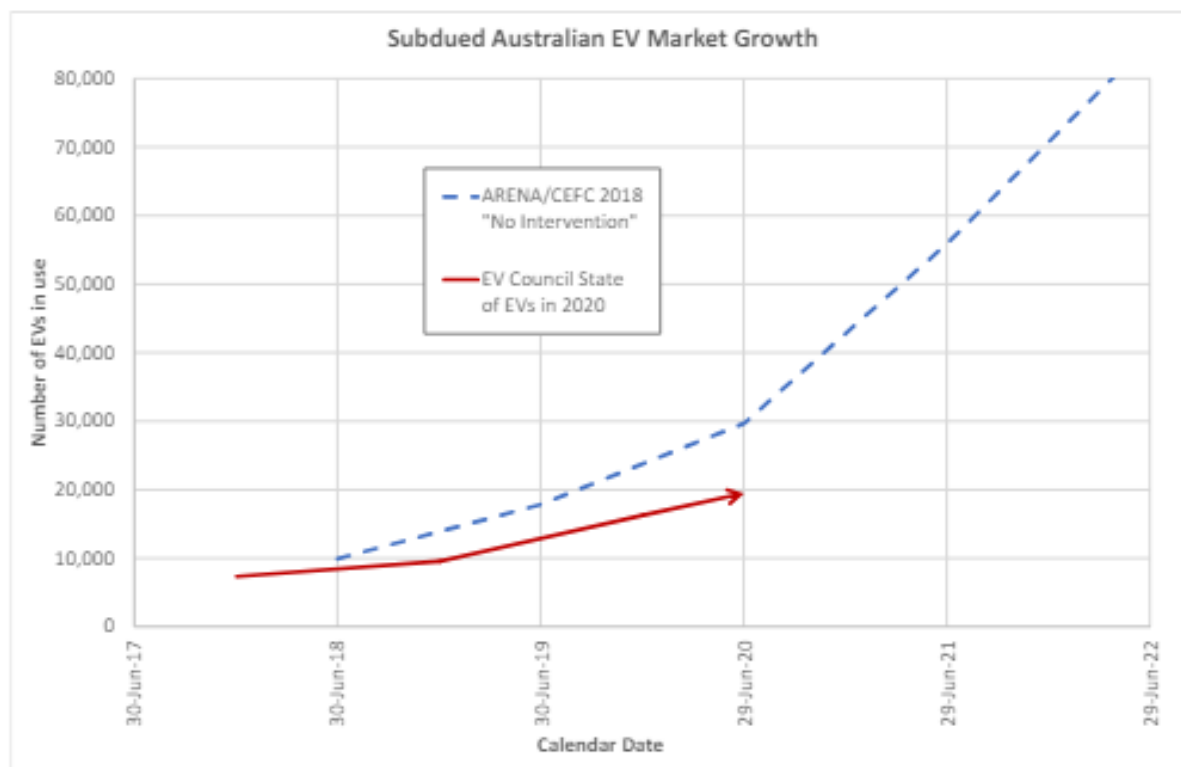
The CCS2 connector emerged as the dominant standard plug type, significantly outpacing CHAdeMO in both adoption and utilisation.

The above trends have implications for charging infrastructure planning, requiring a strategic approach to cater to the prevailing market preferences over time.

3.1.1. Charging Growth

CPOs had varying expectations about charging demand trends and were often surprised by how much or how little growth occurred during their projects. EV uptake, the primary factor dictating demand growth, was heavily influenced by COVID-19. Evie Networks initially noted how unforeseen COVID-19 impacts reduced EV uptake below the levels of even the more conservative industry forecasts on which they had based their expectations (which Figure 2 illustrates).

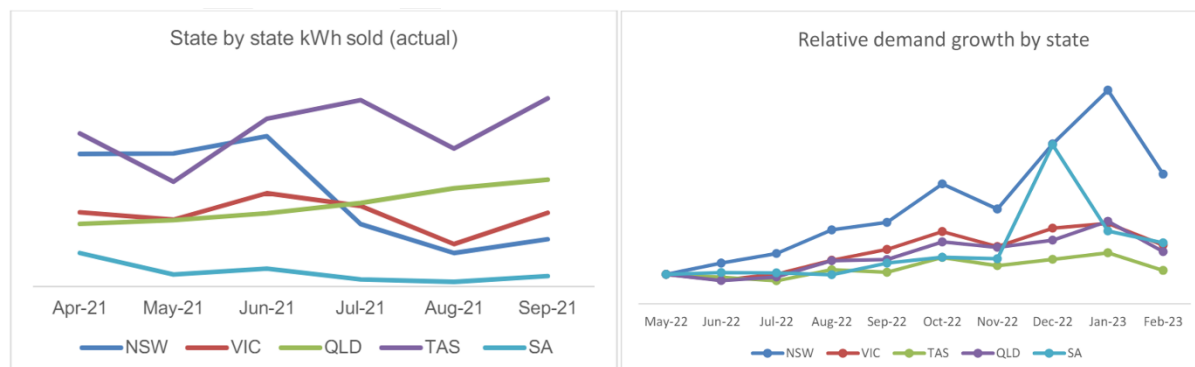
Figure 2 – EV Market Growth Relative to Previous Industry Forecast



Source: Evie Networks, Lessons Learnt Report – September 2020, 2020, pg. 3

As a result, their ultrafast chargers experienced low utilisation of around 1%, or 30 minutes of charging per site per day. This suppressed activity persisted through 2020 and 2021. However, as the influence of COVID-19 subsided through 2022 and 2023, growth had begun doubling every 4 or 5 months at their sites and EV sales reached 5,000 a month, up from 900. Figure 3 shows the strong contrast in Evie's charging demand.

Figure 3 – Evie Charging Demand Growth During (Left) and Post (Right) COVID-19 Lockdowns



Source: Evie, Lessons Learnt Report – October 2021, 2021, pg.4; Evie, Lessons Learnt Report – March 2023, 2023 pg. 4

Both ENGIE and Ampol also experienced higher EV uptake and utilisation than they had initially expected, as written in their 2022 reports. This growth led Evie to expand some high utilisation sites and ENGIE was also planning expansion to manage congestion. Ampol was pleased with the unexpected growth but determined that utilisation still was below the level required to break even.

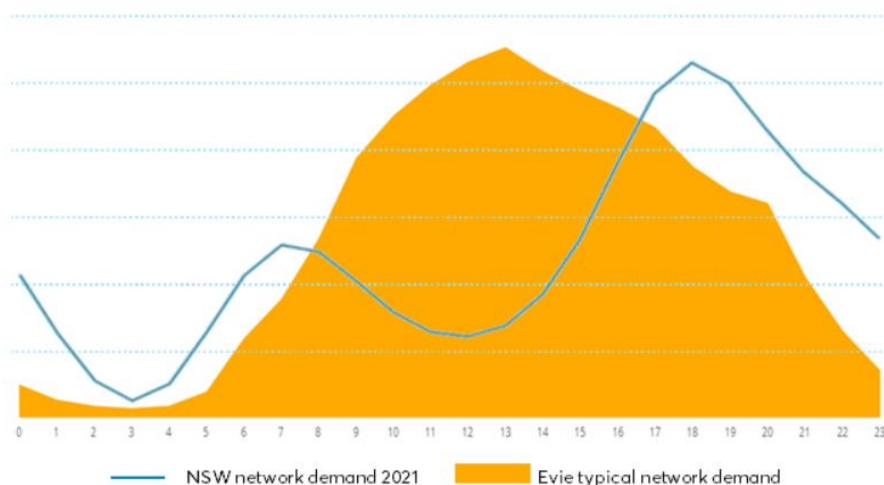
Although the overall EV uptake picture is looking promising for EV charging demand growth, CPOs reported varying results by segment. Most notably, rural sites were still experiencing low utilisation, except for during holiday times. In addition, highway site utilisation seemed to lag behind urban sites. These sites are expected to garner greater demand from professional drivers traveling long distances (for example, truck drivers), but EV uptake for this segment is still relatively low. Overall, Evie regards utilisation as a function of demand, coverage, seasonality, and relative site characteristics.

Because the success of EV charging is reliant on EV uptake, CPOs are considering ways to improve forecasting methods. Electric Highway Tasmania (EHT) wrote a comprehensive piece about their process for estimating the number of sites and bays that will be required in Tasmania for a 100% EV fleet. Using estimates on the current number of vehicles, average distance travelled per year, and energy use per kilometre, EHT calculated that around 1.5 billion kWh of energy would be required each year to charge a 100% EV fleet. EHT expects that public charging would fulfill 2–5% of this demand, and made assumptions around the average kW delivery and hours of daily usage need to estimate that Tasmania would need 1 charging bay for every 900–2,000 EVs. EHT noted that this calculation has plenty of caveats, but the lesson is that developing a reference point of charger requirements can assist in calibrating long-term plans to avoid over- or under-delivering.

3.1.2. Charging Behaviour

CPOs also observed trends in the way that people were charging. For instance, Evie stated that only 5–10% of EV charging happens at public charging sites. EHT made their own estimate and came to a consistent figure of 5–7%. Hence, most drivers appear to be charging predominantly at home. If they are charging in public, they are doing so because they either don't have a charger at home, are currently away from home (that is, travelling long distance or at a destination), or are professional drivers. Evie and Chargefox both observed most of the public charging in their respective networks occurring in the middle of the day, inverse of typical network demand load profiles that peak in the morning and evening, as shown in Figure 4.

Figure 4 – Evie Public Charging Demand Profile vs. NSW Network Demand Profile



Source: Evie, Lessons Learnt Report – October 2022, 2022, pg. 6

Drivers also tended to charge for around 20–30 minutes at a time for 10–20 kWh of energy, as seen by Chargefox and Evie. In other words, drivers are topping up their vehicles opportunistically at public chargers, rather than running their batteries to near empty and filling them up completely like they typically would with an ICE vehicle. Understanding this shift in driver behaviour will be critical for optimising the public charging model.

3.1.3. Plug Types

The final market trend with extensive coverage from CPOs was the observed dominance of the CCS2 EV plug type over the CHAdeMO plug type in EV market shares, with corresponding impact on charger utilisation. Chargefox shared their market findings, with 8 of the top 10 most sold EV models in 2021 (representing 83.8% of all EVs sold that year) having CCS2 plug types. Dominant CCS2 models include Tesla, MG, and Hyundai, whilst the best-selling CHAdeMO models include Nissan and Mitsubishi. Ampol presented their plug type findings, shown in Figure 5, which reinforced this trend and shows that it was dictating charging utilisation at their sites.

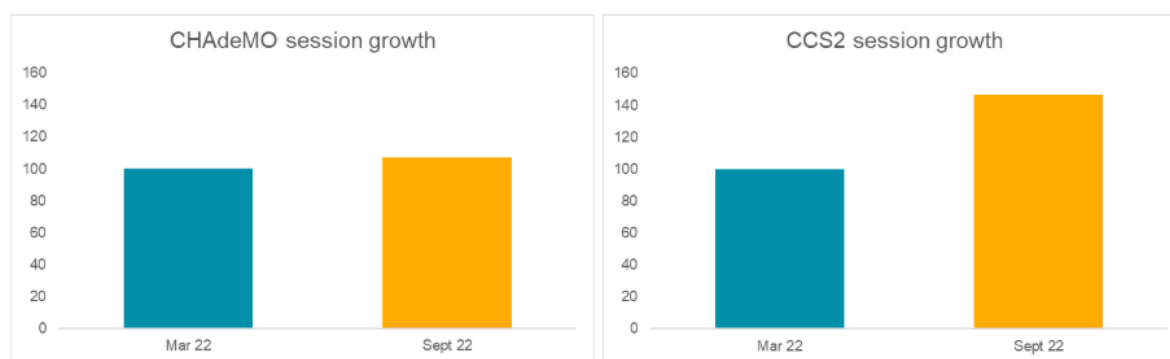
Figure 5 – CCS2 and CHAdeMO Plug Type Market Share and Ampol Site Utilisation



Source: Ampol Australia Petroleum, Addressing Black Spots Fast Charging Program – QLD, NSW, VIC & WA: Lessons Learnt Report, 2022, pg. 6

Figure 7 illustrates Evie's session growth findings by plug type, showing CCS2 sessions growing in volume by about 50% over 6 months, compared to less than 10% growth for CHAdeMO sessions.

Figure 6 – Evie Charging Session Growth by Plug Type



Source: Evie, Lessons Learnt Report – October 2022, 2022, pg. 4

Growth of the CCS2 market presents a dilemma to CPOs that aim to serve drivers with either plug type. Some CPOs like Ampol already have invested in chargers with one plug of each type, leaving the CHAdeMO plug underutilised at each bay. ENGIE plans to expand sites with more CCS2 bays but is committed to finding ways of cost-effectively maintaining some CHAdeMO bays. The future of the CHAdeMO plug type is still uncertain, so CPOs will have to monitor the plug selections of EV manufacturers.

3.2. Charging Station Infrastructure

This section covers any lessons that the CPOs learnt about the selection, procurement, installation, and maintenance of EV fast-charging equipment.

The key findings are that selecting the right chargers involves balancing cost not only with long-term reliability but also with compatibility, because emerging technologies in EV charging can introduce unforeseen complications.

CPOs reported that the procurement phase was particularly complex due to extended lead times exacerbated by global supply chain disruptions, emphasising the need for robust planning and the establishment of contingency measures.

Maintenance also emerged as a crucial ongoing concern, with the availability of skilled technicians and parts of pivotal importance to operational efficiency. The reliability of chargers significantly influences user experience and station profitability, underscoring the importance of choosing reputable equipment and engaging proactive maintenance strategies to mitigate downtime and ensure service continuity.

3.2.1. Selection

When selecting charging equipment, several aspects warrant consideration. While cost and power output were consistently identified as priorities, Chargefox learnt that stability and reliability in the long term are just as important because they affect user experience and maintenance costs. Furthermore, the introduction of new vehicle models in the evolving technology of EV charging presents the potential for unforeseen types of failures.

After purchasing a new set of chargers from one manufacturer with a good reputation for reliable electrical equipment, Chargefox realised that these new chargers were failing to deliver the functionality that the manufacturer promised. When purchasing charging equipment from any manufacturer, it is important to request detailed testing and stability data, and to have access to existing chargers for hands-on testing. This will help ensure that the chargers perform as expected.

Ampol and Evie observed shortfalls in fast-charging equipment standards. Ampol labelled Australian standards governing compliance requirements as ambiguous. Consequently, Ampol had to rely on internationally recognised certifications like Underwriters Laboratories (UL) and Conformité Européenne (CE) and partnered only with suppliers that had a track record of compliant domestic installations. Evie stated that no standards exist for testing the interoperability of EV charging between manufacturers.

If a certain vehicle model has a charging problem the necessary information for troubleshooting is dictated by the plug-type (CCS2 and CHAdeMO) protocols, which cannot be accessed using Open Charge Point Protocol (OCPP) management systems. Only the equipment manufacturer can run detailed diagnostics, making the process more difficult. Evie provided some examples of these complications, shown in Table 3.

Table 3 – Evie Examples of Charging Issues, Diagnosis, and Resolution

Date	Volume	Issue	Diagnosis	Resolution
Nov 2020	One vehicle (isolated)	Unable to charge.	Station connects to vehicle, but negotiation does not finish.	Issue was specific to this vehicle.
Jan 2021	Limited to a specific vehicle model. Intermittent / not repeatable.	Charging session does not commence. Station connects to vehicle but cannot start charging session.	Interoperability issue limited to a specific vehicle model. Related to charging session establishment.	Vehicle model specific issue, escalated to EVSE manufacturer. Patch created.
Feb 2021	One vehicle model	Charging cable does not release. Unable to disconnect and continue journey.	Vehicle security FOB placed to the charging port to unlock the vehicle and release the connector.	Evie to continue testing replicate and advise procedure if occurs again.
Apr 2021	Multiple vehicles. Anecdotal evidence.	Repeated attempts to charge.	Multiple internal charger communication and vehicle communication errors.	EVSE manufacturer created patch.

Source: Evie Networks, Lessons Learnt Report – June 2021, 2021, pg. 6

Evie anticipates that the need for robust standards will only grow as more EV manufacturers enter the market. This raises the likelihood of compatibility issues arising, which may worsen as new charging concepts emerge – such as Plug & Charge.¹⁰

3.2.2. Procurement

Procuring charging equipment also presented a range of associated problems. ENGIE, EHT, Chargefox, and Ampol all experienced extended lead times due to supply chain shortcomings stemming from the COVID-19 global pandemic and ongoing global conflicts. The main complexities contributing to delays were chip shortages and shipping delays. This was worsened by the exponential growth in EV charging demand worldwide. Additionally, raw material price increases raised the costs of charging equipment.

Whilst the origins of these supply chain deficiencies were out of the control of the CPOs, several strategies were adopted to mitigate their effects. For example, Ampol secured long-term, fixed price escalation contracts with equipment suppliers. EHT began stockpiling important equipment and spare parts. ENGIE diversified their supply base so that they were not sourcing components from just one region of the world. Chargefox acknowledged that these problems may never fully resolve as EV

¹⁰ Plug & Charge technology allows EV drivers to pull up to any public charging station, plug in, and immediately begin charging their vehicles. The charging station automatically bills the account connected to the vehicle without requiring a card tap or login from the driver. It was first introduced as the communication protocol ISO 15118. See <https://www.iso.org/standard/77845.html> for more details.

charging remains a growing industry and at times supplies periodically may become unavailable, emphasising the need for planning alternative supply options.

Chargefox also highlighted the substantial costs and resources required in EV charger procurement. \$5.5 million of their \$15 million project budget was dedicated to charger costs. This meant that the success of the project was heavily reliant on the performance of the chargers. That realisation has created a strong incentive to invest considerable time into the procurement phase to make the right choices. For Chargefox, the task took three months of full-time-equivalent hours. This was much longer than they expected, with contributions coming from all aspects of the business as well as external input from electricity distribution networks.

The rapid evolution of EV charging technology, particularly ultrafast chargers, further complicates procurement. Evie and Chargefox struggled to find suitable ultrafast charging suppliers with proven track records. Evie found only two capable suppliers, both of which were still working to fix the remaining minor bugs in their deployed systems. Chargefox encountered difficulties locating an installation team with sufficient familiarity with the new technologies. The CPOs aim to work closely with their suppliers to develop advances in equipment, and complications likely will subside as EV charging technology matures.

3.2.3. Installation and Maintenance

Insufficient numbers of skilled personnel in the charger maintenance service provider market prompted Ampol to guide their existing providers in elevating their expertise. Evie leaders observed that repair scheduling and duration are influenced not only by skilled maintenance crew response times but also by the availability of specialised spare parts, which supply chain problems can render unpredictable. Evie utilised backup power resilience systems that reduced the number and duration of outages by conserving communication and control of the chargers, as Table 4 shows.

Table 4 – Evie Outages Before (Left) and After (Right) Implementing Resilience Solution

August to December 2020			January to March 2021		
	# Outages	Avg duration (hrs)		# Outages	Avg duration (hrs)
Site 1	4	0.6	Site 1	2	0.7
Site 2	5	4.6	Site 2	2	0.5
Site 3	6	2.3	Site 3	1	4.0
Site 4	2	2.5	Site 4	0	0.0
Site 5	0	0.0	Site 5	1	0.3
Total	17	2.6	Total	6	1.8

Source: Evie, Lessons Learnt Report – June 2021, 2021, pgs. 3–4

Jolt had similar success using their remote monitoring system. Continued communication and control are crucial for maintenance in order to identify outages quickly, notify service providers automatically, perform diagnostic checks remotely, and, for minor cases, resolve malfunctions without needing to send staff members to the site.

3.3. Public Charging Commercialisation

This section covers any lessons learnt by the CPOs with respect to the go-to-market strategy of the fast-charging business. It focuses on the factors to consider when designing a business plan, and the key considerations for pricing, value-adding, user experience, and theft prevention.

The findings from these reports emphasised the importance of balancing between economies of scale and economies of opportunity when developing a go-to-market strategy for a fast-charging station business, suggesting a flexible approach to site development to cater to evolving market demands. Pricing strategies should revolve around reflecting the true cost of charging services to consumers, with CPOs advocating for transparency to manage user expectations regarding subsidised charging models. Several CPOs favour value-adding features such as integrating renewable energy sources and storage options at charging sites as effective methods to manage operational costs and enhance service attractiveness. They regard the user experience as a critical factor in commercial success, with a focus on ensuring accessibility, reliability, and convenience at charging stations to foster customer retention and consumer loyalty. Energy theft has also emerged as an issue, where customers deliberately cause their payment to decline after charging, but a simple funds reservation system is an effective solution.

3.3.1. Go-to-Market Strategy

EHT summarised their perspective on the two main commercialisation strategies for charging site development: economies of opportunity and economies of scale. They also highlighted the risks of these strategies.

Development of economies of opportunity involves seeking out the least-costly sites. This strategy has the obvious benefits of reducing risks related to capital investment and has been popular internationally in New Zealand, Japan, and China. Low-cost sites usually are limited in size and capacity, potentially accommodating only one or two charging bays. One downside of small sites is their higher operating cost on a per-charger basis. Another is poorer user experience, resulting from longer wait times if the few bays are already occupied or out of order. In addition, inexpensively procured sites may be far away from established business and residential areas, which may present an opportunity for a competitor to establish a more favourably located site within the area. Ideally, a low-cost site should be developed with access to additional power and space for potential expansion if site popularity grows.

Development of economies of scale relates to large sites. Although more expensive initially, large sites may offer more appeal to drivers by offering greater variety in charging configurations and power levels. Drivers are more likely to find unoccupied bays at large sites and queue times tend to be shorter. Large sites enable power sharing and demand management while simultaneously charging several vehicles, thereby reducing electricity demand charges. Ideally, a large-scale site would be built in phases over time, to allow for charging demand to match development. However, EHT did not discover a simple way to plan out a staged capacity expansion with power authorities over a 5–10 year period. Furthermore, switchboard manufacturers were not familiar with creation of designs capable of increases in capacity greater than 200–300%. The risk with large sites is that demand may never grow enough to justify the size of the site and the financial commitments made.

EHT's preferred commercial strategy involved a mix of opportunity and scale, finding economical sites with strong characteristics and scope for growth. EHT calibrated expansion based on queueing, aiming for less than 5% growth in wait times at a site on average over a year. The ideal size of sites will depend on context, but officials of EHT in Tasmania expect little to no need for sites with greater than eight charging bays.

3.3.2. Pricing Strategy

Another aspect of commercialisation is pricing strategy. Evie wrote extensively on their rationale for pricing at their ultrafast charging sites. In 2020, Evie charged a 35c/kWh power component, plus a 25c/minute time component. The power component is designed to recover the cost of electricity, essentially passing it through to the user. The site cost is recovered through the time component, which is set up as a charge for services and for the scarcity created by occupying a bay. This setup results in variation of total c/kWh prices depending on the total power used in a session, with lower

per-unit of energy costs for higher power sessions, with ~50 kW session typically costing around 65c/kWh, as shown in Table 5.

Table 5 – Evie Ultrafast Charging Session Pricing

Average session power	Net casual session price incl. GST
150kW	35c + 10c = 45c per kWh
100kW	35c + 15c = 50c per kWh
75kW	35c + 20c = 55c per kWh
60kW	35c + 25c = 60c per kWh
50kW	35c + 30c = 65c per kWh
30kW	35c + 50c = 85c per kWh

Source: Evie, Lessons Learnt Report – September 2020, 2020, pg. 14

Despite some customer complaints, Evie regards this method of pricing as reasonable and cost-reflective, and predicts it will be competitive as the power used per charging session grows to its expected levels – the sites have been designed with sessions of ~120 kW in mind. They noted that ultrafast charging is distinctly different from slower public charging options, warranting a different pricing approach.

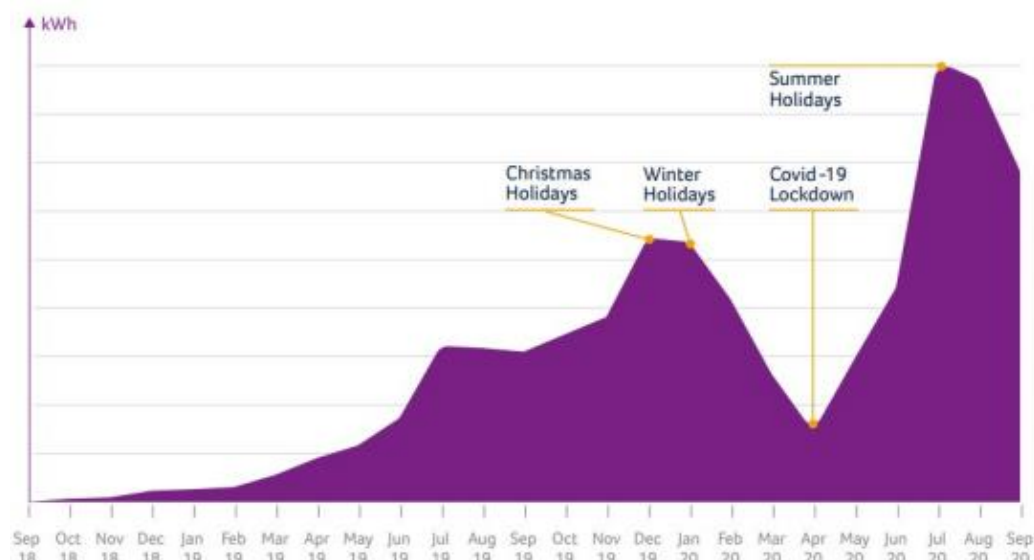
The biggest hindrance that Evie experienced in rolling out this pricing strategy was subsidised charging sites, which do not accurately reflect the true costs of charging. Prices at these sites range from 52c/kWh to free (for service members). Evie expressed concern that subsidised pricing sets unrealistic expectations to the public about the cost of charging, and advocated for explanations to be presented alongside pricing to manage these expectations. Additionally, Evie found that these prices hurt demand at nearby unsubsidised sites, reducing demand at these sites to one-fifth of the level that is seen at sites without a subsidised alternative. They also noticed that most comments complaining about prices originated from sites near subsidised chargers.

Evie suggests the pretence that subsidised charging sites will encourage EV uptake is false, for the following reasons:

- Public charging accounts for only 5–10% of the charging for the typical EV, hence it represents a minor fraction of the total cost of EV ownership
- Research shows that the cost of EV charging is of low priority to drivers, behind coverage, availability and ease of use – although drivers will choose a cheaper option if it is available
- Economically justified pricing still compares favourably to the cost of petrol and international EV charging prices.

As further evidence, Evie presented an international example from IONITY in Europe, which introduced a charging price equivalent to \$1.25/kWh in January 2020 and has exhibited steady growth in demand since, excluding the impact of COVID-19 lockdowns. This is shown in Figure 7.

Figure 7 – IONITY Customer Demand Timeline

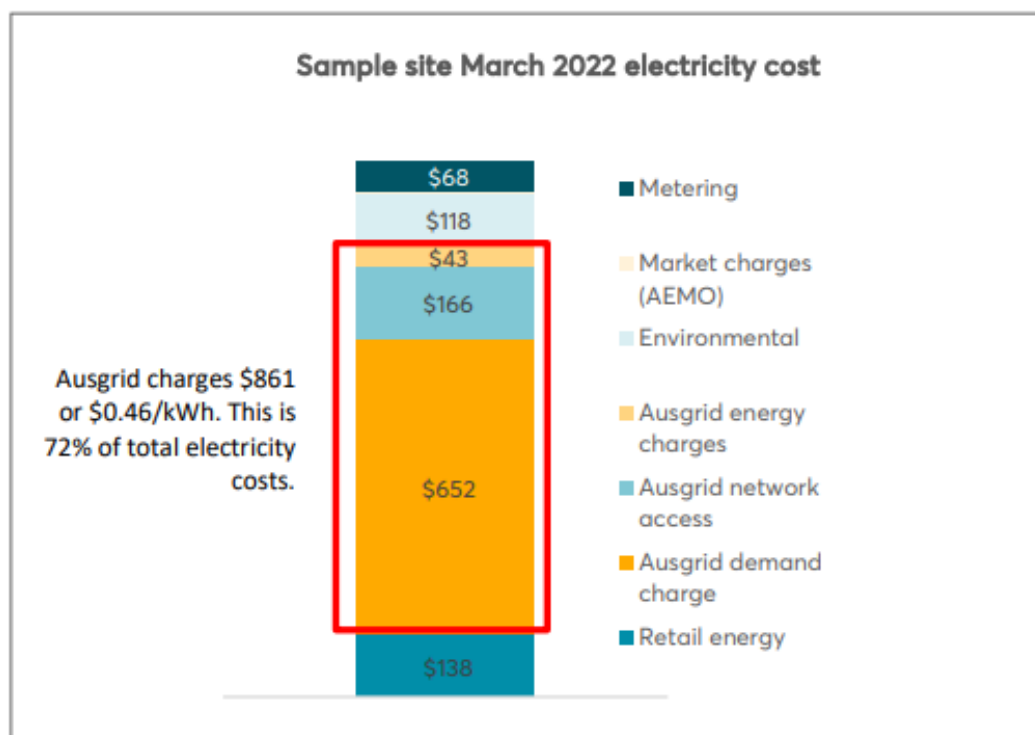


Source: Evie, Lessons Learnt Report – October 2021, 2021, pg. 6

Chargefox concluded that economically efficient prices will not hinder EV uptake in the long term, whilst enabling CPOs to operate their business sustainably.

The price of electricity is a key factor in the commercial viability of the public charging business model. As described by Chargefox, EV charging network costs normally consist of a fixed daily charge, a per-unit charge for energy consumption, and a per-unit charge for maximum demand. High maximum demand billing is common for EV charging due to the intermittent nature of fast charging profiles coupled with high power usage. Evie found that network costs from Ausgrid constituted 72% of their total 63c/kWh electricity costs for their sites, as Figure 8 shows.

Figure 8 – Evie Electricity Cost Components



Source: Evie, Lessons Learnt Report – May 2022, 2022, pg. 5

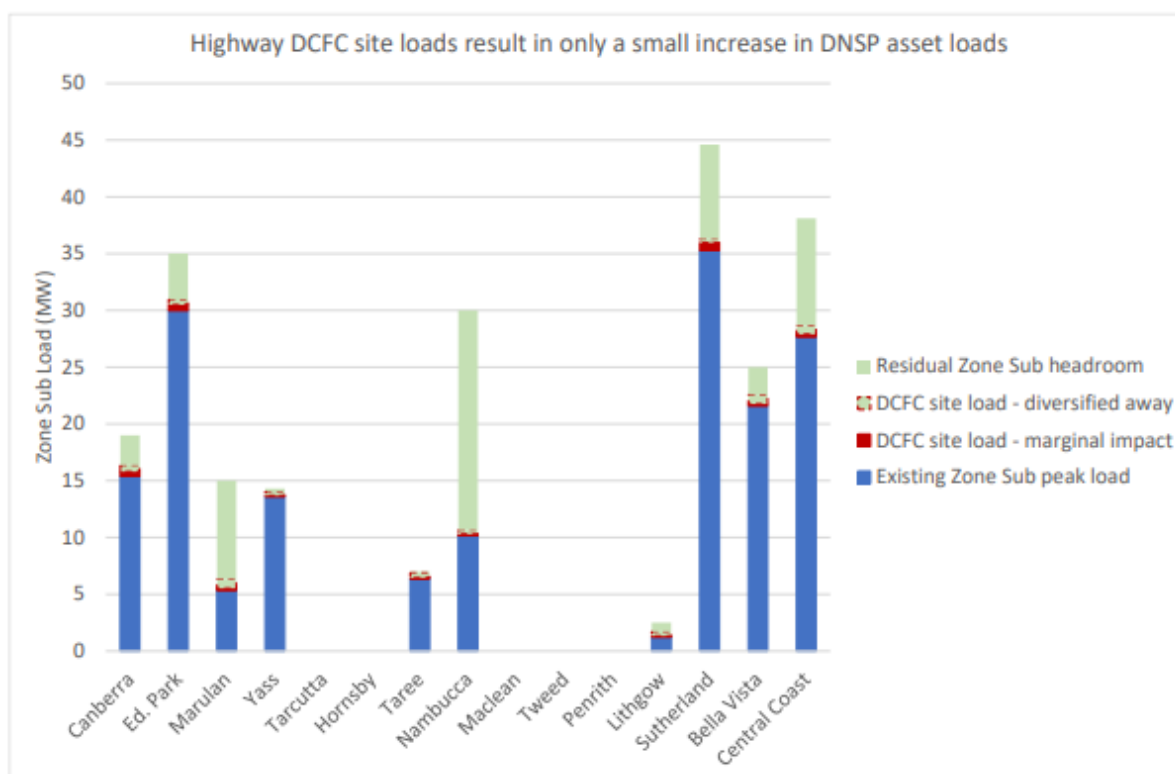
Evie noted that rising wholesale prices in 2022 contributed to increased electricity costs. Evie feared that these electricity costs, which are ultimately passed to the customer, would reduce the affordability of public charging for many consumers.

The CPOs identified several ways to reduce electricity costs. Chargefox suggested diversifying sites and setting maximum power limits or reducing demand peaks and associated charges. Evie asserted that controllability of fast-charging equipment enables adjustments in response to peak demand events.

Evie wrote about the importance of efficient tariff assignment in fostering a sustainable EV charging business model. They felt that their sites were incorrectly being assigned to prohibitively high demand tariffs by default. Evie asserted that these tariffs are not cost reflective for three main reasons:

- Demand tariffs are based on long-run marginal costs which extrapolate the impacts of fast charging on networks in ways that will not materialise, given the low utilisation nature of sites
- Typical peak charging demands do not coincide with the times of network peak demand
- Network assets generally have available headroom to accommodate additional charging demand, as Figure 9 shows.

Figure 9 – Evie Charging Demand Impacts on Network Assets



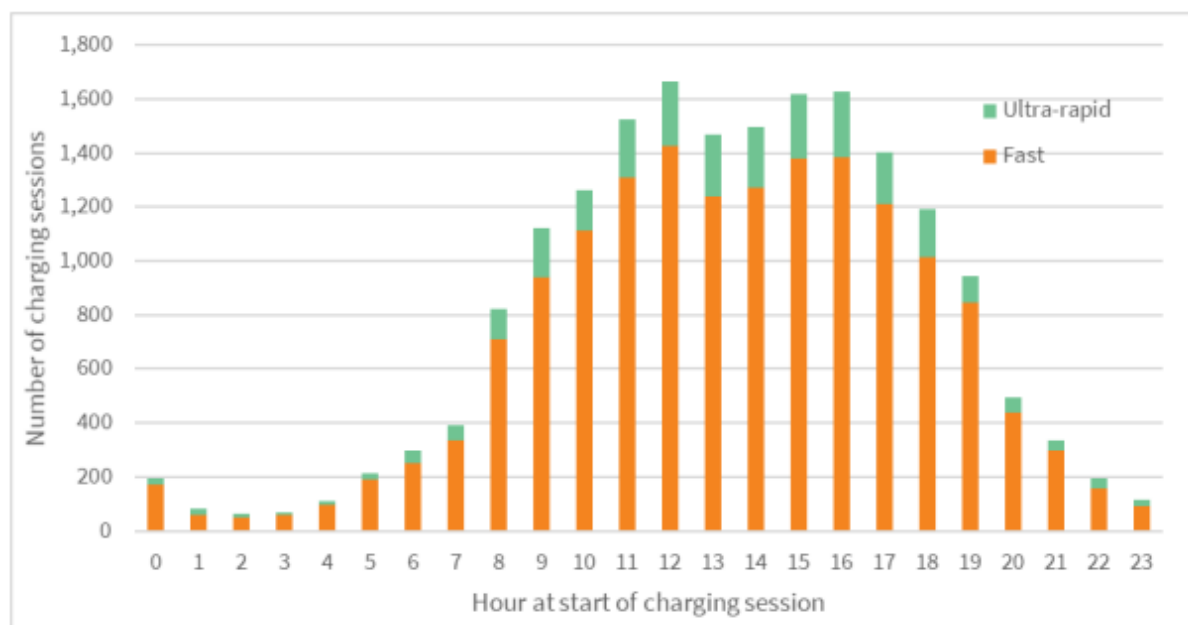
Source: Evie, Lessons Learnt Report – September 2020, 2020, pg. 10

Evie plans to work closely with DNSPs to improve tariff design in a way that will support transport electrification and public charging commercialisation.

3.3.3. Value-Adding

Co-locating renewables also can reduce electricity costs and may even defer the need for network augmentation. Chargefox and Evie both observed the alignment of aggregated charging loads with times of solar PV export (see Figure 10). By installing solar PV, or developing on sites with existing solar PV, charging loads can utilise the on-site solar energy produced, reducing net grid demand.

Figure 10 – Chargefox Count of Charging Sessions by Hour Across Network



Source: Chargefox, Fast Charging Site Selection Guide, 2020, pg. 8

Batteries can be built on charging sites (along with solar PV) to help accommodate power charging demand using on-site renewable energy, particularly when solar PV is not generating at night. Evie acknowledged the benefits of battery storage but found that, at the time of writing, the costs associated with installing battery storage were about double the cost of just paying for grid augmentation. Nonetheless, batteries will reduce ongoing electricity costs, and the cost to install them will continue to fall. Batteries also can earn additional revenue through electricity market arbitrage, as Chargefox observed.

JOLT's business model incorporates display of advertisements at charging sites as another option for generating extra income. JOLT encountered some restrictions with this model in negotiating the nature of advertising content. For example, some councils were concerned about displaying gambling advertising, and JOLT speculated that fast-food advertising may become limited near schools or political advertising may be limited near polling booths during elections.

3.3.4. User Experience

The user experience also is a focus of public charging commercialisation as it relates to retaining customers and developing consumer preference for a CPO brand. User experience can be factored into site design as described in the Site Selection and Charging Bay Configuration sections but is also related to customer service interactions and accessibility. JOLT's strategies to improve customers' experiences include creating a charging app support page linked to video tutorials, frequently asked questions, troubleshooting tips, and details of their 24/7 customer support line. They expect improvements in customer accessibility to comprehensive information will reduce the burden on support teams.

ENGIE conducted a market assessment of customer payment preferences and contactless payment systems for public charging. Most payment methods utilised mobile apps or RFID cards for customer payment, but no standardised contactless payment solution exists due to the limited ability of payment systems to integrate with OCPP EV equipment.

3.3.5. Theft Prevention

Evie uncovered a noticeable number of customer payments declining after the energy has already been delivered to their EV, preventing Evie from recovering revenue from the transaction. The number of declines reached an unsustainably high level, threatening the commercialisation of public charging.

Whilst Evie expected some level of payment decline, an investigation found that some customers were committing fraud by deliberately triggering payment declines, essentially stealing energy. Evie

worked with their payment gateway provider to develop a simple but effective solution. A pre-authorisation system was implemented, where \$30 in funds is held in reserve until the transaction completes, whereafter the funds are released (usually on the same day but can take up to a week if the banks are slow). This pre-authorisation system reduced payment declines by 75%. One negative side effect was that some customers falsely perceived the pre-authorisation as a payment. Evie mitigated the impacts of this through an education program for its customers.

3.4. Grid Connection Needs

This section summarises the key lessons that CPOs learnt related to energising their charging sites. Key considerations included the unexpected time and resources required to engage with electricity distribution networks, the lack of a standardised process, the need for managing the site load to minimise connection costs, and remote commissioning.

The lessons learnt underscore the importance of strategic planning, technological adaptability, and strong partnerships with network providers to facilitate the successful deployment of EV charging stations. Engaging effectively with electricity networks was crucial, often requiring significant time and resources to navigate regulatory hurdles and ensure compliance with local standards. Early and proactive communication with network providers is vital to manage expectations and streamline the connection process. CPOs identified load management as a critical aspect, asserting that dynamic solutions are necessary to efficiently distribute available power and manage demand peaks as a means of avoiding costly network upgrades. Furthermore, remote commissioning has emerged as a valuable practice, enabling remote setup and troubleshooting of stations, which saves time and reduces the need for physical presence on site.

3.4.1. Engaging with Networks

The most frequently discussed learning relating to grid connection needs was determination of the amount of time and resources required to establish new charger connections. Ampol reported that electricity distribution networks were often constrained by the high number of simultaneous projects undertaken and because of interruptions in equipment supply chains (which were exacerbated by the COVID-19 pandemic at the time). They also encountered problems attributable to the poor quality of aging site switchboards that required replacement or upgrades, adding costs and delays. JOLT found that connection processes would take up to six months, depending on project complexity. Evie displayed the significant time taken from application to energisation at their ultrafast charging highway sites, as seen in Table 6.

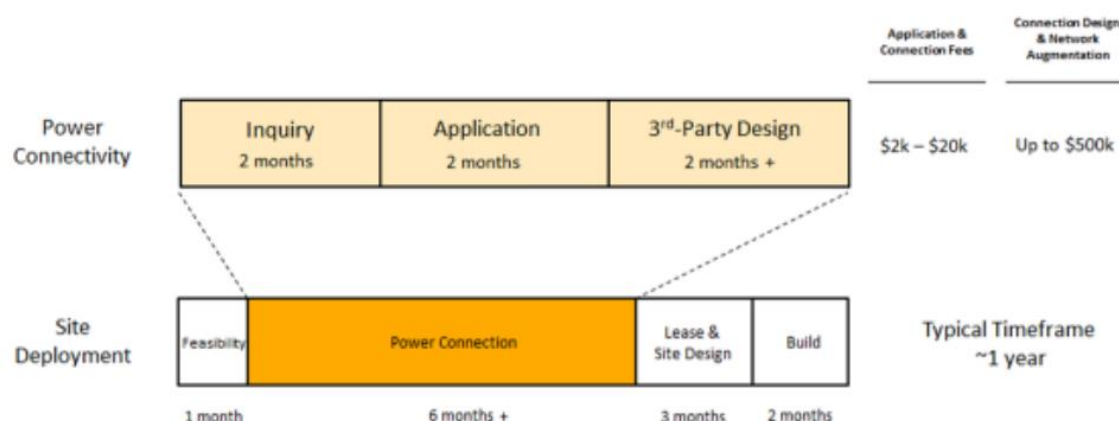
Table 6 – Evie Ultrafast Charging Site Connection Times

Site	Connection application started	Connection offer received	Site energised
BP Northpoint - VIC	June 2020	Sep 2021	28/06/2022
Warrenheip - VIC	Apr 2020	Mar 2022	20/09/2022
Paralowie Village Shopping Centre - SA	Jun 2021	Dec 2021	30/11/2022
Toowoomba - QLD	Feb 2022	May 2022	22/12/2022
Cameron Park - NSW	May 2020	Aug 2021	22/03/2023
Proserpine – QLD	Feb 2022	May 2022	Apr 2023

Source: Evie, Lessons Learnt Report – March 2023, 2023, pg. 5

Evie produced a diagram, shown in Figure 11, detailing the typical connection process, including a timeline and associated costs.

Figure 11 – Evie Typical Grid Connection Process



Source: Evie, Lessons Learnt Report – December 2019, 2019, pg. 6

Chargefox recounted a particularly difficult experience with their first site connection process, which was fraught with delays. After dismissing a designer who was found to be unqualified, the switch to a qualified designer delayed equipment procurement. Chargefox also encountered difficulty finding a suitable transformer, delivery of which was delayed. After the company scheduled a site outage to install the transformer, dispatched a full connection crew, and paid for on-site generation out of pocket to keep the host site operating, poor weather got in the way – forcing the outage to be re-booked on another day, doubling the cost and pushing timelines further. Delays causing flow-on effects recurrently occurred during grid connection processes.

As many CPOs pointed out, these obstacles were beyond their control to prevent. They found that the best course of action was to engage with networks early, even if the site was not yet ready to be energised. Doing so started the connection process and allowed for firmer timeframes and expectations to be established. Early engagement offers the added benefit of building a collaborative relationship with the network for improving subsequent connection processes.

The lack of nationally consistent standards for power connections contributed to delays. ENGIE specifically referred to the lack of a unified charging station metering standard in Australia, which does not require installation of a national metering identifier (NMI) pattern meter on charging station sites. ENGIE proactively installed their charging sites to meet the European measuring instruments directive (MID) metering standards, which they expected to guide future NMI standards. The company also installed NMI pattern meters upstream of sites to future-proof them if standards change and they become a requirement. The lesson here is to maintain awareness of charging connection standards and to stay vigilant for potential changes in standards.

3.4.2. Load Management

Load management enables optimisation and expansion-planning of charging infrastructure. JOLT found that remote monitoring was useful for load management because it yields data on charging usage and patterns. Understanding the times of peak charging demand helps to design sites with efficient capacity allocation, preventing overloads at minimal cost and allowing for load balancing across multiple sites or chargers.

ENGIE noted that site load management is typically done through a building management system (BMS). Because of this, EV chargers need to interface with BMS, which can be difficult to do with the OCPP EV charging system. Chargefox highly recommended dynamic connections for load management, which measure available network asset capacity in real time by considering the power draw of connected loads, while allocating the remainder to EV chargers.

CPOs can mitigate some grid connection problems by using load management to make the most of a site's existing capacity, potentially circumventing the need for lengthy and expensive network augmentation equipment.

3.4.3. Remote Commissioning

COVID-19 lockdowns interfered with CPO processes to obtain access to sites for commissioning grid connections. Several CPOs compensated by developing ways to commission sites remotely.

Ampol and ENGIE both developed virtual tools to carry out feasibility assessments without dispatching personnel to the site. Chargefox developed a remote commissioning system through which charger manufacturers oversee a trained crew of local electricians off-site instead of sending out their own staff. This prevented the need to book busy commissioning teams (another cause of connection delay), thereby increasing the flexibility of operations. Whilst the impact of COVID-19 has waned, remote commissioning tools and systems like these can continue to provide grid connection benefits.

3.5. Site Selection

This section focuses on the key lessons that CPOs learnt concerning the optimal selection of sites for new charging station installations. Key aspects considered include visibility to drivers, safety and accessibility for drivers and maintenance crews, access to sufficient power for current as well as future charging site capacities, and cooperative site owners.

The reports indicate that successful site selection involves a combination of strategic placement, stakeholder collaboration, and infrastructure readiness to support the growing demand for EV charging:

- CPOs should place stations in high-traffic areas to maximise visibility and use.
- While convenience in accessibility enhances the appeal of a charging station, safety is of paramount importance, particularly regarding the perception of a fire hazard.
- Fundamental considerations include access to sufficient power to meet current and future energy needs without extensive network upgrades, which can be costly and time-consuming.
- Lastly, cooperation with site owners is vital for navigating the complexities of lease agreements and ensuring long-term viability and stability of the charging station sites.

3.5.1. Visibility and Utilisation

The site selection criterion that the CPOs consistently considered high priority was selecting the right location for chargers to maximise visibility and utilisation. JOLT aimed to select areas by modelling expected current and future charging demand using traffic volume data (both car and pedestrian), with the additional incentive of increasing advertising visibility on their charging stations.

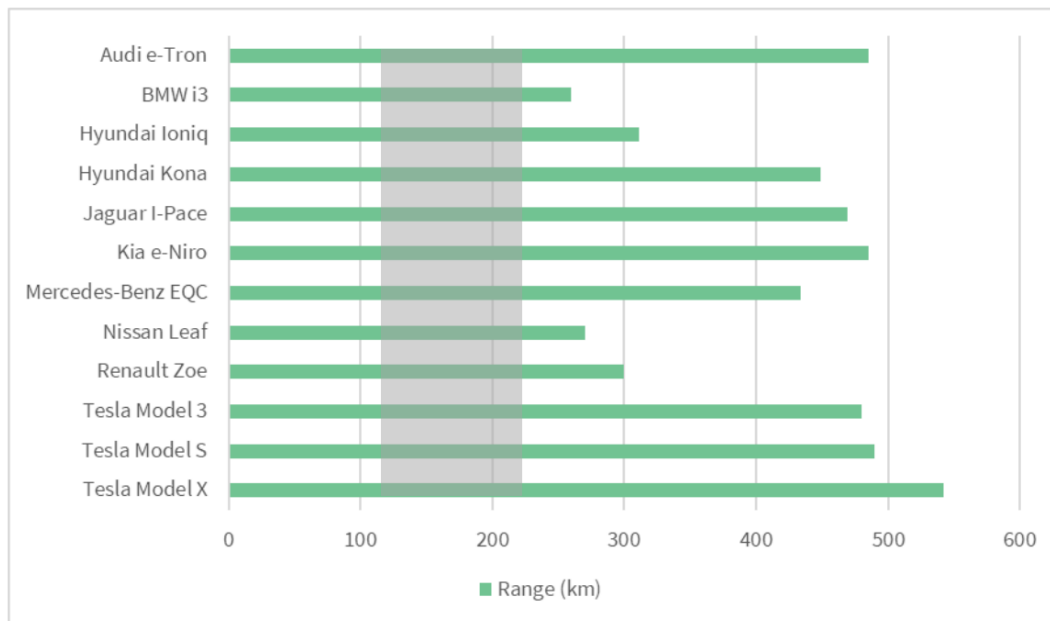
Ampol developed their own utilisation modelling tool that utilises an artificial intelligence (AI) algorithm. They found that the necessary size of the charger to maximise utilisation will vary by location. CPOs also encourage access to nearby amenities including fuel stations, shopping centres, visitor attractions, and urban hubs that contribute to traffic volume concentration.

Chargefox and Evie considered all the above for their ultrafast charging sites, but also factored in spacings between their charging stations conducive to accommodating EV range.

Range anxiety is a common concern for EV drivers looking to travel long distances, although this will decrease as EV battery capacity and efficiency continues to improve. Nonetheless, the expected purpose of an ultrafast highway network is to quell these anxieties with charging options for long-distance travellers with any type of EV.

Figure 12 shows an analysis that Chargefox conducted on typical maximum EV range, and Figure 13 shows the company's resulting selection of ultrafast charging sites and spacings. Chargefox settled on a maximum of ~200km for spacings and Evie and EHT chose ~150km. EHT plans to reduce spacings to ~50km for maximum coverage.

Figure 12 – Chargefox Analysis of Typical Maximum EV Range



Source: Chargefox, Fast Charging Site Selection Guide, 2020, pg. 4, Note: range of ultra-rapid charger spacings shown in grey

Figure 13 – Chargefox Ultrafast Charging Network Spacings (km)



Source: Chargefox, Fast Charging Site Selection Guide, 2020, pg. 5

3.5.2. Safety and Accessibility

Evie and JOLT assign high priority to safety and accessibility in site selection. Accessibility promotes convenience and positive user experiences, usually involving spatial considerations such as the ability for EVs to move in and out of bays and the location of a site relative to highway exits. Accessibility also

encompasses hours of operation. Evie found 24/7 accessibility highly desirable because it maximises potential charger usage and enhances customer satisfaction.

Safety pertains to the protection of driver wellbeing, which will encourage proper usage. The location and surroundings of chargers must be assessed for safety, and sites should be designed with adequate spacing between bays and lighting. Evie noted that security cameras can promote safety by deterring criminal behaviour. Ampol flagged the additional dangers that must be mitigated when installing EV charging sites near existing liquid fuels stations and infrastructure. JOLT encountered similar dangers at their sites when excavating around underground high voltage (HV) cabling and intends to avoid developing sites near them in the future.

Regarding safety, Evie also found that public perception of lithium-ion battery fires (particularly in cheaper products like e-scooters) have negatively affected perceptions of EVs, including EV charging, as a fire hazard, even if evidence does not support this. They cited EVFireSafe, an app that tracks EV fires over the world, which shows that only 21 EV fires have occurred in Australia to date. None of these fires involved EV charging, and of the 7 which involved the battery, all had an external source of combustion (e.g. arson, building fire).

As a result of the perception of EV fires, the Australian Fire Authority Council (AFAC) identifies EVs as a 'special hazard' and recommends special structural considerations and fire protection measures in buildings that may contain EVs. QLD Fire and Emergency Services has similar views and recommends implementing smoke management systems. These additional building requirements could add considerable cost to charging installations. Fire Rescue NSW endorses AFAC's view, going further to say that EV charging should be outdoor only – which would severely impact EV charging by limiting potential sites. Some of Evie's site hosts flagged that insurers are charging premiums for buildings that will house EVs (citing the safety risks), which is discouraging site owners from hosting EV chargers.

Evie hope that governments and CPOs can make a coordinated effort to provide greater certainty to site hosts about the safety of EVs and EV charging, minimising any additional buildings costs.

Accessibility is also of great concern to site installation and maintenance teams. ENGIE wrote about problems with height and weight restrictions that installation crews encountered in underground car parks. A site must offer adequate protection of charging equipment to help prevent costly repairs.

3.5.3. Access to Power

Another high priority for selecting a charging site is suitable access to electricity. Ampol observed that power supply sufficiency requirements can constrain potential site choices. Moreover, the ability to obtain supply without significant network augmentation will make a site more appealing to develop. The Grid Connection Needs section includes detailed discussion about complications associated with augmentation, which creates significant delays and costs.

In 2022, requirements were added to the National Code of Construction (NCC) for a range of building classes to have EV charging provisions as a sustainability initiative, which is mandatory for new buildings. Evie has flagged that this has created an issue, since these requirements were based on slow AC charging but developers are wanting DCFC in their buildings. Evie are finding that the power supply provisions obtained are not suitable for public DCFC, stalling development.

Evie, Chargefox and JOLT have determined that the easiest sites to develop tend to be those with access to existing infrastructure and spare switchboard capacity. Most favourable circumstances include likely availability of more network capacity, and moderate infrastructure upgrade costs to allow for easier future site expansion. Crucial infrastructure elements for a site include proximity to a large-scale transformer and main switchboard.

Both Evie and Ampol mentioned that a second supply point is a potential alternative in some cases but is best avoided because that conflicts with the safety requirements of power authorities that advocate a single point of network isolation for emergency purposes. Charging network operators stated that the site selection process should include screening for any network constraints that could impede site development and operational viability.

3.5.4. Cooperation with Site Owners

CPOs encountered numerous problems related to the final high-priority selection criterion: a willing and cooperative landlord. A location could have all the right features for a high-value EV charging site, but if an agreement cannot be made with the site landlord, development of the site cannot proceed. Ampol and other CPOs may have ownership of some of their sites, which will avoid these problems entirely, but most cases required obtaining approvals, which can be complicated.

Chargefox and Ampol both mentioned the significant time lags associated with seeking site approvals and licences, which can delay projects. Delays can occur for numerous reasons, including:

- Landlords with limited EV knowledge or an inflexible attitude, or that make irrational decisions, making negotiation difficult
- Competition for approvals at sites increasing as new players enter the market, leading to more knowledgeable, noncommittal landlords seeking higher rents
- Differences in the views of landlords and other site property stakeholders, such as opinions on terms, conditions, and strategy between the executive level or property group level and the landlord, or dealing with tenants or subtenants that have different views to the landlord,
- Reluctance of landlords to temporarily sacrifice normal business operations or parking spaces to allow for installation.

Engaging with landlords early and seeking pre-approval is the only way to reduce this risk, and Evie recommended dealing directly with a landlord as opposed to tenants. However, as Chargefox has experienced, barriers can remain in landlord engagement (particularly in the early stages), meaning that success is not guaranteed. They cited multiple instances in which they garnered pre-approval through non-binding letters of intent only to find that landlords or property groups changed their minds later in the process. Table 7 shows Chargefox's summary of instances in which property groups changed positions since the proposal phase.

Table 7 – Chargefox Examples of Property Stakeholder Position Changes

Property Group ID	Change in position since proposal	Reason for change
Group 1	Previously agreed commercial proposal in signed letter of support discarded	Business purchased by Group 2 so aligned to their commercial terms
Group 2	Key contacts and approvals process changed to be slower and more uncertain	Purchased Group 1 so team responsibilities expanded greatly.
Group 3	No longer views commercial agreement as favourable	Other proposals received since the original FFF proposal make them think better commercial terms are available
Group 4	Signed "exclusive" deals with two charging providers, cancelled one following grant announcements	Commercial opportunism
Group 5	Letter of intent no longer certain of proceeding	Corporate strategy now uncertain on EV charging in general

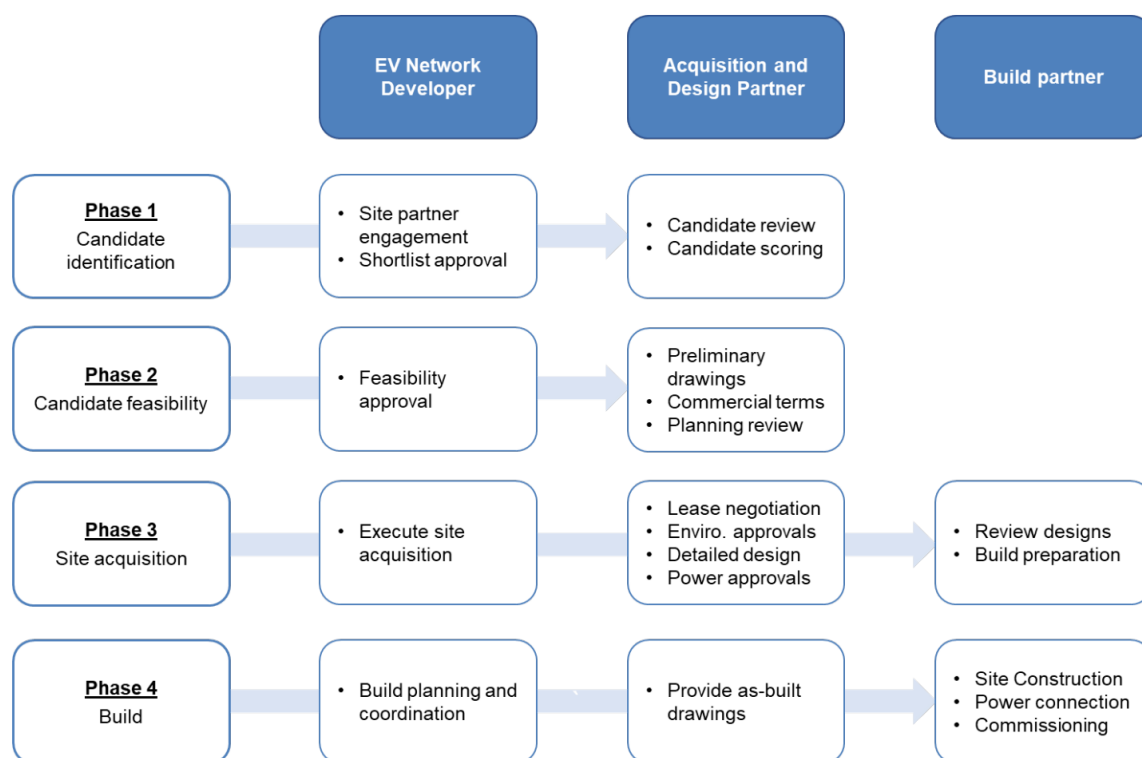
Source: Chargefox, Chargefox Future Fuels Metro Fast Charging: Project results and lessons learnt, 2022, pg. 5

Evie advised network operators that have managed those potential problems to sign long-term agreements enabling projects to operate for a long enough duration to recover costs.

Other important approvals like environmental impact assessments can be time-consuming and difficult to obtain. Evie warned against presuming that any existing works on site will comply with the conditions required to receive these licences.

Figure 14, courtesy of Evie, provides an overview of the complete site selection process, and the amount of licences and approvals required along the way.

Figure 14 – Evie Site Completion Process



Source: Evie, Site Selection How to Guide, 2021, pg. 4

3.6. Charging Bay Configuration

This section covers the key lessons that CPOs learnt regarding the physical layout of their charging stations and any considerations when designing the site. This includes charging differences among EVs, the layout of parking bays, safety, and preventing non-EVs from parking in charging bays.

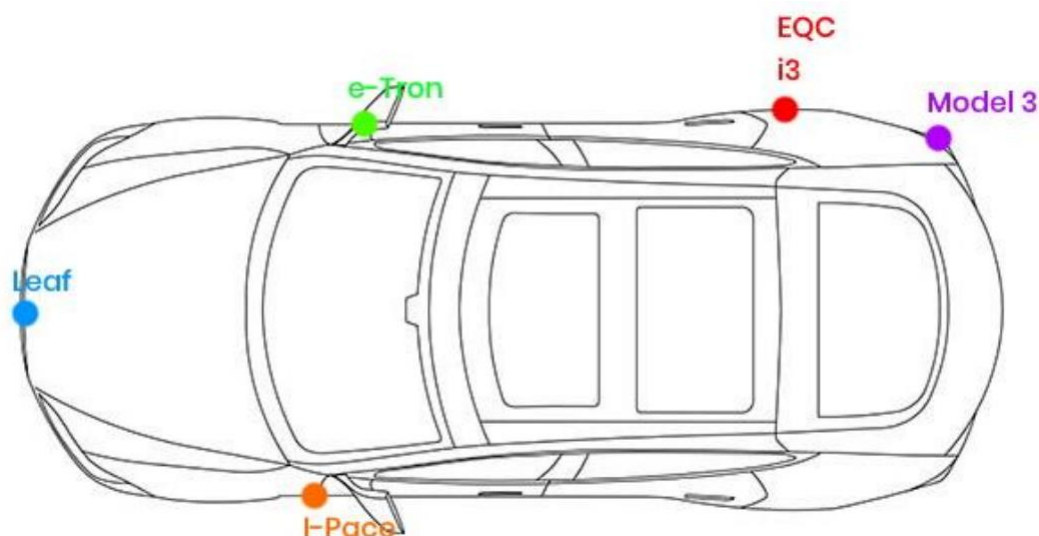
Overall, the findings underscore the need for thoughtful design and strategic planning in the setup of charging stations to enhance usability and safety while accommodating a broad range of EVs. The lessons learnt emphasise the importance of:

- Considering the varying locations of charging ports, which necessitate flexible cable lengths and charger placements to ensure accessibility for all types of EVs
- The layout of parking bays; designs must facilitate easy ingress and egress while preventing damage to vehicles and charging equipment
- The safety and security of the charging environment for users as well as the general public
- The risk of “ICEing” – ICE vehicles parking in designated EV charging spaces – must be mitigated, with strategies such as clear signage and physical barriers recommended.

3.6.1. Vehicle Manufacturer Differences

Chargefox noted a few EV design variabilities that must be considered when configuring charging bays. The location of charging ports is inconsistent among various EV models, as Figure 15 illustrates.

Figure 15 – Locations of Charging Ports for a Selection of EV Models



Note: The Model 3 port is located on the rear left of the vehicle, not the rear right as shown in this image

Source: Chargefox, Fast Charging Site Selection Guide, 2020, pg. 9

Compounding these inconsistencies, charger manufacturers were not governed by any standards that require a minimum charging cable distance. The various locations of charging ports created problems for JOLT, which found that supplied charging cables were too short to reach the ports of many vehicles. Switching from 4-metre to 7-metre cables resolved the problem effectively. Doing so required increasing the slack between their charging separators to prevent cables from dropping to the ground when not in use, creating a tripping hazard.

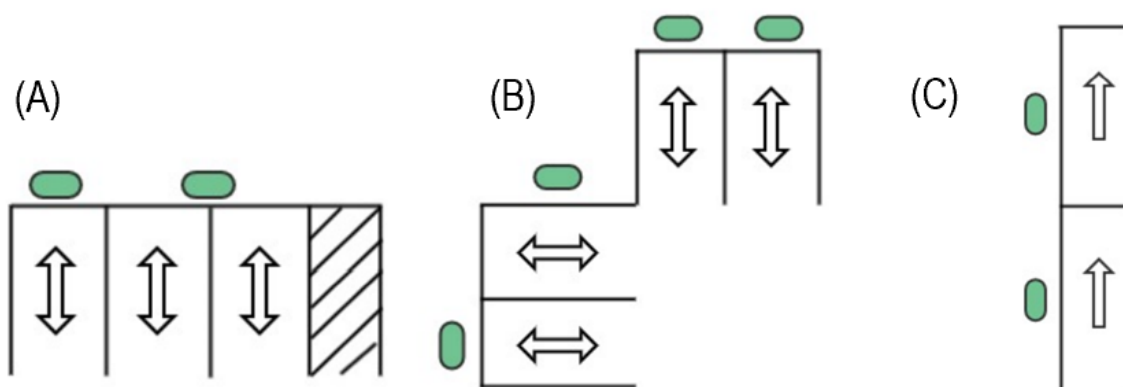
3.6.2. Parking Bay Layout

The importance of wheel stops was a key focus in discussions about manufacturing considerations. Chargefox noted that low-ground-clearance EVs which have difficulty parking over a wheel stop. Meanwhile, JOLT emphasised the significant value of wheel stops in their charging bays. Wheel stops are crucial for protecting charging equipment, enhancing safety, aiding drivers in aligning their vehicles correctly, and ensuring that accessibility pathways remain unobstructed.

Chargefox also documented that charger placement was heavily influenced by the particular layout of the parking bays themselves, whether parallel, perpendicular, or angled, and the bays at each site also will be subject to differing traffic rules. Another important factor that should not be overlooked is the accessibility of EV charging for people with mobility-related disabilities, which Chargefox flagged as not being well understood at the time.

Figure 16 presents three real-world examples of charging bay configurations that Chargefox designed to mitigate configuration problems.

Figure 16 – Chargefox Sites at Barnawartha North (A), Airport West (B), and Murray Bridge (C)



Source: Chargefox, Fast Charging Site Selection Guide, 2020, pg. 10–11

At site (A), a greenfield site, a charger was placed between two bays, providing convenience for drivers of EV models with charging ports near their side mirrors, and a bay for drivers with disabilities could be designated.

At site (B), one of the chargers was placed on the side of a bay. This was due to space constraints, but the result allowed for more flexibility for certain EV models. Creation of a dedicated bay for drivers with disabilities was not possible because the installation was built at an existing site with limited configuration options.

Site (C) was Chargefox’s most challenging site to design. Parallel bays allow for parking only in the direction of traffic flow, making charging difficult for EVs with a charging port on the right side of the car. Longer than standard bays were implemented to give more room to drivers, making it easier for them to get the cable to the port. A bay for disabled drivers could not be created at that site because it would have obstructed the path.

The overall lesson was that every site presents unique obstacles but also opportunities to overcome them. Chargefox’s strategy was to offer a combination of charging options where possible.

3.6.3. Safety

JOLT mentioned that safety regulations constituted operational constraints when designing for a site, specifically in accounting for kerb setbacks, side street sightlines, and applicable pedestrian clearances. JOLT learnt that engaging with relevant public safety stakeholders, including roading authorities, councils, and electricity networks, in parallel with their usual development approval process would help save time and resources.

3.6.4. Preventing ICEing

JOLT made multiple references to “ICEing,” the practice of using a charging bay to park an ICE vehicle (or other non-EV). JOLT resolved this problem with brightly-coloured parking bay markings, as shown in Figure 18, that discouraged ICEing at their sites. Bay marking provides multiple additional benefits, including improving user experience, company name visibility, safety, and enforcement of parking regulations.

Figure 17 – JOLT Charging Bay Markings



Source: JOLT, Metro Advertising Revenue Funded Electric Vehicle Charging Trial Lessons Learnt Report – Final July 2023, 2023, pg. 6

The ability to place a charger in a desired location will depend on the site itself, including what space is available and whether the site is an existing or a new installation. The variability in these design factors make ideal charger placement difficult to achieve in a way that would physically accommodate for every EV model and be convenient for every driver. Nonetheless, in order to serve the best interests of the customer as well as the CPO, site designs should strive to avoid as many incompatibilities as possible. Sites that are accessible and convenient will appeal to more prospective clients, thereby generating higher utilisation and revenue.

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