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Integrating solar energy into electric vehicle charging: User preferences in Western Australia

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Abstract

This study explores electric vehicle (EV) charging behaviour in Western Australia, where abundant sunlight enables integration of solar energy into routines. Drawing on survey and choice experiment data from over 230 users, findings show most charging is at home, with public charging being used as a midday supplement. Users prioritise reliability, affordability, and accessible locations with fast chargers and basic amenities. Solar ownership influences charging time preferences, favouring daytime use. A latent class model reveals two user segments: one price- and convenience-sensitive, the other more flexible. Results highlight the need for tailored infrastructure, pricing, and renewable integration to support sustainable EV uptake.

1 Introduction

The rapid growth in electric vehicle (EV) adoption is driving increasing demand for accessible, user-centred public charging infrastructure—particularly in regions like Western Australia (WA), where abundant sunlight enables many EV users to integrate solar energy into their charging routines. Car-oriented cities such as Perth, along with many Australian and U.S. cities, offer a distinct advantage for EV owners: the ability to charge at home, often within a secure lock-up garage (cf. Morrissey et al., 2016; Lee et al., 2020). Nevertheless, public charging remains a vital, though supplementary, service, especially for those without access to home charging. In this context, user preferences for charger location, service quality, amenities and reliability must be prioritised. Yet, as previous research has shown, reliability is not always guaranteed (Nicholas & Hall, 2018), highlighting a critical area for infrastructure improvement.

This paper investigates EV charging behaviours and preferences using a mixed-methods approach. Drawing on survey responses from over 230 EV users, we combine quantitative data with open-ended qualitative feedback. Informed by observed user behaviour at our institution's own charging bays and recent pricing interventions designed to shift charging demand away from the evening peak, we also implemented a stated choice experiment. This component was designed to quantify the trade-offs users make between price and time-of-day, while controlling for key variables such as charger accessibility and maximum allowed parking duration.

The paper is structured as follows: Section 2 presents a targeted literature review on EV charging preferences, with a particular focus on the role of renewables. Section 3 outlines the survey design and analytical methods. Section 4 describes the sample and summarises observed charging behaviours. Section 5 presents the results of the stated choice experiment, followed by a thematic analysis of qualitative responses in Section 6. The paper concludes in Section 7 with a summary of findings and implications for infrastructure and policy design.

2 Literature review

EV charging behaviour is influenced by a combination of user characteristics, vehicle attributes, and infrastructure features. A consistent finding across recent studies is that home charging dominates: approximately 70–90% of charging events occur at home or work, with the remainder at public locations (Figenbaum & Kolbenstvedt, 2016; Lee et al., 2020; Wolbertus et al., 2018a). Home charging is typically the most convenient and cost-effective option, allowing overnight replenishment at lower residential electricity rates (Funke et al., 2015). Access to a private charger at home significantly reduces reliance on public infrastructure and early EV adopters are often homeowners who can charge in their garage, whereas apartment dwellers without home charging must depend more on public stations (Hardman et al., 2018). This disparity underscores why most EV drivers preferentially charge at home and use public chargers primarily for long trips or when home charging is unavailable (Morrissey et al., 2016). Public charging tends to serve as a safety net to extend range, rather than a daily habit for the majority of owners (Tal et al., 2020). However, a robust public network remains critical for those without residential charging and to alleviate "range anxiety" by providing confidence that energy can be topped up away from home (Wolbertus et al., 2018b). Overall, the literature confirms that home charging plays a central role in EV routines, with public charging filling important but comparatively infrequent needs.

Charging behaviours are not uniform across all EV users; researchers have identified distinct user segments based on where, when, and how drivers prefer to charge. These segments differ in the value they place on charging attributes like cost, speed, and flexibility (Franke & Krems, 2013). Demographic and vehicle factors also drive segmentation. Battery-electric vehicle (BEV) owners, lacking a fuel backup, tend to rely more on home charging, whereas plug-in hybrid electric vehicle (PHEV) owners make greater use of workplace chargers, given their smaller batteries and fuel flexibility (Hardman et al., 2018). Drivers in single-family homes with garages predominantly charge at home, while those in high-density housing more often use public or shared facilities (Funke et al., 2019). Some survey evidence indicates female and older EV owners prefer home charging more than other groups, potentially due to safety and convenience considerations (Franke & Krems, 2013). Prior experiences with technology and risk tolerance further segment users—for instance, "indifferent late adopters" may be less proactive about charging planning (Lavieri & de Oliveira, 2023). A clear implication is that one-size-fits-all charging policies will be suboptimal; instead, tailored strategies should acknowledge the heterogeneity in charging styles and preferences among EV user groups.

In solar-rich regions, the presence of rooftop photovoltaics (PV) is emerging as an important influence on when EV owners charge. Recent Australian survey data show that a significant proportion of EV owners concentrate their charging during daytime hours, taking advantage of plentiful midday solar generation (Philip et al., 2023), to maximise self-consumption of renewable energy (Pellegrini et al., 2023). This behaviour contrasts with the classic pattern of overnight charging and reflects a conscious adaptation of routines to use solar power. In California, which has a high prevalence of rooftop solar, researchers have also observed a growing subset of drivers shifting charging to daytime at work or midday at home, to "soak up" excess solar energy (Nicholas & Hall, 2018). Charging an EV directly from solar can significantly reduce net grid demand and charging costs, providing a win-win for users and the electricity network (Aznavi et al., 2020). Solar-influenced charging tends to be most pronounced in months with abundant sunshine, and some utilities now offer midday "solar soak" electricity tariffs to incentivise EV charging when renewable generation is high (Nicholas & Hall, 2018).

Overall, international literature confirms that solar panel ownership strongly encourages daytime charging habits (often in addition to overnight charging), as EV users seek to capitalise on clean, low-cost energy. This trend is especially notable in sunny climates like southern Europe, California, and Australia, and it suggests that as solar adoption grows, EV charging profiles may shift away from exclusively nocturnal charging toward a dual-peak pattern (morning/evening and midday) tied to solar production.

As EV ownership expands, understanding drivers' preferences and pain points for public charging has become a focal area of research. Drivers tend to favour charging their vehicles at locations that align with their existing travel plans—such as shopping centres, workplaces, or highway rest areas—rather than making separate trips to charging stations that are not conveniently located (Daina et al., 2017). Research consistently shows that when public charging is less convenient than home charging, most users are unlikely to rely on it regularly (Visaria et al., 2022). This highlights convenience as a key determinant—ample parking, easy access, and proximity to one's route all increase the attractiveness of a public charger (Wolbertus & Van den Hoed, 2019). The price of public charging is a well-documented barrier. EV drivers are highly sensitive to electricity tariffs—many will only use public or workplace chargers if the cost per kWh is competitive (or lower) than home rates (Hardman et al., 2018). High public charging fees discourage regular use, whereas free workplace charging or subscription-based discounts can significantly boost public charging frequency (Bitencourt et al., 2023). Users subscribed to a public charging network were more likely to utilise those stations regularly, suggesting that membership perks (flat rates, network familiarity) can overcome some cost barriers (Visaria et al., 2022). Perhaps the most frequently cited barrier in qualitative surveys is unreliable equipment or insufficient availability of public chargers. Drivers report frustration with broken chargers, error-prone payment systems, and stations (Caperello et al., 2013). Even in technology-forward markets, public charging reliability has lagged—one recent audit in California found about 1 in 5 public chargers non-functional at any given time (Nicholas & Hall, 2018). This unreliability erodes user confidence and leads many EV owners to default to home charging whenever possible. Charging speed is another preference divide. For routine daily charging, many drivers are content with slower Level 2 charging at destinations, as it can be done while they work or shop (Speidel & Bräunl, 2014). However, for in-route travel or longer trips, fast charging capability is highly valued; surveys in Europe indicate that charging speed is among the most important characteristics of public stations for drivers, who are even willing to pay a premium for faster charging so long as they do not face long wait times (Wolbertus & Van den Hoed, 2019). In summary, the literature identifies multiple interlocking barriers affecting public charging usage: inadequate coverage in some regions, concerns over charger reliability, pricing and payment inconveniences, and the basic challenge of integrating charging into daily routines seamlessly.

In-depth qualitative studies and user surveys reinforce several cross-cutting themes relevant to EV charging behaviour, many of which align with the above findings. Physical and logistical accessibility of chargers is crucial. EV drivers emphasise the need for charging stations that are easy to find, with clear signage and unhindered access (no obstruction by other vehicles), as well as considerations for personal safety (well-lit, in safe locations) and even disability access (Pan et al., 2020). If a charger is technically available but hard to access or located in an inconvenient spot, it may go underutilised. Reliability concerns permeate user narratives—the expectation that a public charger "just works" every time is not yet met, leading to anxiety and contingency planning (Wolbertus & Van den Hoed, 2019).

Longitudinal studies of EV drivers have documented how early adopters developed charging strategies to cope with unreliable infrastructure, often by building in extra range buffers or double-checking charger status ahead of time (Chakraborty et al., 2019). Improving reliability (through maintenance, real-time status information, and redundancy of charging points) is frequently mentioned as a top priority to improve the EV experience. The theme of cost arises not only in quantitative studies but also in interviews—users commonly perceive public charging costs as high or unpredictable (Noel et al., 2020). The preference for home charging is partially because residential electricity is cheaper; conversely, some drivers voice reluctance to use fast chargers that charge a premium unless it is absolutely necessary. Transparent pricing and affordable tariff structures (such as off-peak discounts or memberships) can mitigate these concerns. But charging speed is a double-edged sword in user perceptions. Many appreciate the ultra-fast charge times of new DC stations, yet others note that beyond a certain point, speed yields diminishing returns if it comes at disproportionate cost or battery health impact (Dimanchev et al., 2023). Qualitative feedback

indicates that drivers categorise charging occasions, either for daily local use, when slower charging is satisfying, or for road trips, when they demand high-speed options (Hardman et al., 2018).

3 Survey and methods

In response to user feedback highlighting the difficulty of accessing charging bays at the University of Western Australia (UWA) after work hours, a peak-hour pricing policy was introduced in February 2024. Before the intervention, operational data showed that charging demand peaked between 4PM and 7PM, with usage levels reaching up to 70%, indicating significant congestion. Following the introduction of time-of-day pricing, a noticeable shift in demand occurred, with reduced usage during peak hours and a more even distribution of charging throughout the day. To better understand user preferences and the effectiveness of pricing as a demand management tool, we administered a stated choice survey to quantify trade-offs users make between price and time-of-day, while controlling for key factors such as station accessibility and permitted length of stay. Additionally, the survey collected information on vehicle ownership, current charging habits (both at home and using public stations), frequency of charging, typical locations, tariffs, time of day, and solar panel ownership. To capture a broader range of issues that may have been overlooked by the researchers, respondents were also invited to answer an open-ended question about their charging preferences and frustrations. This allowed for the identification of user-defined priorities and potential barriers.

3.1 Stated choice design

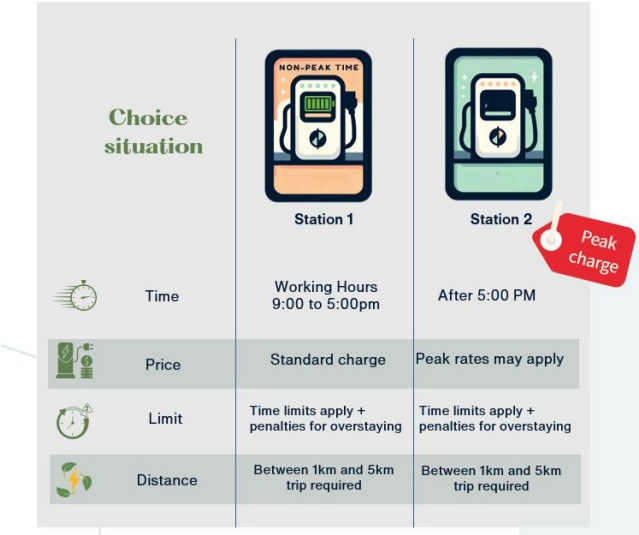
The charging scenario was developed to examine user preferences under varying conditions related to pricing, timing, time limits, and accessibility. As illustrated in the choice experiment (Figure 1), respondents were asked to choose between two hypothetical charging stations with differing characteristics.

The charging time was a key experimental condition. Two periods were tested:

- Station 1: Available during working hours (**10AM or 2PM**), representing a standard tariff (non-peak).
- Station 2: Available after work hours (**5PM or 7PM**), where peak rates may apply.

Price levels, ranging from **15c/KW to 60c/KW**, were presented across four tiers, with intentional overlap. The lowest peak rate was equal to the highest standard tariff. This allowed for some peak-time options to be perceived as cost-neutral relative to standard hours, helping isolate the influence of timing on preferences. Time limits for charging were either **30 minutes or 1 hour**, with penalties applied for overstaying beyond the allotted time. These limits reflect common operational constraints in high-demand charging environments. Finally, accessibility was represented as distance (**1 km or 5 km)** to reach the station.

Figure 1: Overview of choice scenarios



4 Sample description

An online survey deployed in Qualtrics elicited responses from 243 participants. Six observations were eliminated from respondents from states other than WA. The composition of the resulting 237 participants is shown in Table 1. As the sample is exclusively composed of EV owners, the ownership data reflects internal variations within this group rather than comparisons to the Western Australian population as obtained from the 2021 National Census (ref ABS 2022). However, key demographic characteristics of the sample can be compared to Census statistics to understand how EV owners differ from the general population.

Table 1: Sample characteristics and EV ownership

Demographic	No.	%	Demographic	No.	%
Gender			**Main Occupation**		
Male	191	81%	Employed full-time	152	64%
Female	46	19%	Self-employed	40	17%
Age Category			Retired	39	16%
Under 30	8	3%	Student/Not Working	6	3%
30-39	33	14%	**Highest Education**		
40-49	73	31%	High-school or Technical	50	21%
50-64	84	35%	Tertiary - Undergraduate	70	30%
65–74	26	11%	Tertiary - Postgraduate	116	49%
75+	13	5%	**Annual Household Income**		
			< $40,000	13	14%
			$40,000–$90,000	41	20%
			$90,000–$180,000	82	22%
			> $180,000	66	18%
			Prefer not to answer	35	9%

The sample is predominantly male (81%), a significant overrepresentation compared to the nearly equal gender distribution in Western Australia. Age-wise, most respondents are between 40–64 years (66%), compared to a state's median age of 38 years, indicating that middle-aged individuals are more likely to own EVs. Education levels are also markedly higher in the sample, with 49% holding postgraduate qualifications and a further 30% completing bachelor-level studies compared to a total of 23.6% of Western Australians with a bachelor's degree or higher. The demographic profile for these early adopters match other surveys for Western Australia (Evengi, 2023), Queensland (Mortimore et al., 2021) and more broadly Australia (Lavieri and de Oliveira, 2023).

4.1 Electric vehicle ownership

Most households have at least one other conventional ICE or hybrid vehicle (58%) in addition to their EV; 24% of households own a single EV exclusively, with fewer households owning multiple EVs (Figure 2a). As shown in Figure 2b,Tesla is the most common make, accounting for 49% of primary EVs, followed by BYD (16%) and Hyundai (9%). Notably, nearly half of the EVs (49%) were manufactured in 2023 (Figure 2c), reflecting a strong surge in recent EV adoption within this group, with the number of EVs in WA increased by over 500% since the beginning of 2022 (DOT, 2024).

Figure 2: Sample EV ownership

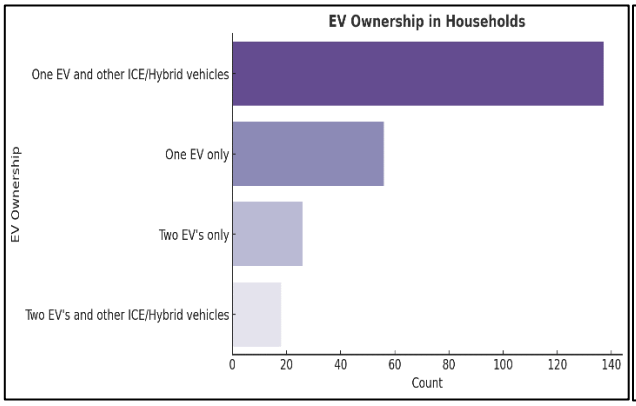


Figure 2a

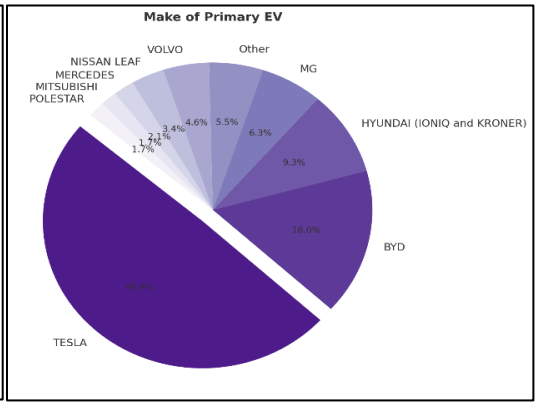


Figure 2b

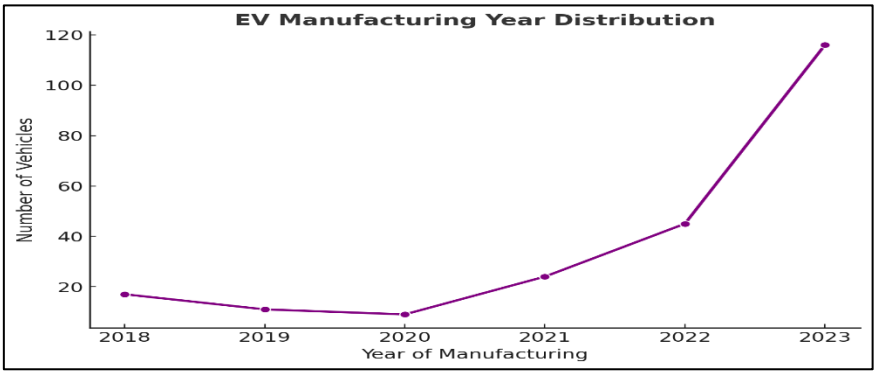


Figure 2c

Figure 2a (top left) Vehicle ownership; Figure 2b (top right) Manufacturer of primary EV; Figure 2c (bottom) Year of manufacture

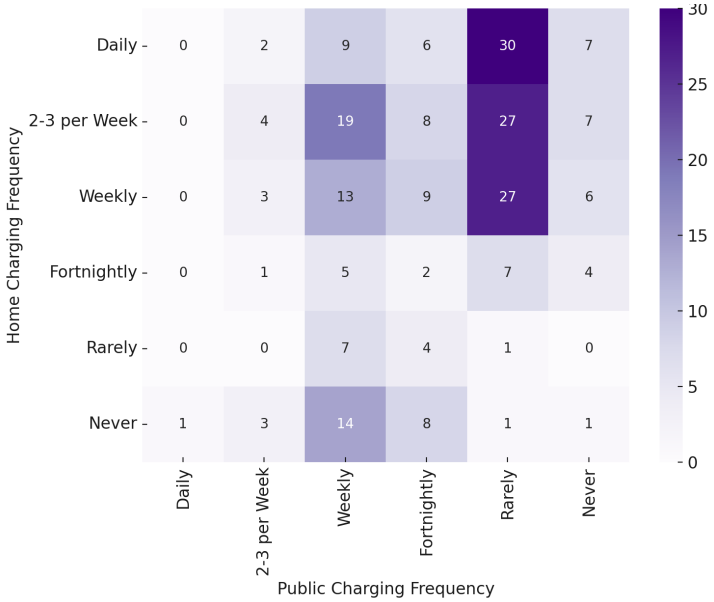
4.2 Electric vehicle charging

Charging at home is more common and frequent, with home charging being undertaken in a garage (55.7%), providing security and access to convenient charging infrastructure. Carports (16.0%) and driveways (8.0%) are also common, indicating that many EV owners make use of private spaces. Of those who do not charge at home, most reported not having the facility

and two-thirds of these respondents charge at a public station at least once a week. Only three respondents chose to charge at public stations, two of whom preferred using fast charging facilities, and the third having access to an EV charger at work.

Figure 3 presents the frequency of home and public charging among respondents. The most common charging pattern (48%) involves charging at home at least fortnightly, while using public charging stations only occasionally, typically when travelling long distances. The second group (34%) also charges at home at least fortnightly but makes more regular use of public chargers. In many cases, this is due to convenient access to charging stations at or near their workplace, or because they combine charging with other activities such as shopping or leisure. Notably, many in this group have access to low-cost public charging. The final group (16%) charges rarely at home. This group is largely made up of respondents who either lack access to home charging facilities or rely on workplace or other convenient public chargers for their needs. There is one individual who claimed to have never charged their vehicle, we are unsure as to how this may be but have kept the data point.

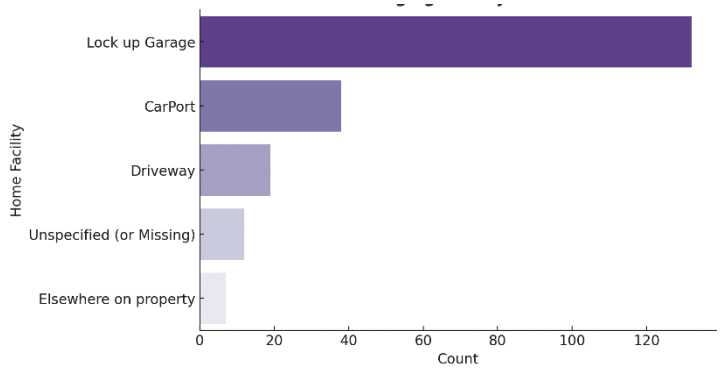
Figure 3: Home vs public charging frequency



4.2.1 Home charging

Perth, like many other Australian and American cities, is characterised by a high degree of suburban development and a strong reliance on private vehicles. This urban form has influenced the way residents accommodate electric vehicle (EV) charging at home. As shown in Figure 4, approximately 50% of respondents charge their vehicle in a private lock-up garage. Overall, among those who reported charging at home, 95% were able to do so on their property in a designated parking space, either a garage, carport, or a driveway; which is consistent with national studies (Lavieri, P. S., & de Oliveira,2023) and Western Australian data (Evenergi, 2021).

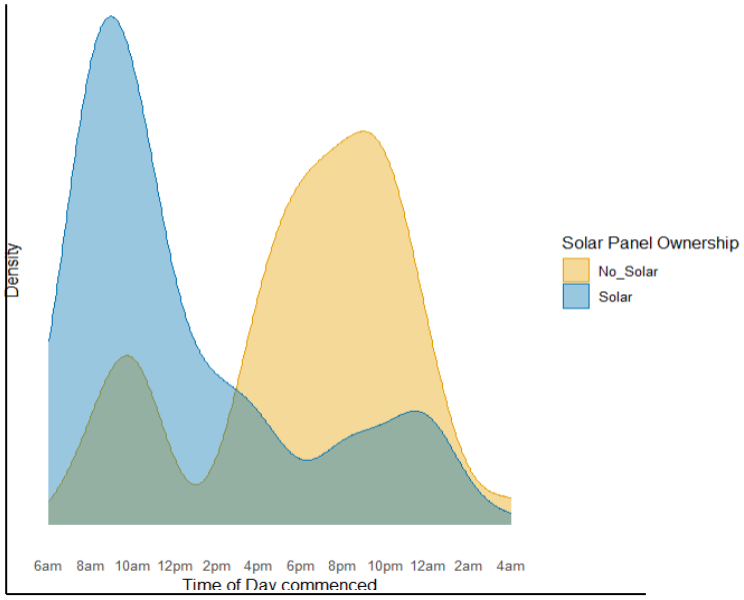
Figure 4: Home Charging locations



Most respondents (68.8%) reported owning solar panels, highlighting the strong uptake of household renewable energy in WA. In contrast, only 17.7% reported having home battery storage, suggesting that while solar generation is widespread, storage technologies are yet to reach similar levels of adoption, aligning with previous studies (Evenergi, 2021).

Figure 5 illustrates EV charging start times, segmented by solar panel ownership. Households with solar panels tend to charge during daylight hours (between approximately 8AM and 6PM), aligning with the availability of solar energy generation. WA's low feed-in tariffs for exporting excess solar power to the grid create an economic incentive for solar panel owners to maximise self-consumption of their generated electricity, reinforcing the observed daytime charging preference. However, not all solar panel owners can charge exclusively during the day, suggesting work or other constraints. Households without solar appear to be less conscious of tariffs, with about two-thirds of households reporting charging during peak times (3PM - 9PM) or standard rate daytime period (6AM-3PM). Approximately one-third charge during off-peak hours (9PM - 6AM).

Figure 5: EV charging start times by solar panel ownership

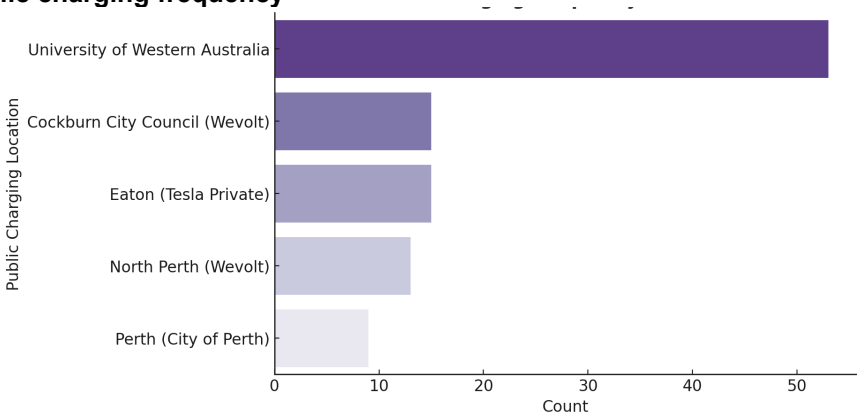


4.2.2 Public charging

The frequently used public charging sites reveal that four of the top five are operated or sponsored by research institutions or local government bodies (Figure 6). These facilities are typically established to encourage EV adoption or enhance the organisation's sustainability credentials. In contrast, only one commercial site—located in Eaton, just outside Bunbury—was reported as frequently used by respondents. This site's popularity is largely attributed to

its location on a key travel corridor between Perth and popular holiday destinations of Margaret River and Dunsborough.

Figure 6: Public charging frequency



The importance of publicly supported infrastructure is further underscored by reported charging costs. Nearly one-third of respondents (30.4%) indicated they paid nothing to charge their vehicles at public stations and a small fraction (7.2%) reported paying commercial rates above 65 cents per kilowatt-hour (kWh). The majority benefited from subsidised or discounted pricing, with 11.0% paying 25 cents or less per kWh and approximately 30.8% paying between 26 and 65 cents per kWh.

Most EV users in the sample charge for less than an hour when using public charging stations (60.3%), with 27.4% charging under 30 minutes. Fewer users charge for one to two hours (13.5%) or two to four hours (13.9%), while only 1.7% report charging for more than four hours. These findings indicate a strong preference for short-stay public charging, likely reflecting the convenience of fast chargers and the use of public infrastructure for quick top-ups rather than long-duration charging.

5 Charging station preference model

A Latent Class Model (LCM) was employed to uncover underlying preference heterogeneity among electric vehicle users about public charging scenarios. The analysis revealed two distinct respondent segments with significantly different charging preferences. The results are in Table 2.

Class 1, which comprised the majority of the sample, exhibited a clear tendency to trade-off price with accessibility and longer time limits. Members of this class preferred lower tariffs, even if it required a longer diversion (up to 5 km) or extended charging duration. Importantly, membership in this group was negatively and significantly associated with full-time employment (FTEMP), suggesting that respondents without full-time work commitments were more cost-sensitive and more flexible for time and travel distance. This dominant class likely reflects the homogeneity of our sample—primarily high-income households living in detached dwellings, with a preference for home solar charging via private garages. However, this aligns with the profile of early adopters, and as the market matures, we may see greater uptake among younger apartment residents whose limited access to home charging and workplace flexibility will shape different public charging demands.

In contrast, Class 2 consisted of respondents in full-time employment, and their preferences were notably different, with a strong sensitivity to the time-of-day for charging. Specifically, during off-peak periods, full-time workers showed a preference for earlier charging times (10AM over 2PM), likely aligning with commuting schedules. Similarly, during peak periods, they preferred a later evening time slot (7PM over 5PM), reflecting availability after work hours. Interestingly, full-time employees in this class were less sensitive to price and largely disregarded time limits and station accessibility when making their choices. This indicates a prioritisation of schedule compatibility over economic or convenience factors.

Table 2 Latent class estimation model

Variable	Coefficient	t-stat	p-value
Class 1			
Tariff	-0.101	9.02	0.000
Accessibility	-0.221	8.23	0.000
Time Limit and Penalties	0.878	4.16	0.000
Off-Peak afternoon (2pm)	-0.079	0.19	0.848
Peak Evening (7pm)	0.336	0.83	0.405
Age of respondent (off-peak)	0.016	2.40	0.016
Solar Panels (off-peak)	-0.243	1.18	0.240
Class 2			
Tariff	-0.058	1.96	0.050
Accessibility	-0.050	0.74	0.462
Time Limit and Penalties	0.102	0.21	0.835
Off-Peak afternoon (2pm)	-2.500	1.97	0.049
Peak Evening (7pm)	2.457	1.79	0.074
Age of respondent (off-peak)	0.007	0.34	0.733
Solar Panels (off-peak)	0.430	0.69	0.490
Class Probability Parameters			
Constant	2.643	6.11	0.000
Full time employment	-1.700	3.48	0.001
Statistic	**Value**		
Log-likelihood (final)	-590.3		
Restricted log-likelihood	-881.7		
McFadden Pseudo R-squared	0.330		
Class probabilities (avg.)	0.830 (class 1)	0.170 (class 2)	
Panel groups	237		

6 Text responses to an open-ended question

To complement the structured elements of the charging experiment, we included an open-ended question designed to capture broader user experiences, frustrations, and preferences, particularly those not addressed directly in the experimental design.

Participants were reminded that the primary focus of the study was to explore whether peak pricing or off-peak discounting could be used to help manage charging demand. They were also informed of the growing importance of public charging infrastructure as EV adoption increases. However, to ensure that other relevant issues could be surfaced, respondents were explicitly invited to share what truly matters to them. The prompt read as follows:

> *"To this point, you will be aware that we are looking at whether peak pricing (or off-peak discounting) can help smooth demand. Public stations will be increasingly important as the share of EV grows. We have inquired on a specific aspect, but this may not be the most important consideration for you. Your experiences, opinions and suggestions will inform both government policy and commercial decisions on the way the charging network will develop. Please tell us what matters to you."*

This approach allowed us to identify user-led priorities and uncover practical concerns not captured in the quantitative choice tasks, thereby enriching our understanding of charging behaviour and informing more responsive infrastructure planning.

6.1 Response rate and word frequency

The open-ended question received a strong engagement rate, with 65% of respondents providing a written response. In total, the responses comprised 7,650 words, averaging 50 words per respondent. This word count suggests that many participants offered thoughtful and multi-faceted reflections, often addressing more than one aspect of their charging experience.

The distribution of response lengths shows that while some entries were brief, a substantial number exceeded 100 words, indicating a high level of engagement and willingness to contribute to shaping future charging infrastructure and policy. These responses offer rich qualitative insights into user needs, helping to identify pain points and expectations that go beyond the structured experimental design.

To visually represent the key themes emerging from the open-ended responses, a word cloud was generated based on word frequency (Figure 7). Unsurprisingly, the term **"home"** dominated, underscoring the fact that most respondents primarily charge their EVs at home. "Public" was also prominent, however, in many cases this was raised as the distinction between their preference for "*home charging over public stations…"* or as a lead in to raise other themes such as reliability and convenience. This aligns with quantitative findings indicating a high prevalence of home-based charging, often supplemented by occasional top-up charges during longer trips.

Excluding the high-frequency terms "home" and "public," several recurring themes emerge:

- **Price**: cost of charging remains a key concern, particularly in public contexts.
- **Time**: includes concerns over time-of-day pricing, duration limits, and having time resources to access and wait for charging.
- **Work**: reflects both employment-related charging constraints and workplace charging preferences.
- **Solar**: Suggests interest in renewable energy sources and self-sufficiency in home charging setups.

These terms reveal that respondents are thinking not just about access to charging, but also about affordability, scheduling convenience, and sustainable energy use, offering useful guidance for policy and infrastructure development.

Figure 7: Word cloud

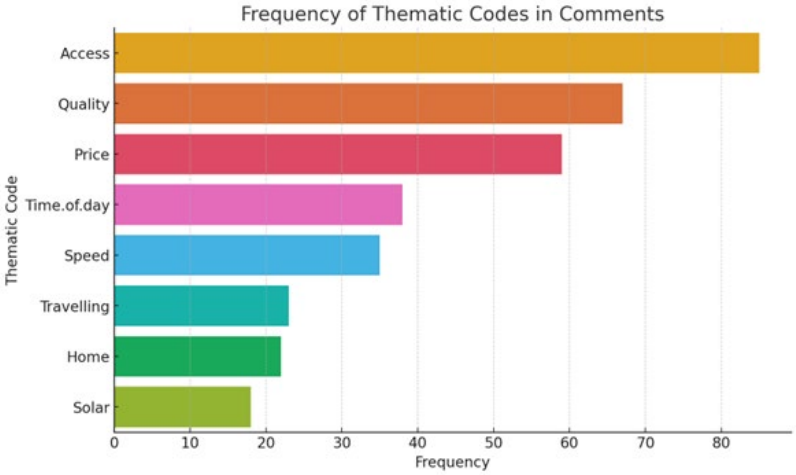
6.2 Thematic findings

To systematically analyse the open-ended text responses, we applied a thematic coding method. The aim was to identify recurring issues, preferences, and concerns raised by participants beyond those addressed in the structured survey components. The process began with three researchers independently coding a common sample of responses. This subset was drawn from responses containing more than 20 words to ensure sufficient context for interpretation. Following independent theme generation, the researchers convened to compare findings and establish a consensus on eight key themes that appeared consistently across the data.

Once the thematic framework was finalised, the remaining responses were divided among the researchers, with each coding approximately one-third of the dataset independently.

The frequency of thematic codes, indicating how often each theme was referenced across responses, is summarised in Figure 8. The most prevalent concern was access, followed closely by charging quality and price. Issues related to time-of-day availability, charging speed, and distance travelled also appeared prominently. Although home charging and solar energy use were less frequently mentioned, they nonetheless formed part of the broader narrative around convenience and sustainability.

Figure 8: Frequency thematic codes



6.2.1 Accessibility, Quality and Reliability

While *accessibility* emerged as the dominant theme in participant responses, it was rarely mentioned in isolation. Instead, access was commonly framed in relation to charger reliability and station quality—a reflection of the real-world frustrations users face when infrastructure fails to meet expectations. Several respondents highlighted that having a charger nearby is meaningless if it cannot be depended upon:

> *"From my own experience, roughly 1 in 5 events, the charger is not available (either broken or network down)."*

This sentiment was echoed by others who emphasised that the predictability and functionality of the system are paramount, especially for users with limited flexibility or charging options:

> *"I just want reliable chargers that are accessible when I need them. Because charging away from home or work is a rare occurrence, price is just not important."*

While the spatial availability of chargers was acknowledged, many respondents viewed queuing and downtime as greater barriers than distance. For some, the call was simply for more chargers to reduce wait times:

> *"More stations – no waiting or little time – less than 5 mins."*

Beyond speed and access, some users expressed expectations for a holistic service experience, including amenities that support longer stops:

> *"Access to reliable fast DC charging where and when I need it, with low risk of queueing, and convenient access to refreshment and particularly toilets."*

These comments illustrate that for many users, access and quality are inseparable. Convenience is defined not only by the presence of a charger but also by its functionality, reliability, and the user experience surrounding it. The emphasis placed on these attributes suggests that infrastructure investment should go beyond quantity, focusing equally on charger uptime, service speed, and amenity integration to meet evolving expectations.

6.2.2 Price and charging speed

Although price was a commonly referenced theme across open-ended responses, it was frequently positioned as a secondary concern, particularly when compared to charging speed. For many participants, especially those using public infrastructure while travelling longer distances, the overriding priority was minimising time spent at the charger.

> *"When travelling, top consideration is the charging power or duration of the charge. Less than 1/2 hour is ideal."*

This view was echoed by others who indicated a willingness to accept higher tariffs if it ensured a faster, more efficient charging experience. While affordable pricing remains important, particularly for routine or local charging, the data suggest that ultrafast DC charging at key travel corridors is highly valued, even if it comes at a premium. These findings imply that pricing strategies must account for contextual use cases, balancing affordability for regular users with value-added services for time-sensitive travellers.

6.2.3 Home, solar and time of day

Among the thematic responses, renewable energy use (i.e., solar) stood out as a distinct and meaningful topic. Many respondents who owned solar panels expressed a clear preference for charging during daylight hours, aligning EV charging with peak photovoltaic (PV) production to reduce household energy costs and environmental impact:

> *"Encourage EV charging during peak PV solar production to use excess production that power utilities are starting to complain about. This may mean workplace and public parking that enables charging during these hours for increasing number of EVs."*

Another noted how home-based charging, especially during remote work, could be better integrated into a sustainable routine if employers supported more flexible work arrangements:

> *"Potentially using EV for charging during peak solar production at home (on days when working from home), may help, but more flexibility from workplaces (work from home) and more EVs with V2G capability will be required."*

This preference for daytime home charging supports earlier quantitative findings that solar-owning respondents strongly favoured charging during daylight hours, suggesting a clear behavioural and economic logic. However, not all users had access to home charging or flexible hours. In these cases, convenience and speed became dominant. For those with tight schedules, the ability to charge efficiently after work was a greater concern than pricing or sustainability:

> *"Since I work a regular 9-to-5 job, I only have a particular window of time to charge the car—usually right after work or after dinner. Convenience is more important than price."*

In tying these insights together, the analysis points to a highly contextual approach to EV charging preferences:

- At home or work: convenience and cost-saving, especially via solar panels, are key.
- While travelling or without home charging, speed and charger reliability dominate.

This underscores the need for differentiated infrastructure strategies—enabling solar-aligned home charging for some, and fast, reliable public charging for others.

7 Conclusion

Our results align with existing literature on EV charging behaviour, reaffirming the centrality of home-based charging and, despite the lower demand, EV owners consider the quality and price attributes of public infrastructure. Like earlier studies (Figenbaum & Kolbenstvedt, 2016; Funke et al., 2015), we found that most respondents primarily charge at home, taking advantage of lower costs, convenience and control over. The thematic analysis reinforced this: "home" was the most dominant concept in open-ended responses, and nearly all participants who had home charging access preferred it.

Consistent with work by Hardman et al. (2018) and Morrissey et al. (2016), our findings also highlight that public charging is generally seen as supplementary, used mostly when travelling. Respondents expressed strong preferences for public chargers that are fast, reliable, and easily accessible, echoing widespread concerns in the literature about the unreliability and inconvenience of many public stations (Caperello et al., 2013; Wolbertus & Van den Hoed, 2019). One in five of our respondents directly reported a negative charging experience due to broken or offline infrastructure, a rate matching other audits (Nicholas & Hall, 2018).

Importantly, our latent class model further supports the segmentation of EV users found in the literature (Franke & Krems, 2013). We identified one class of users, mostly not in full-time work, who were price- and access-sensitive, willing to make trade-offs for lower tariffs and more flexible time limits. Conversely, full-time employed respondents were more time-sensitive, preferring charging windows that aligned with their daily routines, and showed little concern for price or distance. This confirms prior evidence that user characteristics (e.g., employment status, housing type) significantly shape charging preferences and behaviour.

The influence of rooftop solar ownership also emerged as a key factor in charging behaviour, consistent with recent studies in Australia and California (Philip et al., 2023; Nicholas & Hall, 2018). Many solar-owning respondents deliberately timed charging during the day to maximise self-consumption and reduce costs. This behaviour reflects a growing shift toward daytime charging routines, especially in solar-rich contexts like Australia, as highlighted in Pellegrini et al. (2023). Notably, these choices were not purely environmental: for many, the motivation was economic, i.e. lower cost and higher energy independence.

Finally, our qualitative data helped surface user expectations and frustrations that go beyond standard choice attributes. Access was not just about the physical presence of a charger, but about reliable, predictable access with minimal waiting—a concern deeply intertwined with perceptions of infrastructure quality. Many respondents framed quality as encompassing both hardware reliability and amenities at the stations (e.g., bathrooms, lighting), further supporting recommendations in Pan et al. (2020) and Chakraborty et al. (2019) for improving the overall user experience.

Our findings illustrate how user type, location, and energy context (e.g., solar availability) shape charging routines and priorities. Crucially, they suggest that policy and infrastructure strategies must be tailored to this diversity, supporting home and workplace charging for those with access, while ensuring that public charging is fast, reliable, and integrated into existing travel patterns for everyone else.

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