Investigating the effects of energy export options and policies on consumers' electric vehicle preferences in a low-uptake country

Thara Philip [a,*], Jake Whitehead [b], Carlo Prato [a,c], Andrea La Nauze [d,e]

[a] School of Civil Engineering, The University of Queensland, Brisbane, QLD 4072, Australia
[b] Institute of Transport and Logistics Studies, The University of Sydney, Darlington, NSW 2006, Australia
[c] School of Civil Engineering, University of Leeds, Leeds LS2 9JT, United Kingdom
[d] Deakin Business School, Deakin University, Burwood, VIC 3125 Australia
[e] School of Economics, The University of Queensland, Brisbane, QLD 4072, Australia

A R T I C L E I N F O

JEL codes:
Q49
R49

Keywords:
V2G
V2H
Battery electric vehicle
Consumer preferences
Road user charge
Willingness-to-pay
Australia

A B S T R A C T

Electric vehicles (EVs) are pivotal for decarbonising the transport sector, yet adoption rates in many countries fall short of what is needed to meet climate targets. Existing research on consumer preferences for EVs predominantly examines high-adoption regions, focusing on established EV attributes and policies. However, as EV technologies evolve and the policy landscape shifts, understanding their impact on shaping consumer preferences in low-adoption markets is critical. This study investigates the influence of advanced energy export capabilities – Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H) – and emerging policies on consumers' EV preferences in a low-adoption market. We use stated preference data collected from a nationally representative sample in Australia. Notably, this is also the first study to quantify the impact of EV-specific road user charges on consumer preferences. The findings reveal that V2G and V2H capabilities significantly enhance consumer appeal, increasing willingness to pay by up to AUD 8991. This is comparable to the willingness to pay increase of AUD 10,006 associated with a purchase subsidy of AUD 5000. Moreover, favourable monetary incentives deliver greater perceived value to consumers. Conversely, non-favourable policies, such as EV-exclusive road user charges, diminish consumer interest, with a 1 cent per km charge reducing willingness to pay by AUD 5415. These findings underscore the transformative potential of EV energy export features to drive adoption, comparable to the effect of financial incentives, while highlighting the necessity of balanced, consumer-focused policy frameworks to accelerate EV adoption in low-adoption markets.

1. Introduction

Road transport accounts for over 15 percent of global energy-related emissions, making its decarbonisation critical to achieving net-zero climate targets. Electric vehicles (EV) are widely recognised as the key technology to achieve this transition, with the International Energy Agency estimating that 60 percent of global new cars sales must be EVs by 2030 (International Energy Agency). However, as of 2023, EVs comprised only 18 percent of global car sales, with 95 percent of these sales concentrated in China, Europe, and the United States (International Energy Agency, 2022c,2024). This disparity underscores the urgent need for targeted strategies to accelerate EV adoption, particularly in low-adoption and emerging markets.

* Corresponding author.
E-mail addresses: t.philip@uq.edu.au (T. Philip), c.prato@leeds.ac.uk (C. Prato), a.lanauze@deakin.edu.au (A.L. Nauze).

Recent advancements in EV energy export technologies, such as vehicle-to-grid (V2G) and vehicle-to-home (V2H), have further expanded the role of EVs beyond transport, integrating vehicles into the energy ecosystem. V2G enables EVs to absorb surplus energy during periods of high renewable generation and export it back to the grid during peak demand or low renewable energy generation periods, enhancing grid stability and potentially reducing energy costs for consumers (Sturmberg et al., 2024; Xu et al., 2023). V2H extends these benefits by allowing EVs to power homes during emergencies, improving consumers' energy resilience. These features are anticipated to significantly boost the appeal of EVs to consumers, particularly in regions with growing renewable energy capacity. Despite their transformative potential, the influence of V2G and V2H on consumer preferences remains underexplored.

Existing research on EV adoption has predominantly focussed on traditional attributes such as price, driving range, charging infrastructure, and policies, with most studies centred on high-adoption markets, US or China (Biresselioglu et al., 2018; Kumar & Alok, 2020; Liao et al., 2017). Only three extant studies – Parsons et al. (2014), Noel et al. (2019) and Philip et al. (2023) have explored the role of energy export capabilities in shaping consumers' EV preferences. Parsons et al. (2014) made an important early contribution by empirically examining whether V2G functionality could enhance consumer interest in EVs. Using a nationally representative sample of U.S. drivers, their study employed a two-part experimental design to isolate willingness to accept contractual terms associated with V2G participation – focusing on V2G as a grid service requiring engagement through formal agreements. This design enabled the authors to estimate the compensation consumers would require to offset the disutility of participating in such schemes. While the methodological innovation of the study remains notable, the data underpinning the analysis were collected in 2009 – well before the technological maturation of bidirectional charging systems and shifts in consumer familiarity with distributed energy systems. As such, its empirical insights, though foundational, are increasingly constrained in their relevance to present-day EV adoption dynamics and policy contexts. Noel et al. (2019) investigated the effect of V2G on shaping consumers' EV preferences and reported mixed results. The data for this study was collected in 2016–17 using a representative sample of the Nordic population. The historically high EV adoption rates in Nordic countries limit the generalisability of findings to majority of other global markets. Philip et al. (2023) explored effect of both V2G and V2H in Australia, a low-adoption market, and found stronger consumer preference for EVs with V2H. However, this study relied on region-specific data collected during COVID pandemic lockdowns, a unique context that may not fully reflect broader consumer behaviours. While these studies offer valuable initial insights, their limitations in sampling, scope, and timeliness highlight the need for more rigorous and current analyses that is generalisable.

The global policy landscape for EVs is rapidly evolving, further accentuating the need for updated research. Governments worldwide are intensifying efforts to electrify transport and meet net-zero targets, employing financial incentives as a key mechanism to accelerate EV adoption. Simultaneously, policies such as road user charges (RUCs) are being introduced to address declining fuel tax revenues as the vehicle fleet is progressively electrified (Secretariat of the Parliament, 2023; State of California, 2024). While these measures aim to establish a sustainable revenue model, they risk being perceived as punitive, particularly when applied exclusively to low-emission vehicles in low-adoption markets. For example, many low-adoption regions such as New Zealand and various states in Australia have recently introduced or are considering near-term introduction of road user charges (Ministry of Transport; NSW Government; VicRoads), which could potentially stall adoption in these low-uptake markets. Despite the critical interplay that could exist between incentives and disincentives, no existing study has comprehensively examined the impact of road user charges on EV adoption or their potential to counteract supportive policies. As the global policy landscape continues to evolve, timely and contextually relevant insights into how consumer preferences are shaped by both favourable and unfavourable policies will be essential for developing strategies that balance adoption acceleration with the need for sustainable revenue models.

1.1. Research objectives and significance

This study provides a comprehensive analysis of the factors influencing EV adoption in low-adoption markets, with a particular emphasis on the role of energy export capabilities. It builds upon and significantly extends the contributions of Noel et al. (2019) and Philip et al. (2023) by addressing their contextual, temporal, and methodological limitations while broadening the scope of study.

This study is guided by four key research questions:

1. How do energy export capabilities such as V2G and V2H influence consumer preferences for EVs?
2. How do financial incentives influence consumer adoption of EVs?
3. How do disincentives, such as road user charges, influence EV adoption decisions?
4. What are consumers' preferences for other critical EV attributes, such as driving range and fast charging time?

To address these questions, this research uses stated preference data collected from a nationally representative sample of Australia, a country historically characterised by low EV adoption. This approach ensures the generalisability of findings to other low-adoption markets. The dataset is also larger and more recent than those used in the extant limited literature.

This study further contributes to the literature by evaluating the effects of currently relevant policy interventions, including financial incentives such as purchase subsidies, tax exemptions and disincentives such as road user charges. By enabling direct comparisons between the effectiveness of energy export options and policy interventions – both incentives and disincentives – it provides a holistic understanding of the dynamics shaping EV adoption. Importantly, this is the first study to incorporate the impact of road user charges into its analysis, providing a unique perspective on how such measures influence consumer behaviour in low-adoption markets.

The study's contextual relevance and timeliness are particularly significant. Australia, where EV sales have grown from 2.05 percent in 2021 to 9.5 percent in 2024, still falls well below the global average of 14 percent (International Energy Agency, 2024) and lags the 50 percent EV sales target required by 2030 to meet national decarbonisation goals (ClimateWorks Australia, 2020; Climateworks CENTRE, 2022; Electric Vehicle Council, 2023). The country's recent approval of V2G standards, coupled with its world-leading adoption of rooftop solar – with over 30 percent homes having one installed and contributing over 10 percent of the nation's electricity – uniquely positions it to better harness renewable energy through EVs (Australian Government, 2024; STANDARDS Australia, 2024). The Australian Energy Market Operator estimates that integrating rooftop solar and EVs via V2G could deliver substantial grid support and avoid billions in infrastructure investments, reducing energy costs (Australian Energy Market Operator, 2024). This underscores the transformative potential of V2G technology, and the lessons would be applicable to other low-adoption markets with abundant renewable energy resources such as United States, India and Japan.

Thus, this study makes a timely and impactful contribution to the EV adoption literature by integrating advanced EV features, financial incentives, disincentives, and other key attributes into a comprehensive framework. These critical insights into how consumer preferences are shaped by contemporary policies and technological advancements would equip policymakers and stakeholders with evidence-based strategies to accelerate EV uptake, optimise grid integration, and advance decarbonisation efforts across transport and energy sectors in many countries.

The rest of this paper is structured as follows: Section 2 outlines the materials and methods used in the empirical analysis. Section 3 presents the results, followed by a discussion of findings in Section 4. Section 5 concludes with key insights, policy implications, and suggestions for future research.

2. Materials & methods

2.1. Experimental design and data

This study employed a discrete choice experiment (DCE) to investigate consumer preferences towards energy export options, policies and EV attributes. While data for a discrete choice experiment could be collected via stated preferences or revealed preferences, this study makes use of stated preference data due to low EV adoption rates, and V2G and other energy export options being a hypothetical technology for majority of Australians and others globally. Using stated preference data also allowed for incorporation of other hypothetical attributes and attribute levels and prevention of potential early adopter bias from using revealed preferences data in a low EV uptake context.

The stated preference survey was designed using the Conjoint.ly platform as a fractional factorial choice experiment. The survey was designed to be as concise as possible to minimise participant fatigue. The survey was conducted in four parts and the median completion time was 10 min. In the first part, participants were informed of the research program, survey and provided their consent to participate. The second part consisted of a set of questions, mainly multiple-choice questions, aimed to collect their travel and car usage patterns and existing knowledge on EVs. The primary intention of including these questions, prior to the experiment, was to

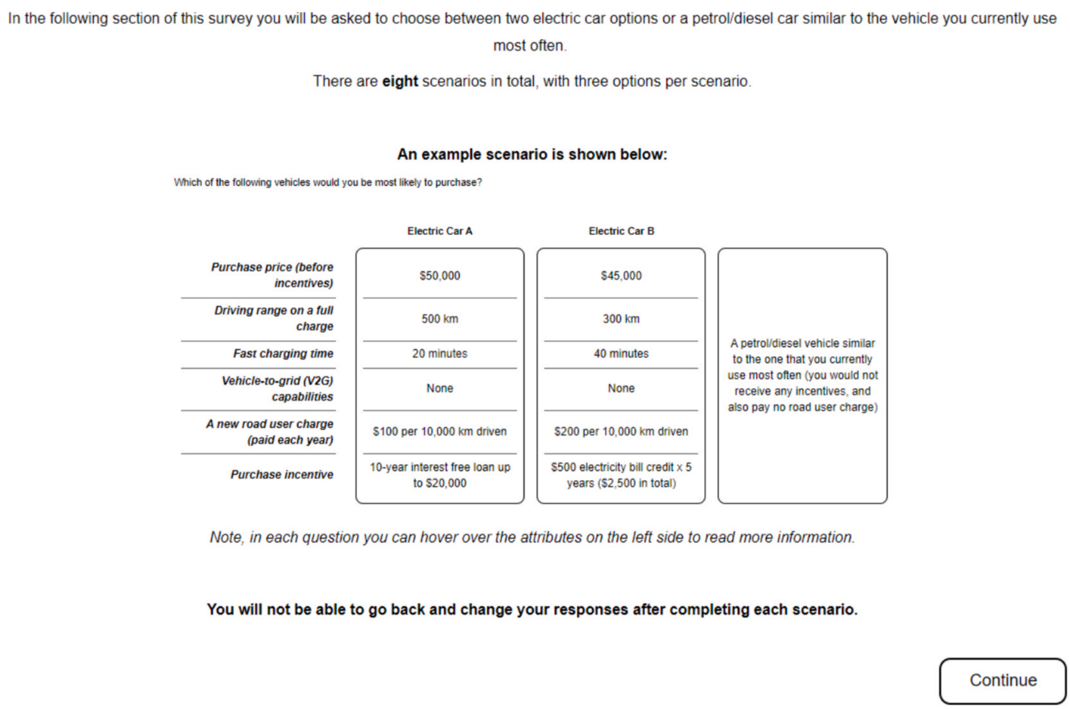

Fig. 1. Sample choice experiment.

encourage participants to think through their current travel needs, and as a result, choose the most appropriate alternatives presented to them in the subsequent choice tasks. This was followed by a short informative video shown to participants to educate them about EVs. This video provided a basic overview of EVs and their ability to export energy to external systems such as homes or the grid – technologies that many participants may not have previously encountered or used. While the video intentionally avoided technical complexity to maintain accessibility, it did include core concepts such as the potential for electricity cost savings and the concept of EV battery charging and discharging. This framing was designed to ensure that respondents were sufficiently informed to evaluate energy export features when presented within the choice tasks, without overwhelming them with unfamiliar detail. The third section consisted of the choice experiments. To make participants familiar with what was expected before proceeding to the experiment, they were first provided with an example choice task. In the choice experiment, participants were presented with eight choice tasks. In each choice task, participants were presented with three options: two EV alternatives with varying attributes and a third option representing an internal combustion engine vehicle (ICEV) similar to the one they used most often. The ICEV option effectively served as the opt-out choice from selecting an EV. By offering participants the opportunity to choose from between the hypothetical EVs and an ICEV, we aimed to encourage more deliberate decision-making, potentially enhancing the quality of their choices within each task. An example choice task is shown in Fig. 1 below. The fourth and final part of the survey consisted of questions to capture more demographic information such as type of house, ownership, rooftop solar and home battery availability, number of children, household income etc.

Table 1
Demographic statistics of survey participants.

Variable	Survey sample	Australian general population
Age (adjusted to exclude below 18 years)		
18–24	5.22 %	11.01 %
25–34	18.33 %	18.40 %
35–44	20.00 %	17.77 %
45–54	16.55 %	16.13 %
55–64	13.30 %	14.85 %
65 or more	26.60 %	21.84 %
Gender		
Female	51 %	50.70 %
Male	49 %	49.30 %
Non-binary	–	–
Prefer not to say	–	–
Location		
Australian Capital Territory	1.58 %	1.68 %
Northern Territory-City	0.30 %	0.57 %
Northern Territory-Regional	0.20 %	0.38 %
Tasmania-City	1.18 %	0.85 %
Tasmania-Regional	1.58 %	1.26 %
Western Australia-City	7.39 %	8.16 %
Western Australia-Regional	1.38 %	2.21 %
South Australia-City	6.80 %	5.08 %
South Australia-Regional	1.77 %	1.81 %
Queensland-City	14.29 %	13.03 %
Queensland-Regional	7.39 %	7.12 %
Victoria-City	19.61 %	20.36 %
Victoria-Regional	7.39 %	5.71 %
New South Wales-City	20.30 %	24.04 %
New South Wales-Regional	8.87 %	7.75 %
Household weekly income before tax		
A$ 0	0.71 %	0.65 %
A$ 1–199 (A$ 1–10399 annually)	0.82 %	1.82 %
A$ 200–299 (A$ 10,400–15,599 annually)	1.83 %	0.79 %
A$ 300–399 (A$ 15,600–20,799 annually)	2.85 %	1.41 %
A$ 400–599 (A$ 20,800–31,199 annually)	8.36 %	9.48 %
A$ 600–799 (A$ 31,200–41,599 annually)	8.97 %	6.15 %
A$ 800–999 (A$ 41,600–51,999 annually)	9.89 %	7.07 %
A$ 1000–1249 (A$ 52,000–64,999 annually)	8.87 %	9.86 %
A$ 1250–1499 (A$ 65,000–77,999 annually)	8.56 %	5.04 %
A$ 1500–1999 (A$ 78,000–103,999 annually)	14.48 %	12.95 %
A$ 2000–2499 (A$ 104,000–129,999 annually)	7.54 %	12.46 %
A$ 2500–2999 (A$ 130,000–155,999 annually)	8.87 %	6.58 %
A$ 3000–3499 (A$ 156,000–181,999 annually)	4.38 %	6.89 %
A$ 3500–3999 (A$ 182,000–207,999 annually)	4.18 %	5.11 %
A$ 4000 or more (A$ 208,000 or more annually)	3.87 %	13.67 %
Prefer not to answer	5.81 %	

Appendix A includes all survey questions.

The survey was conducted in December 2021 and participants were recruited through the panel provider Dynata. The sample was restricted to the Australian adult population (18 years or above) who owned, leased or had access to a private car. Additionally, another selection criteria was applied to include individuals willing to spend AUD 20,000 on their next car purchase, resulting in 95 percent of the sample meeting this threshold. This was because the cheapest EV available in Australia is priced about AUD 45,000 and purchase prices of new EVs were not expected to fall below that price level in the near future (Costello, 2022). 1206 responses were selected from 1969 participants after a screening process that assessed completeness, response quality and demographic representation of the population. Table 1 below provides a comparison of the survey sample with the general Australian population. With 95 percent of the sample restricted to people who were willing to spend at least AUD 20,000 on their next car purchase, it is not surprising to see that the age group 18–24 is underrepresented in the sample compared to general population. Ultimately, the final sample was broadly representative of the potential new car buyers within the Australian adult population in terms of gender, location, income and age group– noting around 1 million new cars are sold in Australia each year (Federal Chamber of Automotive Industries, 2023). Table 1 below includes some of the demographic details of participants, and rest of the details are provided in Appendix B.

2.2. Survey attributes and levels

The attributes and levels for this study were carefully designed based on a comprehensive literature review of previous studies, in addition to considering the local context. The attributes included in this study were purchase price, driving range on a full charge, fast charging time, vehicle-to-grid capabilities, a new road user charge and purchase and other financial incentives.

Extant studies have investigated consumer preferences towards battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV) or both. Amongst all categories of EVs, BEVs have the lowest life-cycle GHG emissions (Muncrief, 2021) and are about three times more efficient compared to ICEVs (International Energy Agency, 2021). Due to this advantage of BEVs, this study focuses exclusively on consumer preferences towards BEVs-referred to as EVs-throughout the remainder of this paper.

Purchase price, driving range and fast charging time have been consistently identified as significant factors influencing consumers' EV preferences in extant studies (Beak et al., 2020; Bjerkan et al., 2016; Cecere et al., 2018; Fluchs, 2020; Higgins et al., 2017; Rotaris et al., 2021; Sommer & Vance, 2021; Wolbertus et al., 2018). The attribute levels for these factors were selected to closely align with both current market offerings and projected developments in the market. In 2021, the global average EV price was USD 36,000 (AUD 24,840), while the lowest priced EV available in Australia was AUD 45,000 (Costello, 2022). Given the expectation of a gradual reduction in EV prices, the purchase price attributes levels were set between AUD 30,000 and AUD 60,000. Notably, this price range remains relevant in the current Australian market, where the lowest priced EV is AUD 35,000 (Carsales, 2024). In terms of driving range, the average for an EV was 350 km in 2021 (International Energy Agency, 2022c). Accordingly, the driving range attribute was set to vary between 300 km and 600 km. Fast charging time was set at four levels, ranging from 10 to 40 min, reflecting both existing fast charging conditions and anticipated improvements in the near term.

The introduction of a road user charge targeting EVs has become a topic of great interest, as EV adoption increases and global discussions on sustainable alternatives to fuel excise taxes gain momentum. Road use charges are being increasingly implemented globally (Ministry of Transport; State of California, 2024). A road user charge can influence the cost-benefit analysis of EV ownership, and hence could negatively impact consumer preferences. Yet, the effects of road user charge on consumer preferences towards EVs has not been investigated. The Victorian State Government introduced an EV-focussed road user charge in July 2021, which was subsequently withdrawn following a successful legal challenge. Similarly, the New South Wales State Government plans to implement a road user charge for EVs from 1 July 2027 or when EVs make up 30 percent of all new vehicle sales (whichever occurs first). These rates are currently placed at AUD 200–250 per 10,000 km for different types of EVs (NSW Government; VicRoads). Hence, investigating the impacts of road user charge, if any, is particularly important in the current Australian context. Accordingly, the road user charge attribute levels were set to reflect the charges that an average Australian driver might face under various road user charge schemes that were either implemented or proposed.

Financial incentives in various forms have been reported to have a significant positive effect in accelerating EV uptake, and often more effective than non-financial incentives. Also, the effectiveness of incentives has been reported to vary by region and demographics (Clinton & Steinberg, 2019; Martins et al., 2024; Hardman, 2019). This study included various purchase and other financial incentives such as stamp duty exemption, 10 percent sales tax (GST) exemption, interest free loan up to AUD 20,000, electricity bill credit of AUD 500 per year for 5 years, annual registration discount of AUD 500 per year for 5 years and AUD 5000 rebate as purchase incentives. These attribute levels are generally representative of incentives currently offered by various Australian governments (EV central, 2022). The electricity bill credit, although not yet an incentive on offer, has been previously reported as having the potential to be highly effective in the Australian context (Ghasri et al., 2019; Philip et al., 2023).

The attribute levels for energy export options, broadly conceptualised as V2G capabilities in this study, were designed to capture the key options currently available, while drawing on insights from previous studies (Noel et al., 2019; Philip et al., 2023). Four levels were established to capture a broad range of consumer scenarios: no energy export (the current default), vehicle can only export energy to home (V2H only), vehicle can only export energy to the grid (V2G only), and a combined option allowing both V2G and V2H. These attribute levels reflect the primary distinctions in energy export use - either for the consumer's personal benefit or to support the grid - aligned with current and anticipated energy export configurations accessible to consumers.

Distance between fast chargers has previously been found to be a significant factor in many studies, although there are also a few recent studies that did not find distance between fast charging stations as significantly affecting consumers' EV preferences (Danielis et al., 2020; Rotaris et al., 2021). This attribute is not investigated in the study owing to multiple reasons- firstly due to limitations in the number of attributes that can be included in the choice tasks and secondly, because Australia is currently in transition towards having a well-connected charging network. Australia currently has 1928 fast charger locations and 4943 public chargers across 2392 locations (Electric Vehicle Council, 2022a). Recently, there has been increasing focus and government funding on the installation of EV fast charging stations – both in capital cities and regional centres – through Australian Future Fuels Fund, which aims to deliver 403 new fast charging stations across Australia (Australian Renewable Energy Agency, 2021; International Energy Agency, 2022a). Additionally, the ideal number of fast charging locations varies between countries/regions depending on the availability of home and workplace charging facilities, typical travel distances and population density. It is acknowledged that adequacy of fast charging facilities and their sustained maintenance remains an important factor in EV adoption but is not the key focus of this study.

2.3. Model

The data collected via stated preferences survey was analysed using a Mixed Logit (MXL) model. Mixed logit modelling allows unrestricted substitution patterns, random taste variation and correlation in unobserved factors over time (Train, 2009) and is one of the most used methods in recent literature.

Based on the Random Utility model (McFadden, 1973; McFadden & Train, 2000; Train, 2009), the utility that individual n receives from an alternative j in choice situation t, *denoted by* U_{njt}, is

$$U_{njt} = x_{njt}\beta_n + w_{njt}\alpha + z_{nt}\delta_j + \varepsilon_{njt} \tag{1}$$

where x_{njt} is a vector of alternative-specific variables with random coefficients β_n, w_{njt} is a vector of alternative specific variables with fixed coefficients $\propto$, z_{nt} is a vector of case-specific variables with fixed, alternative-specific coefficients δ_j and ε_{njt} is the independent and identically distributed extreme value over time, individuals and alternatives. The probability that individual n chooses alternative j at time t, conditional on the random parameter β_j is

$$P_{njt}(\beta) = \frac{e^{x_{njt}\beta_n + w_{njt}\alpha + z_{nt}\delta_j}}{\sum_{j=1}^{J} e^{x_{njt}\beta_n + w_{njt}\alpha + z_{nt}\delta_j}} \tag{2}$$

The unconditional or mixed logit probability, denoted as P_{njt} , is the weighted average of logit formula evaluated at different values of β, with weights given by density $f(\beta)$.

$$P_{njt} = \int L_{njt}(\beta) f(\beta) d\beta \tag{3}$$

The above integral with dimension d, where d equal the number of random parameters, and is approximated using Monte Carlo simulations. The simulated likelihood for the nth case is

$$L_n = \prod_{t=1}^{t} \sum_{j=1}^{J} d_{njt} \widehat{P_{njt}} \tag{4}$$

where d_{njt} is1 for the chosen alternative at time t and 0 otherwise and $\widehat{P_{njt}}$ are the simulated probabilities

$$\widehat{P_{njt}} = \frac{1}{M} \sum_{m=1}^{M} P_{njt}(\beta^m) \tag{5}$$

β^m are the random parameters drawn from f(β) and M is the number of random draws used to generate the point sets used in Monte Carlo integration. In this case, we used 1000 Halton draws.

The log likelihood function, LL, which is the sum of the logarithm of these simulated probabilities is then maximized.

$$LL = \sum_{n=1}^{N} \ln(L_n). \widehat{P_{njt}} \tag{6}$$

WTP was calculated to quantify consumers' preferences towards various attributes, by calculating the amount of money they were willing to pay for different levels of attributes. Since price is linear in the specified model, WTP is simply the ratio of the coefficient of interest to the coefficient of the price variable (Hess & Train, 2017; Train, 2009).

$$WTP_k = -\frac{\beta_k}{\beta_{price}} \tag{7}$$

For attributes following a lognormal distribution (de Bekker-Grob et al., 2013), the WTP is estimated as

$$WTP_k = -(\beta_k / x_k) / \beta_{price} \tag{8}$$

Delta method is used to estimate the standard errors of the WTP estimates, which accounts for the sample variance of estimated parameters in the estimated model. The standard error (S.E.) of WTP is calculated as:

$$S.E\left(WTP_k\right) = \left(\frac{1}{\beta_{price}}\right)\sqrt{var(\beta_k) - 2WTP_k cov(\beta_k, \beta price) + WTP_k^2 var\left(\beta_{price}\right)} \tag{9}$$

3. Results

3.1. Parameter estimates

The mixed logit model was estimated using STATA, and the model estimates are provided in Table 3. The final model included all the attributes under consideration, as listed in Table 2. As a main topic of this study and a less investigated attribute in literature, all three energy export options were assumed to have random coefficients with normal distribution owing to a priori expectation. To account for correlation found to exist between fast charging time and driving range, fast charging time and driving range were also assumed to have random coefficients with normal distributions. The standard deviations of these random coefficients in the estimated model indicate high levels of heterogeneity across participants for these attributes. Correlation between observations for each participant is accounted for in the model by adjusting standard errors for clustering on the panel variable (survey participant).

The following socio-economic variables were included in the model in the form of dummy variables: age less than 45, familiarity with V2G technology, awareness on EVs, and currently owning an EV (BEV or PHEV). Familiarity with V2G technology and currently owning an EV were scaled by 10 and 100 respectively before estimation. This was done to improve the interpretability of the coefficients. People who reported to have at least one of the following - BEV experience as a driver/passenger, seen an EV charger or had heard of at least one major charger brand - were classified as having EV awareness. People who had heard of V2G were classified as having V2G familiarity and who currently owned a BEV or PHEV were classified as currently owning an EV.

The overall results align with similar studies in the Australian context (Ghasri et al., 2019; Gong et al., 2020; Philip et al., 2023) and global context (Cherchi, 2017; Danielis et al., 2020; Fluchs, 2020; Guerra & Daziano, 2020; Li et al., 2020; Rietmann & Lieven, 2019; Rotaris et al., 2021). All of the estimated coefficients in the model have expected signs.

It is seen that consumers prefer EVs with energy export capabilities over an EV with no such capability. The coefficients of all energy export options were positive and significant at the 95 percent confidence level. As for preferences between these three options, consumers had the highest preference for energy export facility to both home and grid and the lowest preference for energy export facility to grid only. These results corroborate the findings of Philip et al. (2023). The high standard deviations observed across all three energy export options suggest substantial heterogeneity in individual preferences, indicating that consumer attitudes toward these energy export capabilities vary widely. While there is some overlap in the confidence intervals of two energy export options-namely energy export to home only and energy export to grid only, results from the Wald test confirm that the differences in preferences between the various energy export options are statistically significant.

In terms of vehicle and infrastructure attributes, purchase price has a negative coefficient, as expected and consistent with extant literature, indicating that consumer willingness to purchase EVs decreases as prices increase. The positive coefficient for driving range indicates a clear preference for EVs with longer ranges. However, the large standard deviation suggests considerable variation in consumer preferences for driving range within the provided levels of 300–600 km, reflecting heterogeneous attitudes toward this attribute. Fast charging time also has a negative coefficient, indicating that consumers favour shorter fast charging times. The high standard deviation for this attribute further indicates significant heterogeneity in preferences across the sample. These findings are consistent with the broader literature on EV adoption (Bahamonde-Birke & Hanappi, 2016; Guerra & Daziano, 2020; Hackbarth & Madlener, 2016; Li et al., 2020; Rotaris et al., 2021; Wang et al., 2017).

All financial incentives, the 10 percent sales tax/GST exemption, 10-year interest free loan of up to AUD 20,000, electricity bill credit of AUD 500 per year over a period of 5 years, AUD 5000 purchase rebate/subsidy, stamp duty exemption and the annual registration discount of AUD 500 per year for a period of 5 years were found to be statistically significant and positive, consistent with previous findings that financial incentives could play an important role in EV adoption (Fluchs, 2020; Ghasri et al., 2019; Mersky et al., 2016; Rietmann & Lieven, 2019; Taefi et al., 2016). Different policies are found to have different impacts, with AUD 5000 purchase rebate/subsidy having the largest positive impact of all the incentives under consideration.

An EV-focused road user charge was found to have a significant and negative coefficient, implying that consumers' willingness to buy EVs would decrease if road user charges are implemented. This is as expected, given the owner would incur additional cost from this new policy. As the first study to investigate the effect of road user charges on EV adoption, there is no literature to compare with.

EV related knowledge and experiences were significantly correlated with consumer preferences. Consumers who had some level of EV knowledge - that is had at least seen an EV charger or knew one of the major EV charger brands or had experience as passenger/driver in a BEV – was found to have increased likelihood of choosing an EV for their next car purchase, compared to someone who had no EV knowledge. 80 percent of the sample was identified as having some knowledge on EVs. Likewise, familiarity with V2G technology was found to increase likelihood of choosing an EV for the next car purchase, compared to being unfamiliar with the technology. 25 percent of the sample reported to have V2G familiarity. Also, participants who already owned an EV (BEV or PHEV) were more likely to choose an EV for their next car purchase, compared to someone who did not currently own an EV. Only 1.3 percent of the sample currently owned an EV – this is around double the proportion of Australia's passenger and light commercial vehicle fleet which are EVs (Electric Vehicle Council, 2022a).

Of all other socio-demographic attributes investigated, only age was found to be significantly associated with consumers' EV preferences. Participants below 45 years old were found to have stronger preferences for EVs.

Table 2
Attributes and levels in the SP survey.

Sl. no.	Attribute	Attribute levels
1	Purchase price	AUD 30,000
		AUD 35,000
		AUD 40,000
		AUD 45,000
		AUD 50,000
		AUD 55,000
		AUD 60,000
2	Driving range on a full charge	300 km
		400 km
		500 km
		600 km
3	Fast charging time	10 min
		20 min
		30 min
		40 min
4	A new road user charge (paid each year)	None
		$100 per 10,000 km driven
		$200 per 10,000 km driven
		$300 per 10,000 km driven
		$400 per 10,000 km driven
5	Purchase incentive	None
		Stamp duty exemption
		10 percent sales tax exemption
		10-year interest free loan up to AUD 20,000
		AUD 500 electricity bill credit × 5 years (AUD 2,500 in total; equivalent to free fuel for 5 years)
		AUD 500 annual registration discount × 5 years
		AUD 5,000 rebate/subsidy
6	Vehicle-to-grid (V2G) capabilities	None
		Vehicle can only power your home
		Vehicle can only sell electricity to the grid
		Vehicle can power your home and/or sell electricity to the grid

3.2. *Willingness to pay*

The WTP estimates calculated from this choice experiment are provided in Table 4 below. The results suggest that consumers are willing to pay higher amounts for improved EV attributes and are mostly comparable with the previous findings of Philip et al. (2023). It is to be noted that the latter study relied on a sample of 500 participants representative of the Australian State of Queensland's population, while this study uses a larger sample of 1206 participants representative of the Australian adult population. Additionally, the data for latter was collected through a survey conducted in November 2020. It may be assumed that pandemic related travel restrictions and changes in general lifestyle including daily travel patterns prevalent at that time would likely have had some kind of impact on their results.

The highest WTP is observed for a one-off rebate/subsidy of AUD 5000 and it increased consumers' WTP for an EV by AUD 10,006.42 (USD 6904).[1] The second highest increase in WTP was observed at AUD 8,991.08 (USD 6204) for the facility to export energy from vehicle to both home and grid and the third highest for electricity bill credit of AUD 500 per year for a period of 5 years at AUD 5877.67 (USD 4056).

Implementing a road user charge of 1 cent per km (or $1 per every 100 km driven) reduced WTP by AUD 5415.72 (USD 3737) – suggesting the pre-emptive introduction of such charges could significantly impede adoption compared to what could be possible without those.

Consumers' WTP for EVs were also found to considerably improve with financial incentives, with consumers perceiving greater value for the incentives on offer. Purchase subsidy/rebate valued at AUD 5000 (USD 3450) was found to have the highest impact with a WTP increase of AUD 10,006.642 (USD 6904). Electricity bill credits of AUD 500 per year over a period of 5 years totalling AUD 2500 (USD 1725) increased consumers' WTP by AUD 5877.67 (USD 4056). However, the same incentive amount offered as annual registration discount of AUD 500 per year for 5 years increased consumers' WTP by only AUD 3501.29 (USD 2415.89). 10-year interest free loan up to AUD 20,000 (USD 13,800) increased consumers' WTP by AUD 4,163.24 (USD 2872.64). 10 percent sales tax exemption and stamp duty exemption were found to increase consumers' WTP by AUD 3512.65. (USD 2424) and AUD 2471.05 (USD 1705) respectively.

Consumers place a clear premium on EVs equipped with any form of energy-export capability. In this study, the highest marginal WTP was estimated at AUD 8,991 (USD 6204) for an EV offering both V2H and V2G, followed by AUD 4,186 (USD 2888) for V2H-only and AUD 2,155 (USD 1487) for V2G-only. These results broadly mirror the patterns reported by Philip et al. (2023) which estimated an

[1] 1 AUD= 0.69 USD.

Table 3
Mixed logit model estimates.

Variable	β	Std. Error (Robust)	p value	95 % CI	
Alternative specific constant (EV)	2.103	0.275	0.000	1.564	2.642
Vehicle and infrastructural features					
Purchase price (EV) [10,000 AUD]	−0.544	0.029	0.000	−0.599	−0.488
Driving range (EV) [100 km]	0.139	0.021	0.000	0.098	0.180
SD of driving range	0.510	0.024	0.000	0.466	0.559
Fast charging time (EV)	−0.020	0.002	0.000	−0.023	−0.016
SD of fast charging time	0.031	0.003	0.000	0.026	0.037
Policy effects					
10 percent sales tax exemption	0.191	0.066	0.004	0.062	0.320
10-year interest free loan up to AUD 20,000	0.226	0.069	0.001	0.090	0.363
AUD 500 electricity bill credit × 5 years (AUD 2500 total)	0.320	0.070	0.000	0.182	0.457
AUD 5,000 rebate/subsidy	0.544	0.070	0.000	0.411	0.678
AUD 500 annual registration discount × 5 years (AUD 2500 total)	0.190	0.065	0.004	0.063	0.318
Stamp duty exemption	0.134	0.065	0.040	0.006	0.263
Road user charge	−0.295	0.049	0.000	−0.391	−0.199
Energy export/ Vehicle-to-grid (V2G) capabilities					
Home only	0.228	0.052	0.000	0.127	0.329
SD of home only	0.438	0.111	0.000	0.267	0.721
Grid only	0.117	0.055	0.033	0.009	0.225
SD of grid only	0.631	0.091	0.000	0.476	0.837
Home and grid	0.489	0.056	0.000	0.380	0.598
SD of home and grid	0.580	0.098	0.000	0.417	0.807
Socio-economic variables					
Under 45 years old [dummy]	0.864	0.198	0.000	0.476	1.252
Familiarity with V2G technology [×10] [dummy]	0.096	0.023	0.000	0.051	0.141
Knowledge of EVs [dummy]	0.766	0.249	0.002	0.276	1.255
Currently own an EV [×100][dummy]	0.019	0.009	0.034	0.001	0.037
Model diagnostics					
Number of observations		28,944			
Number of cases		9648			
Number of individuals (panels)		1206			
Number of cases per panel		8			
Log likelihood		−7853.6709			
Number of Halton draws		1000			
AIC		15755.34			
BIC		15927.53			

Table 4
Willingness to pay (WTP) estimates.

Variable	WTP (AUD)	WTP range (95 % CI)	Unit
Driving range (km)	25.54	17.81,33.26	AUD/km
Fast charging time (minute)	−359.34	−436.28, −282.40	AUD/minute
AUD 500 electricity bill credit x 5 years (AUD 2,500 in total)	5877.67	3332.48, 8422.86	AUD/unit
Rebate/ subsidy AUD 5,000	10,006.42	7482.35, 12530.48	AUD/unit
10-year interest free loan up to AUD 20,000	4163.24	1623.22, 6703.25	AUD/unit
Stamp duty exemption	2471.05	116.70, 4825.39	AUD/unit
GST Exemption	3512.65	1135.00,5890.29	AUD/unit
AUD 500 annual registration discount × 5 years (AUD 2500 total)	3501.29	1133.91,5868.67	AUD/ unit
Road User Charge (cents per km)	−5415.72	−7214.22, −3617.22	AUD/ unit
Export energy from vehicle only to home	4185.78	2256.47, 6115.10	AUD/unit
Export energy from vehicle only to grid	2155.15	148.82, 4161.48	AUD/unit
Export energy from vehicle to both home and/or grid	8991.08	6753.03, 11,229.13	AUD/unit

increase in consumers' WTP for an EV by AUD 5346.22 for energy export facility to both home and grid, AUD 3780.50 for energy export from vehicle to home only and AUD 2319.41 for energy export to grid only. The higher WTP magnitudes observed in the present study can be plausibly explained by differences in sampling frames and survey timing. Philip et al. (2023) drew from a Queensland-based regional sample surveyed in 2020, whereas the current study employs a nationally representative Australian sample surveyed in

2021. The estimated WTP for an EV with both V2G and V2H are comparable to that of Noel et al. (2019) which estimated consumers' WTP for V2G at USD 5668[2] in Norway and USD 4360 in Finland. The findings of this study reveal that consumers in low-adoption countries attribute significant value for EV energy export options– comparable to that of consumers in high-adoption Nordic countries- but notably, the capacity to export energy to the home is identified as a more highly valued feature than the extensively studied capability of exporting energy to the grid, signalling consumer preferences towards functionalities that directly benefit household energy management.

On average, the participants were willing to pay AUD 25.54 (USD 17) for every added kilometre of driving range that an EV could offer. They were also willing to pay AUD 359.34 (USD 248) for every minute saved in fast charging the EV. These closely align with Philip et al. (2023) which reported WTP increase of AUD 24.79 for every added kilometre of driving range and AUD 380.73 for per minute reduction of fast charging time. Similar WTP values for improved driving range have been reported by Hidrue et al. (2011), Inci et al. (2022), Parsons et al. (2014) and Hackbarth and Madlener (2016). The WTP values for per minute reduction in fast charging time aligns with that of Qian et al. (2019) which estimated the same at USD 387 per minute saved.

4. Discussion

4.1. Energy export capabilities

This study demonstrates that consumers in low-adoption countries exhibit a strong preference for EVs equipped with energy export capabilities. Consumers' marginal WTP for an EV that could export energy to both home and grid at AUD 8,991.08 is comparable to their marginal WTP at AUD 10,006.42 for an EV with a purchase subsidy of AUD 5000 on offer. Given the higher upfront costs of EVs relative to ICEVs, governments globally have implemented a range of purchase and financial incentives to drive EV adoption. This study finds that facilitating both V2G and V2H capabilities could be nearly as effective as purchase subsidies- one of the most effective policies, even at a global level (Bjerkan et al., 2016; Langbroek et al., 2016). As such, they present a unique opportunity to increase EV adoption rates in lagging markets based primarily on organic consumer demand, in addition to accelerating adoption via incentive policies. Working towards a system where energy export from EVs is the norm offers double benefits – it could increase EV adoption while also facilitating the use of EV batteries to support grid stability and improve the renewable energy mix in the grid. Australia's recent approval of V2G standards marks a critical step towards realising this potential (STANDARDS Australia, 2024).

The lowest consumer preference is observed for the energy export to grid only option. This could imply that while energy export options do increase consumers' willingness to adopt EVs, it is not necessarily stemming from a desire to export energy to the grid or support the grid – at least not for everyone. Rather, consumers appear to derive greater value from household-oriented benefits, such as using the EV as a backup power source during outages, reducing electricity bills, or enhancing household energy self-sufficiency. This distinction underscores that the appeal of bidirectional charging is fundamentally grounded in direct, tangible home-energy advantages, rather than broader system-level motivations. This is not surprising considering that Australia has a high rate of rooftop solar penetration, with more than a quarter of households now generating power on their roofs (CSIRO, 2021; Department of Climate Change, 2022). For these households, an EV with bidirectional capability becomes a natural extension of their existing energy ecosystem, enabling them to amplify these household-level advantages by storing surplus daytime solar generation and discharging it during periods of high demand or low renewable availability. Consequently, even as EVs with energy-export features become more widespread, dedicated incentives and program designs will be required to encourage EV owners to participate in V2G services, if system-level value of distributed storage needs to be fully realised.

4.2. Vehicle features, incentives, and other policies

The driving range of EVs has increased considerably over the past decade. The mean driving range of a BEV is reported to have increased from 127 km in 2010 to 349 km in 2021 (International Energy Agency, 2022c). While all EVs may not offer the same driving range as their equivalent conventional counterparts, there are multiple options for a potential buyer to choose from such that it meets all their daily travel needs. Several EVs currently available in Australia claim driving ranges of over 400 km (Electric Vehicle Council, 2022b), and hence are capable of meeting the average Australian consumer's daily driving distance reported at 35 km per day (Australian Bureau of Statistics, 2020). Driving range anxiety may alleviate over time, particularly as people become more aware of their driving needs and get familiarised with using EVs. Despite concerns of looming range anxiety, EVs are now increasingly becoming the primary cars in many households, and in some cases the only car. This would mean that EVs are not just being treated as city cars or secondary cars but are expected to meet all the travel requirements of the household, including long distance trips. Our study suggests that an Australia consumer is willing to pay an extra AUD 5108 for an EV with 500 km driving range versus an EV with 300 km driving range.

Purchase price was found to be the most influential vehicle attribute affecting consumers' purchase decisions. The purchase price of EVs is expected to continue falling in the coming years – arising from both technological advancements and increasing economies of scale, due to the increased focus of governments and car manufacturers on the electrification of transport. EVs are expected to achieve unsubsidised price parity with ICEVs in most segments and countries by the late 2020 s (BloombergNEF, 2022). However, EV uptake in

[2] 1 Euro= 1.09 USD.

Australia is not on track to meet existing, aggregated state and territory targets, equivalent to 46 percent new car sales being EVs by 2030 (Climateworks CENTRE, 2022). As such, there is a pressing need to roll out effective policies to achieve subsidised price parity with ICE vehicles and incentivise the uptake of EVs. Australian federal, state, and territory governments have recently introduced many financial incentives aimed at promoting the adoption of new EVs. These policy measures appear to have played a significant role in the growth of EV sales, with market penetration rising from 3.8 percent in 2022 to 9.5 percent in 2024.

EV favouring policies have played a major role in the adoption of EVs in leading countries/regions including but not limited to Norway, California and China (International Energy Agency, 2022c). Purchase rebates remain among the most effective incentives globally and in Australia (Bjerkan et al., 2016; Ghasri et al., 2019; Langbroek et al., 2016), a finding reinforced by this study. The high price elasticity of demand for electricity in Australia (Chesser et al., 2018; Fan & Hyndman, 2011; Krishnamurthy & Kriström, 2015) explains the significant positive impact of electricity bill credits on consumer willingness to pay for EVs. However, the observed effectiveness of electricity bill credits in this study is lower than that reported by Philip et al. (2023), likely due to differences in incentive structure. This study offered credits as instalments, whereas Philip et al. (2023) offered a one-off payment. Demographic differences, with this study using a nationally representative sample, may also contribute to the variation. Stamp duty, calculated as a percentage of a vehicle's purchase price, varies across Australian states and depends on factors such as vehicle type and purpose. For EVs, stamp duty rates can reach up to 6.5 percent of the vehicle's value, posing a significant financial burden for potential buyers.

The estimated increase in consumers' WTP in response to various financial incentives suggests that the perceived value consumers associate with these incentives exceeds the actual benefits received. This elevated WTP likely reflects consumers' desire to capitalise on available incentives for EV adoption or their propensity to assign greater value to EVs when government policies send positive signals. Similar findings have been reported in other global studies: Hackbarth and Madlener (2016) reported that German consumers attributed a higher value to EV tax exemptions than the actual monetary benefit while Kwon et al. (2018) reported analogous behaviour among South Korean consumers, with marginal WTP for EVs surpassing the value of purchase subsidy and charger installation subsidy.

4.2.1. Road user charge

While the need to review road taxation systems in all nations is widely acknowledged, this study highlights the potential risks associated with prematurely introducing road user charges targeting EVs. At a time when governments are striving to accelerate EV adoption, such policies risk undermining progress by significantly reducing consumer WTP for EVs. Using an average annual driving distance of 12,100 km (Australian Bureau of Statistics, 2020), a road user charge of AUD 2.5 per 100 km (VicRoads) implies an additional cost of AUD 303 per year. Our estimates indicate that such a charge would reduce consumers' WTP for an EV by AUD 13,538 relative to a scenario without RUC. In effect, this reduction in WTP exceeds forty years of road user charge payments, indicating how EV-targeted road user charging schemes could deter EV adoption. This reduction is also substantial when compared to the positive effects of pro-EV policies. For instance, a purchase subsidy of AUD 5000 increased WTP by approximately AUD 10,006. However, the negative impact of road user charges far outweighs these gains, illustrating their potential to nullify the benefits of even the most effective incentives. These findings suggest that the premature implementation of road user charges in regions with low EV adoption rates could negate the benefits of financial incentives and other supportive policies, potentially slowing EV adoption and jeopardising progress toward net zero targets.

4.2.2. Consumer awareness

As identified in previous studies, socio-demographic factors affect consumer preferences towards EVs. This study particularly aimed to investigate impact of consumer knowledge on adoption rates, amongst others. 20 percent of the sample reported to have no EV knowledge. A participant who had no BEV experience, had not seen an EV charger nor had heard of any major charger brands was considered to have limited to no knowledge on EVs, while if they answered yes to any of these, they were considered to have some level of knowledge on EVs. Of the 1206 participants, 75 percent had no BEV experience, 43 percent had never seen an EV charging station while 35 percent were not familiar with any of the major charging brands. This potentially signals a high level of non-awareness of EV and related attributes among the general population, and important role for government and industry to play in raising EV awareness levels.

Findings of this study further suggest that consumers who have heard of V2G capabilities are more likely to purchase an EV as compared to someone who have not heard of it. Only 25 percent of the 1206 participants in this study had heard of V2G. While this does not imply causation, it suggests that as EV uptake grows and public awareness of technologies such as V2G becomes more widespread, broader familiarity with these features may coincide with increased consumer interest in EVs.

4.3. Policy implications

Drawing on the findings of this study, this section examines policy pathways that could place Australia's passenger car sector on a credible trajectory towards transport decarbonisation and, ultimately, support the achievement of national climate objectives, including the Australian Government's legislated net-zero emissions target for 2050.

4.3.1. Smart charging infrastructure support

This study identified that energy export facilities could significantly improve consumer willingness to adopt EVs. Additionally, facilitating V2G allows for better demand management, increased use of renewable energy, could improve grid stability by means of frequency control ancillary services and offers more economical charging opportunities for the EV owner. Hence it is recommended that governments, EV manufacturers and energy sector stakeholders gear up to prepare for and actively support the roll-out of this technology in the near-term.

Consumers' higher WTP for vehicles with energy export facilities suggest that depending on the costs of adding them, vehicle manufacturers could consider incorporating these capabilities into their existing and new EV models. A vehicle is on average used for about 15 years. This means that a vehicle which enters the market in 2025 could still be on the roads in 2040. With increasing number of EVs and increasing energy demand, V2G and associated features could roll out partially-if not with the full-fledged aim of supporting the grid at all times. More vehicle manufacturers could aim to provide one of more options such as Vehicle-to-load (V2L), Vehicle-to-any (V2X) or vehicle-to-grid (V2G) as is offered by some EV brands today. At the time of the survey, only three EV models available in Australia supported V2G functionality - the Nissan Leaf (BEV), Mitsubishi Outlander (PHEV), and Mitsubishi Eclipse Cross (PHEV). Since then, the Australian market has expanded rapidly, with an increasing number of EV models now offering V2G or other bidirectional charging capabilities.

Achieving V2G at a deployable, system-wide scale requires far more than the availability of bidirectional-capable EVs. It hinges on the establishment of a coherent technical, regulatory, and communication framework that supports secure, predictable, and interoperable energy exchange across the entire ecosystem. This involves adopting an appropriate suite of standards, including the Open Charge Point Protocol (OCPP), ISO 15118, and the Australian Common Smart Inverter Profile (CSIP-AUS), to enable authenticated communication, accurate metering, device visibility, disturbance-ride-through capability, and real-time controllability between EVs, charging equipment, aggregators, and market operators. Without consistent implementation of these standards, and without interoperability across hardware and software platforms, bidirectional charging risks fragmentation, inconsistent performance, and operational uncertainty for networks and market participants. In parallel, OEMs and battery manufacturers require a stronger evidence base on the effects of V2G cycling on battery longevity and warranty risk in order to provide clear guidance and support consumer confidence.

4.3.2. Financial incentives

This study has identified that purchase and other financial incentives have a positive and significant impact on consumer willingness to adopt EVs. With emissions from transport constituting 19 percent of the country's GHG emissions, decarbonisation of transport plays an important role in achieving net zero targets set by the governments. Electrification of transport is the key to decarbonising the sector (International Energy Agency, 2022b). In this context, it is recommended that adequate financial incentives such as purchase subsidy, sales tax exemption, discounts on annual registration and stamp duty exemptions be continued or newly set up by the governments as required, at least until EVs achieve price parity with ICEVs or until electrification targets are met.

Electricity bill credit, particularly, could be an effective way of promoting EV adoption, corroborating the findings of previous studies (Ghasri et al., 2019; Gong et al., 2020; Philip et al., 2023). The mean annual driving distance in Australia is 12,600 km (Australian Bureau of Statistics, 2021). The annual electricity rates for an EV being charged average electricity tariff rates at 25c/kWh is estimated to be around AUD 500. As such, an annual energy bill credit capped at AUD 500 essentially serves as providing free fuel for the vehicle for a short-period of time. As proposed by Philip et al. (2023), although this total cost is lower than some subsidies already on offer, if marketed as free fuel for the first several years of ownership, this policy has the potential to act a significant, yet more cost-effective incentive for EV adoption. Additionally, the electricity bill credit could be utilised to encourage charging of EVs during desirable times of the day. As such, it is suggested that such electricity bill credits be provided in exchange for the EV users agreeing to charge their cars at desirable hours of the day. For example, any new EV buyer gets a fixed minimal amount of annual electricity bill credit with opportunity to earn higher amounts if they opt-in to a smart charging program that regulates their EV charging times. Thus, this incentive could be used as a powerful tool to both increase EV adoption as well as regulate the time of charging by EV users.

4.3.3. Road tax reform/road user charge

The results suggest that introduction of road user charges exclusive to EVs have negative impact on consumer preferences towards EVs. Policy formulations on road user charges would need to be considered in the broader context of Australian EV scenario. With the recent introduction of New Vehicle Efficiency Standards, Australia,has at last addressed its status as one of the last two OECD nations without such regulations. While the Australian government had previously announced its intention to develop these standards, their implementation marks a significant step forward in curbing the supply of inefficient, high-polluting vehicles, which had long been a challenge (Australian Government, 2023), often making it a dumping ground for less efficient and high polluting models by manufacturers. While there are 450 electric car models available globally there are only 45 models with 60 BEV variants in Australia as of October 2022 (International Energy Agency, 2022c). Despite 450 electric car models being available globally, only 45 models with 60 BEV variants were available in Australia as of October 2022 (International Energy Agency, 2022c). Manufacturers, already prioritising other markets to avoid penalties, may still view road user charges specific to EVs as a disincentive, potentially affecting supply. This could continue to delay consumer adoption by sending negative signals to the market.

It is acknowledged that the effects of introducing road user charges would be different in different regions, like many other policies. For instance, in a country such as Norway with high rates of EV adoption, introduction of road user charges for all vehicles maybe inevitable and would have different impacts as compared to introduction of road user charges exclusive to EVs in a low-adoption country such as Australia. However, based on the findings of this study, it is recommended that governments in low EV adoption countries refrain from premature introduction of EV-focussed road user charges as this would further delay uptake. Instead, governments could pursue a strategic approach, and aim to reform road taxation more broadly, considering the phase-out of existing taxes, to be replaced by a new road pricing scheme which does not only target EVs, but considers the broader externalities of our transport system (congestion, safety, road wear, emissions), and support a transition to this new scheme which is equitable, and importantly, continues to encourage EV adoption.

4.3.4. *Consumer awareness*

It was found that consumers with greater knowledge on EVs and V2G technology were more likely to buy EVs. Also, a major percentage of the sample was found to have limited to no EV knowledge or experience. Hence, it is recommended that governments and industry work in collaboration to improve consumer awareness on EVs. Sharing information on EV performance and driving range capabilities, organising automobile shows and test drives, as well as promoting the broader benefits of EVs, could serve to alleviate consumers' concerns, while providing greater awareness of how an EV might suit their needs. Additionally, the increased adoption of EVs by government and other fleets, as well as electrification of public transport, is likely to also be effective in increasing both the visibility and awareness of EVs by the public.

4.4. *Limitations and Future research*

4.4.1. *Limitations*

Relying on stated preferences naturally introduces the possibility for hypothetical bias. However, stated preferences studies play a pivotal role in understanding consumer preferences towards new or yet to be available technology or products, which is the case with this study. To prevent overloading of information and participant fatigue it is also necessary to restrict the number of attributes and attribute levels. This has been an important consideration of this study. To prevent participant fatigue, this study included only upto six attributes per choice task, and did not include distance between fast charging stations- an attribute which has been found to be significant by some in the existing literature.

Another limitation of this study was with regards to demographic representation. This study primarily targeted potential new buyers of EVs. It would be essential to also look into consumer preferences of used car buyers to capture the whole EV market.

4.4.2. *Future research*

This study focused on understanding consumer preferences of new and private EV owners. Future research can aim to investigate preferences of different sectors such as used car market, business and fleet owners. As more EV models enter the market, it would also be worth studying consumer preferences towards different car types and models.

As more policies are rolled out to electrify transport, it would also become essential to look at social equity issues arising out of various policies. Hence, we suggest that these issues be further looked into so that the electrification of transport is inclusive.

The findings of this study indicate that consumers often perceive greater values for the monetary incentives than the actual monetary benefit they receive. Future research could explore whether this perception is consistent across different contexts, regions, and incentive structures to assess the generalisability of these results.

This study reported that energy export options could have a significant positive impact on consumer preferences towards EVs. Further studies are required to examine the scope of implementing smart charging and V2G programs, and to investigate consumer preferences towards various smart charging features.

5. Conclusion

Transport is a major contributor to global greenhouse gas emissions, and low EV adoption countries face a narrowing window to electrify their transport sectors and meet decarbonisation goals. Beyond meeting climate targets, these countries risk missing out on substantial economic opportunities associated with this transition. To avoid falling behind, it is essential to leverage all available resources and technologies effectively.

This study offers a comprehensive analysis of the factors influencing consumer preferences for EVs in low-adoption markets, with a particular focus on advanced technologies such as V2G and V2H within an evolving policy framework. It is the first to use a nationally representative sample from a low-adoption country and to evaluate the impact of road user charges on EV adoption.

The findings reveal that the ability of EVs to integrate with the energy ecosystem through V2G and V2H capabilities are not just technical enhancements but core attributes that redefine the value of EVs for consumers. Consumers place high value on energy export capabilities, even exceeding the perceived benefits of many financial incentives. While financial incentives and improved EV attributes remain critical for adoption, the appeal of energy export features underscores the need for policies that enhance their accessibility and visibility. Notably, the higher preference for V2H over V2G suggests that consumers prioritise functionalities that offer direct household or personal energy management benefits over broader grid-level applications.

The study also highlights the risks of poorly calibrated policy measures, such as EV-specific road user charges. While these are intended to address fiscal sustainability, they could reduce consumer interest and even stall EV adoption, if not strategically planned.

This research provides a clear roadmap for aligning EV technologies and policy interventions to accelerate adoption in low-adoption markets. Its findings will be critical for tailoring strategies to diverse market contexts, ensuring that the full potential of EV technologies are fully realised in decarbonising both the transport and energy sectors.

CRediT authorship contribution statement

Thara Philip: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jake Whitehead:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation. **Carlo Prato:** Writing – review & editing, Supervision, Methodology. **Andrea La Nauze:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

iMOVE CRC. Advance Queensland, Queensland Government.

Appendix A

This section includes questions asked in Sections 1, 2 And 4 of the survey.

Questions-Section 1 and 2

- What is your age?
- Do you currently own, lease or have access to a private car?
- If you were to purchase a new car in the next few years, approximately how much would you be willing to spend?
- Where do you currently live?
- What is your gender?
- How many registered cars are in your household?
- How many kilometres do you estimate you drive each day (on average)?
- What is the fuel type of the car you use the most often?
- For the vehicle you use most often, how much was it worth when it was purchased?
- Have you ever driven, or been driven in a battery electric car (100 % electric)?
- Have you ever seen an electric vehicle charging station?
- Are you familiar with any of the following electric vehicle charging networks/brands in Australia?
- Have you previously heard about vehicle-to-grid (V2G) capabilities in relation to electric vehicles?

Questions-Section 4

- What type of home do you live in (the majority of the time)?
- Do you own or rent this home?
- Do you have rooftop solar where you currently live?
- Do you have a home battery (e.g. Tesla Powerwall) where you currently live?
- How many children do you have under the age of 16?
- What is your household weekly income before tax?

Appendix B

Other reported socio-demographic characteristics of survey participants.

Daily driving distance	
<10 km	18 %
10–19 km	21.70 %
20–29 km	23.10 %
30–39 km	14.80 %
40–49 km	7.30 %
50–59 km	7.50 %
60 km or more	7.50 %
V2G familiarity	
Heard of V2G	25.20 %
Not heard of V2G	74.80 %
Familiarity with brands related to EV charging	

(*continued on next page*)

(*continued*)

Daily driving distance		
Tritium	6.70 %	
Evie Networks	4.30 %	
Chargefox	4.30 %	
ABB	6.90 %	
Tesla	59.50 %	
Jetcharge	4.10 %	
None	34.90 %	
Seen EV charging station		
Yes	57.50 %	
No	42.50 %	
BEV experience		
Driven	10.30 %	
Passenger	13.70 %	
No	74.70 %	
Unsure	1.30 %	
Amount willing to spend on next car purchase		
<20 k	5.50 %	
20–40 k	52.60 %	
40–60 k	29.80 %	
60k+	12.20 %	
0		59.40 %
1		19.70 %
2		15.80 %
3		3.70 %
4 or more		1.40 %
Number of registered cars in the household		
0		0.70 %
1		56.70 %
2		34.70 %
3		5.80 %
4 or more		2.00 %
Type of dwelling		
Free-standing house		70.30 %
Townhouse/Villa		14.60 %
Apartment		15.10 %
Current dwelling ownership		
Own		73.10 %
Rent		26.90 %
Rooftop solar		
Yes		36.70 %
No		59.50 %
No, but planning to install in the next 2 years		3.90 %
Home battery		
Yes		9.30 %
No		86.20 %
No, but planning to install in next 2 years		4.60 %

Data availability

Data will be made available on request.

References

Australian Bureau of Statistics, 2020. *Survey of Motor Vehicle Use, Australia*. Retrieved December 5 from https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/latest-release.

Australian Bureau of Statistics, 2021. *Electric passenger vehicle use, experimental estimates*. ABS. Retrieved March 24 from https://www.abs.gov.au/articles/electric-passenger-vehicle-use-experimental-estimates.

Australian Energy Market Operator, 2024. *2024 Integrated System Plan*. https://aemo.com.au/-/media/files/major-publications/isp/2024/2024-integrated-system-plan-isp.pdf?la=en.

Australian Government, 2023. *The Fuel Efficiency Standard – Cleaner, Cheaper to Run Cars for Australia*. https://www.infrastructure.gov.au/sites/default/files/documents/fuel-efficiency-standard-cleaner-cheaper-run-cars-australia-consultation-paper-april2023.pdf.

Australian Government, 2024. *Australia hits rooftop solar milestone*. Retrieved November 25 from https://www.energy.gov.au/news-media/news/australia-hits-rooftop-solar-milestone.

Australian Renewable Energy Agency, 2021. *Future Fuels Fund revved up to provide EV charging nationally*. Australian Renewable Energy Agency. Retrieved June 27 from https://arena.gov.au/news/future-fuels-fund-revved-up-to-provide-ev-charging-nationally/.

Bahamonde-Birke, F.J., Hanappi, T., 2016. The potential of electromobility in Austria: evidence from hybrid choice models under the presence of unreported information. Transp. Res. A Policy Pract. 83, 30–41.

Beak, Y., Kim, K., Maeng, K., Cho, Y., 2020. Is the environment-friendly factor attractive to customers when purchasing electric vehicles? evidence from South Korea. Bus. Strateg. Environ. 29 (3), 996–1006.

Biresselioglu, M.E., Kaplan, M.D., Yilmaz, B.K., 2018. Electric mobility in Europe: a comprehensive review of motivators and barriers in decision making processes. Transp. Res. A Policy Pract. 109, 1–13.

Bjerkan, K.Y., Nørbech, T.E., Nordtømme, M.E., 2016. Incentives for promoting battery electric vehicle (BEV) adoption in Norway. Transp. Res. Part D: Transp. Environ. 43, 169–180.

BloombergNEF. (2022). *Electric Vehicle Outlook 2022*. https://bnef.turtl.co/story/evo-2022/page/1?teaser=yes.

Carsales, 2024. *Australia's cheapest EV now even cheaper*. Retrieved July 4 from https://www.carsales.com.au/editorial/details/australias-cheapest-ev-now-even-cheaper-145325/.

Cecere, G., Corrocher, N., Guerzoni, M., 2018. Price or performance? a probabilistic choice analysis of the intention to buy electric vehicles in European countries. Energy Policy 118, 19–32.

Cherchi, E., 2017. A stated choice experiment to measure the effect of informational and normative conformity in the preference for electric vehicles. Transp. Res. A Policy Pract. 100, 88–104.

Chesser, M., Hanly, J., Cassells, D., Apergis, N., 2018. The positive feedback cycle in the electricity market: residential solar PV adoption, electricity demand and prices. Energy Policy 122, 36–44.

ClimateWorks Australia, 2020. *Decarbonisation Futures: Solutions, actions and benchmarks for a net zero emissions Australia*. Decarbonisation Futures: Solutions, actions and benchmarks for a net zero emissions Australia.

Climateworks CENTRE, 2022. *Accelerating EV uptake*. https://www.climateworkscentre.org/resource/accelerating-ev-uptake-policies-to-realise-australias-electric-vehicle-potential/.

Clinton, B.C., Steinberg, D.C., 2019. Providing the Spark: impact of financial incentives on battery electric vehicle adoption. J. Environ. Econ. Manag. 98, 102255. https://doi.org/10.1016/j.jeem.2019.102255.

Correia Sinézio Martins, E., Lépine, J., Corbett, J., 2024. Assessing the effectiveness of financial incentives on electric vehicle adoption in Europe: multi-period difference-in-difference approach. Transp. Res. A Policy Pract. 189, 104217. https://doi.org/10.1016/j.tra.2024.104217.

Costello, M., 2022. *New MG 4 hatch could be Australia's cheapest EV in 2023*. Car Exp. https://www.carexpert.com.au/car-news/new-mg-4-hatch-could-be-australias-cheapest-ev-in-2023.

CSIRO, 2021. *Australia installs record-breaking number of rooftop solar panels*. Retrieved February 7 from https://www.csiro.au/en/news/news-releases/2021/australia-installs-record-breaking-number-of-rooftop-solar-panels.

Danielis, R., Rotaris, L., Giansoldati, M., Scorrano, M., 2020. Drivers' preferences for electric cars in Italy. evidence from a country with limited but growing electric car uptake. Transp. Res. A Policy Pract. 137, 79–94.

de Bekker-Grob, E.W., Rose, J.M., Bliemer, M.C., 2013. A closer look at decision and analyst error by including nonlinearities in discrete choice models: implications on willingness-to-pay estimates derived from discrete choice data in healthcare. Pharmacoeconomics 31, 1169–1183.

Department of Climate Change, E., the Environment and Water, 2022. *Australia leads world in rooftop solar as share of renewables jumps to 35%*. Department of Climate Change,Energy,the Environment and Water. https://www.energy.gov.au/news-media/news/australia-leads-world-rooftop-solar-share-renewables-jumps-35#:~:text=2021%20was%20the%20fifth%20record,the%20largest%20generator%20in%20Australia.

(2022a). Australian Electric Vehicle Industry Recap, 2022. https://electricvehiclecouncil.com.au/wp-content/uploads/2023/02/AUSTRALIAN-ELECTRIC-VEHICLE-INDUSTRY-RECAP-2022.pdf.

Electric Vehicle Council, 2022b. *State of Electric Vehicles*. https://electricvehiclecouncil.com.au/wp-content/uploads/2022/10/State-of-EVs-October-2022.pdf.

Electric Vehicle Council. (2023). *State of Electric Vehicles*. https://electricvehiclecouncil.com.au/wp-content/uploads/2023/07/State-of-EVs_July-2023_.pdf.

EV central, 2022. *Complete guide to rebates, discounts and incentives when buying an EV in Australia*. EV central. Retrieved December 10 from https://evcentral.com.au/complete-guide-to-discounts-and-incentives-when-buying-an-ev-in-australia/.

Fan, S., Hyndman, R.J., 2011. The price elasticity of electricity demand in South Australia. Energy Policy 39 (6), 3709–3719.

Federal Chamber of Automotive Industries, 2023, Jan 5. *FCAI releases 2022 new car sales data* https://www.fcai.com.au/news/index/view/news/787#:~:text=Media%20Releases&text=Australia's%20automotive%20industry%20delivered%20more,year%20when%20demand%20exceeded%20supply.

Fluchs, S., 2020. The diffusion of electric mobility in the European Union and beyond. Transp. Res. Part D: Transp. Environ. 86, 102462.

Ghasri, M., Ardeshiri, A., Rashidi, T., 2019. Perception towards electric vehicles and the impact on consumers' preference. Transp. Res. Part D: Transp. Environ. 77, 271–291.

Gong, S., Ardeshiri, A., Rashidi, T.H., 2020. Impact of government incentives on the market penetration of electric vehicles in Australia. Transp. Res. Part D: Transp. Environ. 83, 102353.

Guerra, E., Daziano, R.A., 2020. Electric vehicles and residential parking in an urban environment: results from a stated preference experiment. Transp. Res. Part D: Transp. Environ. 79, 102222.

Hackbarth, A., Madlener, R., 2016. Willingness-to-pay for alternative fuel vehicle characteristics: a stated choice study for Germany. Transp. Res. A Policy Pract. 85, 89–111.

Hardman, S., 2019. Understanding the impact of reoccurring and non-financial incentives on plug-in electric vehicle adoption–a review. Transp. Res. A Policy Pract. 119, 1–14.

Hess, S., Train, K., 2017. Correlation and scale in mixed logit models. J. Choice Model. 23, 1–8.

Hidrue, M.K., Parsons, G.R., Kempton, W., Gardner, M.P., 2011. Willingness to pay for electric vehicles and their attributes. Resour. Energy Econ. 33 (3), 686–705.

Higgins, C.D., Mohamed, M., Ferguson, M.R., 2017. Size matters: how vehicle body type affects consumer preferences for electric vehicles. Transp. Res. A Policy Pract. 100, 182–201.

Inci, E., Tatar Taspinar, Z., Ulengin, B., 2022. A choice experiment on preferences for electric and hybrid cars in Istanbul. Transport. Res. Part D: Transport Environ. 107, 103295. https://doi.org/10.1016/j.trd.2022.103295.

International Energy Agency. *Electric Vehicles*. Retrieved July 10 from https://www.iea.org/energy-system/transport/electric-vehicles.

International Energy Agency, 2021. *Net Zero by 2050*. https://www.iea.org/reports/net-zero-by-2050.

International Energy Agency, 2022a. *Australian Future Fuels Fund* International Energy Agency. Retrieved December 30 from https://www.iea.org/policies/12902-australian-future-fuels-fund.
International Energy Agency, 2022b. *Electric Vehicles*. https://www.iea.org/reports/electric-vehicles.
International Energy Agency. (2022c). *Global EV Outlook 2022*. https://iea.blob.core.windows.net/assets/e0d2081d-487d-4818-8c59-69b638969f9e/GlobalElectricVehicleOutlook2022.pdf.
International Energy Agency. (2024). *Global EV Outlook 2024*. https://www.iea.org/reports/global-ev-outlook-2024.
Krishnamurthy, C.K.B., Kriström, B., 2015. A cross-country analysis of residential electricity demand in 11 OECD-countries. Resour. Energy Econ. 39, 68–88.
Kumar, R.R., Alok, K., 2020. Adoption of electric vehicle: a literature review and prospects for sustainability. J. Clean. Prod. 253, 119911.
Kwon, Y., Son, S., Jang, K., 2018. Evaluation of incentive policies for electric vehicles: an experimental study on Jeju Island. Transp. Res. A Policy Pract. 116, 404–412. https://doi.org/10.1016/j.tra.2018.06.015.
Langbroek, J.H., Franklin, J.P., Susilo, Y.O., 2016. The effect of policy incentives on electric vehicle adoption. Energy Policy 94, 94–103.
Li, L., Wang, Z., Chen, L., Wang, Z., 2020. Consumer preferences for battery electric vehicles: a choice experimental survey in China. Transp. Res. Part D: Transp. Environ. 78, 102185.
Liao, F., Molin, E., van Wee, B., 2017. Consumer preferences for electric vehicles: a literature review. Transp. Rev. 37 (3), 252–275.
McFadden, D., 1973. Conditional logit analysis of qualitative choice behavior.
McFadden, D., Train, K., 2000. Mixed MNL models for discrete response. J. Appl. Economet. 15 (5), 447–470.
Mersky, A.C., Sprei, F., Samaras, C., Qian, Z., 2016. Effectiveness of incentives on electric vehicle adoption in Norway. Transp. Res. Part D: Transp. Environ. 46, 56–68. https://doi.org/10.1016/j.trd.2016.03.011.
Ministry of Transport. *Electric Vehicles Programme*. Ministry of Transport,. Retrieved January 11 from https://www.transport.govt.nz/area-of-interest/environment-and-climate-change/electric-vehicles-programme/.
Muncrief, R., 2021. Why are electric vehicles the only way to quickly and substantially decarbonize transport? https://theicct.org/why-are-electric-vehicles-the-only-way-to-quickly-and-substantially-decarbonize-transport/.
Noel, L., Carrone, A.P., Jensen, A.F., de Rubens, G.Z., Kester, J., Sovacool, B.K., 2019. Willingness to pay for electric vehicles and vehicle-to-grid applications: a Nordic choice experiment. Energy Econ. 78, 525–534.
NSW Government. *A fair and sustainable road user charge*. Retrieved January 5 from https://www.nsw.gov.au/driving-boating-and-transport/nsw-governments-electric-vehicle-strategy/road-user-charge.
Parsons, G.R., Hidrue, M.K., Kempton, W., Gardner, M.P., 2014. Willingness to pay for vehicle-to-grid (V2G) electric vehicles and their contract terms. Energy Econ. 42, 313–324.
Philip, T., Whitehead, J., Prato, C.G., 2023. Adoption of electric vehicles in a laggard, car-dependent nation: investigating the potential influence of V2G and broader energy benefits on adoption. Transp. Res. A Policy Pract. 167, 103555.
Qian, L., Grisolía, J.M., Soopramanien, D., 2019. The impact of service and government-policy attributes on consumer preferences for electric vehicles in China. Transp. Res. A Policy Pract. 122, 70–84.
Rietmann, N., Lieven, T., 2019. How policy measures succeeded to promote electric mobility–Worldwide review and outlook. J. Clean. Prod. 206, 66–75.
Rotaris, L., Giansoldati, M., Scorrano, M., 2021. The slow uptake of electric cars in Italy and Slovenia. evidence from a stated-preference survey and the role of knowledge and environmental awareness. Transp. Res. A Policy Pract. 144, 1–18.
Secretariat of the Parliament, 2023. *Parliamentary Document 850, 154th Legislative Session 507th Case: Mileage Fee for the Use of Clean Energy and Plug-in Hybrid Vehicles Act No. 101 December 27, 2023*. https://www.althingi.is/altext/154/s/0850.html.
Sommer, S., Vance, C., 2021. Do more chargers mean more electric cars? Environ. Res. Lett. 16 (6), 064092. https://doi.org/10.1088/1748-9326/ac05f0.
STANDARDS Australia, 2024, December 10. What's new in AS/NZS 4777.1:2024? Key updates for inverter energy systems. https://www.standards.org.au/blog/as-nzs-4777-updates.
State of California, 2024. *California Road Charge*. https://caroadcharge.com/about (Retrieved November 20).
Sturmberg, B.C.P., Hapuarachchi, L., Jones, L., Lucas-Healey, K., van Biljon, J., 2024. Vehicle-to-grid response to a frequency contingency in a national grid. NPJ Sust. Mob. Transport 1 (1), 7. https://doi.org/10.1038/s44333-024-00010-8.
Taefi, T.T., Kreutzfeldt, J., Held, T., Fink, A., 2016. Supporting the adoption of electric vehicles in urban road freight transport–a multi-criteria analysis of policy measures in Germany. Transp. Res. A Policy Pract. 91, 61–79.
Train, K., 2009. *Discrete Choice Methods with Simulation*, second ed. Cambridge University Press. Doi: 10.1017/CBO9780511805271.
VicRoads. *ZLEV road-user charge* Retrieved 2022 from https://www.vicroads.vic.gov.au/registration/registration-fees/zlev-road-user-charge#:~:text=From%201%20July%202021%2C%20a,will%20pay%20their%20fair%20share.
Wang, N., Tang, L., Pan, H., 2017. Effectiveness of policy incentives on electric vehicle acceptance in China: a discrete choice analysis. Transp. Res. A Policy Pract. 105, 210–218.
Wolbertus, R., Kroesen, M., van den Hoed, R., Chorus, C.G., 2018. Policy effects on charging behaviour of electric vehicle owners and on purchase intentions of prospective owners: natural and stated choice experiments. Transp. Res. Part D: Transp. Environ. 62, 283–297.
Xu, C., Behrens, P., Gasper, P., Smith, K., Hu, M., Tukker, A., Steubing, B., 2023. Electric vehicle batteries alone could satisfy short-term grid storage demand by as early as 2030. Nat. Commun. 14 (1), 119. https://doi.org/10.1038/s41467-022-35393-0.