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Designing the User Experience for New Modes of Electric Vehicle Charging: A Shared Vision, Potential User Issues and User Attitudes

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ELECTRIC VEHICLE (EV) uptake has been increasing greatly and steadily over recent years. Vehicle-to-Grid (V2G), is an emerging energy system, with the potential to reduce peak loads and support the balance of the electricity grid. To benefit the 34% of the UK population without off-street parking, street furniture charging solutions have been developed. This requires the design of new services and digital interactions for buying, and selling back, electricity to the grid, leading to new customer experiences. The ultimate goal of this research is to understand and design these new user experiences. The overall system is complex, involving energy flows, financial flows, new technology, consumer interaction, and consumer acceptance. To explore the potential issues of a V2G-supported EV charging system and examine consumers' attitudes towards such system, a mixed-methods approach was employed. Part 1 of this paper specifically explores the creation of a holistic vision of consumers, EVs, street furniture charging solutions, and V2G. A workshop was organised with 22 participants from across the different specialisms within the project team. Consumer motivations, enablers, and barriers were explored. Part 2 of this paper examines consumer attitudes and intention-to-buy based on a scenario of V2G system, which was created with the foundation of the outcome from Part 1. Consumers showed positive views towards EV adoption, while the intention-to-buy V2G-supported EV charging system varied. Consumers tended to be cautious about making a full commitment to V2G packages. This paper also discusses the design implications for future research and practitioners.

Keywords: Vehicle-to-Grid; electric vehicle charging; street furniture charging solutions; user experience; mixed-methods approach

1 Introduction

To reduce the significant dependence on fossil fuels, discussions about how decarbonisation can be achieved through electric vehicles (EV) have been raised worldwide. The International Energy Agency suggests that EVs must make up at least 40% of new vehicle sales globally by 2040 (Axsen et al., 2017). Consequently, the increased adoption of EVs will invariably impact the local electricity grid due to the increased electricity demand. Smart meters and time-of-day tariffs can incentivise EV owners to charge at off-peak times, when wind and solar power are plentiful, and electricity is cheaper (The Guardian[1], 2017). However, even with the temporal shifting of demand peaks, the National Grid has warned

that (The Guardian[2], 2017) by 2030, electric cars could require 3.5-8GW of additional capacity, on top of the current peak demand of 60GW. To further lower the pressure on the grid caused by EVs, the batteries in these EVs are perfect external storages, to store electricity when it is plentiful, and give it back to the grid when it is in high demand. Researchers have explored an integration of EVs, which enables EVs to switch between the roles of electrical loads and energy resources. This integration is known as vehicle-to-grid (V2G) (Guille & Gross, 2009). V2G utilises bi-directional power transfer, so that the electricity grid can maintain reliable operations in a more economic manner. However, V2G remains at a nascent stage of technical development and research efforts in recent years mainly focus on solving technical problems. Very few have explored social acceptance, consumer needs, narrative visions of V2G as a future system (Sovacool et al., 2018), and it is still uncertain in which form V2G will be introduced to end consumers. In this paper, we intend to create a holistic vision of how V2G will be embodied and examine potential issues and consumers' attitudes towards the new EV charging system.

To achieve widespread EV and V2G adoption, V2G needs to penetrate commercial and residential markets. An important challenge is to deploy widespread V2G charging infrastructure that enables bi-directional charging and billing for EVs. A 2010 survey shows that 34% of the UK population does not have access to off-street parking (English Housing Survey Home, 2010), so on-street charging infrastructure is needed. Meanwhile, on-street charging infrastructure is facing a chicken-and-egg problem that people will not buy EVs if they cannot see that infrastructure is available, and local authorities will not install infrastructure if they cannot see the demand for EVs. Technically, *street furniture* charging solutions are viable: pilots have proven their optimal flexibility and space-saving features above standard charging points (Ubitricity, 2018). However, there is still a need for more understanding of consumer perception in terms of launching services to the market.

In our overall research, the ultimate goal is to design the user experience of a future EV charging system, which involves digital interactive technology and V2G technology delivered through street furniture charging solutions. The first step is to investigate consumer understanding and opinions. The aim of this paper is to:

- Create a holistic vision of how V2G will be embodied.
- Explore potential issues for the end-users of a V2G-connected EV charging system.
- Examine consumers' attitudes and intention-to-buy towards the new system.

At the inception of this research, a major challenge was how to sensitise people to a scenario of a grid-connected EV concept with street furniture chargers, such as lamp posts. This scenario does not currently exist which makes it difficult to ask people's opinions on them. Therefore, we decided to take a mixed-methods approach, in which Part 1 aimed to create a shared vision of V2G and provide materials for user engagement and Part 2 aimed to explore consumers' attitudes towards a V2G-connected EV implementation. This paper contributes to the knowledge of how diverse stakeholders view the new EV charging system at a high-level and how end consumers view such a system in terms of their attitudes and intention-to-buy towards this system. This paper provides detailed discussion about how this study can benefit future empirical researches and design practitioners in the context of V2G, EV charging, and street furniture chargers.

2 Related Work

2.1 The V2G Concept

Vehicle-to-grid (V2G) refers to efforts to bi-directionally link the electricity grid and the transportation system in ways that improve the sustainability and security of both. It describes a system in which EVs communicate with the electricity grid to import electricity from the grid and export electricity back to the grid. V2G creates a flexible and decentralised power system that supports load balancing, reduces peak loads, and helps to integrate intermittent renewable electricity generation to the grid. Research efforts in recent years mainly focus on exploring V2G at a theoretical and technical level, such as creating a conceptual framework for V2G implementation (Guille & Gross, 2009), developing an inductive power interface for EVs in V2G systems (Madawala & Thrimawithana, 2011), exploring an autonomous distributed V2G control scheme (Ota et al., 2012), modelling the cost of EV battery wear due to V2G application in power systems (Zhou et al., 2011), and estimating the achievable power capacity from EVs for V2G frequency regulation (Han et al., 2011). Very little existing research has focused on understanding consumer attitudes to EV-related technologies (Axsen et al., 2017). There are a number of demonstration projects that have brought V2G into the real world and have physically deployed V2G technology for a specific use case. A V2G global report has been produced to review the on-going and existing V2G-related projects (UK Power Networks, 2018). This report shows that almost all projects had a technical element (98%), while few focused on social aspects or the perspective of end consumers (27%) (UK Power Networks, 2018). This report emphasises the need for greater focus on user behaviour. For example, in the commercial project 'Parker' in Denmark, charge points and EVs were provided to the consumers. A fee per month was required which provided charger, maintenance, and tools to manage charging. The study demonstrated the importance of understanding detailed aspects of consumer behaviour, such as schedules, to manage when and how much to charge or drain the EV batteries. In this paper, we intended to create a holistic vision of how V2G will be embodied and test this vision via consumer engagement.

2.2 Street Furniture Charging Solutions

The implementation of charging infrastructure is a prerequisite for the diffusion of EVs and for a widespread V2G network. Studies show that the most commonly used charging location of EV owners is at home (70%), while 5% of them use the charging spots at their work place (Vassileva & Campillo, 2017). However, 34% of the UK population does not have access to off-street parking (English Housing Survey Home, 2010) and up to 85% of households in some urban residential areas must park on the street (Fleetworld, 2018). To encourage increased EV adoption by residents without off-street parking, on-street charging infrastructure is planned to be widely developed and deployed. Currently, researchers and companies have started to work on developing and testing on-street EV charging facilities. One promising type of on-street charge point is that installed on existing lamp posts (Warwick News, 2017), resulting in no requirement to add another power supply or dig up the road or pathway. In this project, we aim to focus on street-furniture, such as lamp post charge points, and how consumers perceive them in the context of the V2G concept. This paper intends to create a vision of a V2G-connected EV concept, where the electricity is delivered and retuned back to the grid through lamp post charge points.

2.3 Research Challenges

V2G is currently at a research and development stage with only a few pilots globally (UK Power Networks 2018), so the concept of V2G is not yet common knowledge (Axsen et al., 2017). The major challenge in this research is how to ask people to respond to questions regarding a future technology system, which does not yet exist and is rarely heard of. Axsen et al. used an interview protocol where researchers verbally explained to participants how utility-controlled charging (UCC – a new smart charging system) works, then directly followed by asking participants' opinions about UCC. They reported that participants could not easily conceptualise UCC, that more than half of the participants had trouble understanding how UCC would facilitate the electricity grid when researchers tried to explain the concept in basic terms. As they have addressed this problem in the paper that "*some of this confusion could be attributed to an inability of the researchers to successfully describe the UCC concept in an easy to understand manner*", this paper intends to take a different approach – Design Fiction. Design fictions can take the form of narratives, short stories, and semi-working prototypes. They have been used to re-consider existing or emerging ubiquitous computing technologies (Dourish & Bell, 2014) and to illustrate potential technologies and services (Briggs et al., 2012). In addition, visualisation has been proved to be an effective method in various fields of studies (Salter et al., 2009; Kantola & Jokela, 2007). Therefore, this paper intends to employ visualisation and design fiction, making the best use of sensitising concepts (Bowen 2006), to make it easier for participants to understand the new EV charging system.

3 Part 1

3.1 Study design

In Part 1 of the mixed-methods approach, we aimed to create a holistic vision of V2G-connected EV (V2G-EV) charging system and identify potential issues. A workshop was organised with 22 participants, representing stakeholders in this project. The holistic vision was created to show common understanding towards this new EV charging system among stakeholders. The potential issues were prompted in the workshop and framed into three topics – 'motivations', 'enablers', and 'barriers' to consumer adoption of V2G-EV technology. The three topics have been explored in the contexts of perception of new technology and willingness to engaging in a certain activity, such as bottom-up grassroots innovation in transport (Ross et al., 2012), voluntary participation in an online crowdsourcing platform (Baruch et al., 2016), and learning and knowledge sharing in virtual communities of practice (Ardichvili, 2008). The holistic vision was further used to generate a scenario for the purposes of sensitising participants in Part 2.

3.2 Participants

We organised and delivered a workshop with 22 participants from diverse backgrounds - design researchers (5), regulatory researchers (2), energy supplier (2), distribution network operator (1), local authorities (4), smart energy management (3), EV charging (3), and car club (2).

3.3 Study procedure and data analysis

The workshop consisted of two sessions. The first session aimed to form a high-level vision of how stakeholders and infrastructures are connected together within a V2G system. To encourage and stimulate discussions, a diagram was prepared (see figure 1). This was based on an existing schematic basic sketch of a V2G system (Ebbs and Flows of Energy

Systems) on which to scaffold participants' discussions. 22 participants were divided into three groups and each group had balanced backgrounds of expertise. During the 15 minute discussion, three questions were explored: (i) are the terminologies right in this diagram? (ii) are there any missing components or links? (iii) Where do the participants see themselves in this system? 5 minutes' presentation was allocated to each group to explain their understandings and opinions towards the V2G-EV diagram. The second session of this workshop aimed to enrich the vision of how the V2G system will be embodied, taking a consumer perspective. Participants were asked to discuss: (i) what are the main motivations that would drive consumers to consider V2G-EV charging system? (ii) what are the user enablers to consumer adoption of V2G-EV charging system? (iii) what are the user barriers to consumer adoption of V2G-EV charging system?

Three sets of data were collected from the three groups in the workshop. The data was qualitative in nature. Thematic analysis and Affinity Diagramming (Britz, 2000) was employed to group similar ideas together as a theme.

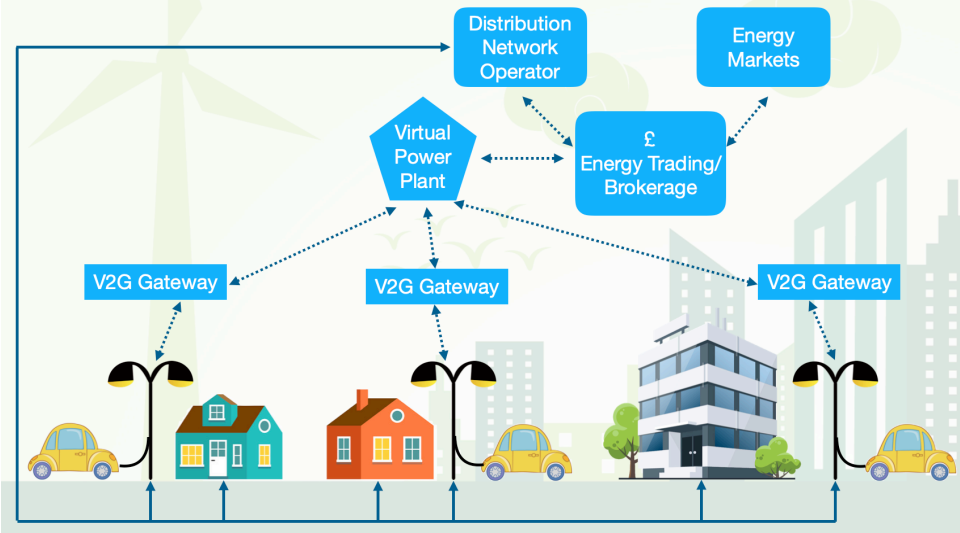

Figure 1. Diagram of how V2G stakeholders and infrastructures are connected.

3.4 Results

3.4.1 Shared vision of V2G at a high level

In the first session of the workshop, participants had a thorough discussion based on the V2G system diagram (see figure 1). This was an open-ended discussion, with participants representing the different stakeholders all exhibiting different perceptions. As shown in figure 2, firstly, street furniture charge points such as lamp posts are V2G gateways. These lamp post charge points can potentially be installed in residential, work, and leisure areas. When an EV is plugged in through a lamp post charger, this EV is connected to the electricity grid, where bi-directional charging can occur. At this moment, smart energy management companies (also known as aggregators in the context of V2G) play a part in controlling when to charge or discharge an EV. However, there are different levels of flow amongst all the stakeholders. The most important three levels of flow are energy flow, data flow, and monetary flow. In other words, the structure of how stakeholders communicate may vary, according to which virtual product is in discussion and which stakeholder is playing the 'interface' role of connecting V2G and end consumers. For example, if a consumer signs a contract with an EV charging company, the consumer only talks to this company in terms of

payment, electricity, and data sharing. At the back-end, this company will then work out the rest (e.g., electricity flows, how revenues are shared, and who has access to consumer data) with councils, aggregators, energy suppliers, and network operators. If the consumer signs a contract with an energy supplier, the whole package and cooperation agreements will change accordingly. But these agreements should not concern the end consumer. From a consumer research point of view, the vision shown in figure 2 does not need to illustrate the details of the aforementioned agreements (i.e. the green box can be 'hidden' from the consumer).

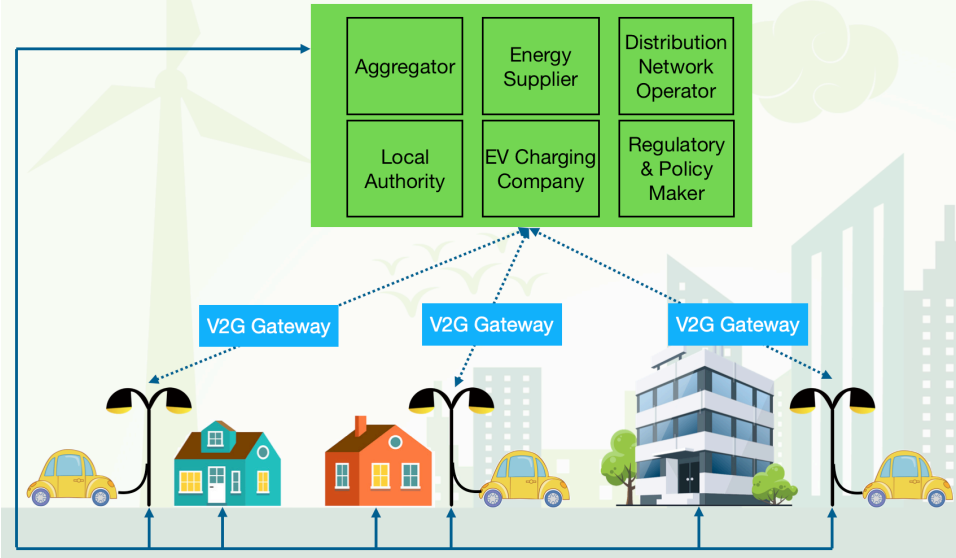

Figure 2. Shared vision of how V2G is embodied at a high level.

3.4.2 Motivations, enablers, and barriers

Motivations. To put flesh on the vision shown in figure. 2, the first topic that the participants were required to focus on was "What are the main motivations that would drive consumers to consider V2G-EV charging system?" Table 1 shows the most important five motivations in order of importance. The first motivation, financial benefit, was mentioned by all participants and ranked fairly high in everyone's list. Financial benefit refers to any form of income generation or cost saving, such as government incentives, savings in vehicle usage cost, cheaper electricity for charging, etc. Although participants have given explanations from different perspectives, they all strongly agreed that financial benefit is a significant motivation. Another major motivation is that consumers are looking for a better user experience, most importantly, the convenience of parking on street and charging through street furniture. There are three more motivations mentioned: environmental considerations (e.g. reducing carbon footprint and reducing emissions), interest in technology capabilities (e.g. trend setters and attractiveness of EVs), and social influence (e.g. peer influence and word-of-mouth).

Table 1 Motivations, enablers, and barriers to consumer adoption of V2G-EV systems

Motivations	**Enablers**	**Barriers**
1. Financial benefit	1. Competitive package	1. User unawareness
2. User experience	2. Reliability & Convenience	2. Fear/Uncertainty
3. Environment	3. Future regulation	3. EV market
4. Technology	4. Technical challenges	4. Current & future regulation
5. Social influence	5. User experience	5. User engagement

Enablers. The second topic that the participants were required to focus on was "what are the user enablers to consumer adoption of V2G-EV charging system?" The first enabler, a competitive package of EV charging, was mentioned by all participants. A competitive package is comprised of a financial aspect (e.g. costs of charging and charging cable, financial incentives, exemptions from road tax) and a functional aspect (e.g. guaranteed minimum level of battery, required plug-in length per day). Whether a package can meet a consumer's needs or not will significantly influence his/her opinions towards EV/V2G adoption. The next important enabler is the reliability and convenience of infrastructure, such as parking conditions and charging availability. The remaining three enablers are future regulation (e.g. government schemes), technical challenges (e.g. charging speed and battery performance), and user experience (e.g. ease of use, ease of registration, and flexibility of contracts).

Barriers. The third topic that the participants were required to focus on was "what are the user barriers to consumer adoption of V2G-EV charging system?" Table 1 shows the most significant five barriers, in which the top three are the most mentioned. User unawareness refers to the lack of knowledge and public information on V2G related topics, such as how V2G works, different packages of V2G, stability of electricity grid, performance of EVs, etc. For people who have some knowledge of EV/V2G, they may have fears and uncertainties that will deter them from adopting EV/V2G. For example, people worry about the degradation of battery caused by repeated charging and discharging, people fear the loss of control in terms of when to charge and discharge. Market factors such as the cost of EVs and limited options of EV models also play as barriers to consumers. Other barriers mentioned in the workshop are current & future regulations towards V2G and how consumers will finally behave and engage in the EV charging system.

4 Part 2

4.1 Study design

In Part 2, we aimed to explore consumers' attitudes to the V2G concept and their intention-to-buy. We conducted semi-structured interviews with 20 participants. The interview contained two parts: (i) an introduction to the new EV charging system in a set scenario, (ii) a paper-based questionnaire that contained questions about attitudes and intention-to-buy, followed by a brief interview to obtain participants' opinions towards this system. To sensitise participants to the V2G-EV concept, a scenario was created based on the outcome from Part 1 and current literature. The questions designed in the survey were developed from TAM (Park, 2009) and existing works that explore attitudes to, and intention-to-use, new technologies (Pavre et al., 2014). This paper only reports the results of the questionnaire.

The scenario used in Part 2 (see figure 3) was created on the foundation of the output from Part 1. The scenario was limited to an 'on-street parking only' community. Lamp post charge points were the gateways to access to the electricity grid, while there was a virtual organisation taking control of when to charge and drain the battery, along with how much battery. In this scenario, participants had owned an EV with a driving range of 270.04km, which is the minimum driving range of a fully charged Nissan Leaf. To better sensitise participants to this V2G-EV concept, a V2G package was presented with more details. The items in the packages were generated based on literatures (Hidrue et al., 2011; Parsons et al., 2014). In this scenario of signing up to a V2G package, consumers would: (i) get a free

cable to plug in, a reserved parking space at certain time slots, and the ability to plug in at any available lamp post charging point; (ii) get discount on charging rate and rewards on selling electricity back to the electricity grid; (iii) need to plug in a certain amount of time per day and pay monthly for all the services; (iv) get a guaranteed minimum level of battery and an App to view live battery updates and plan *ad hoc* journeys. The details were provided to the participant one at a time, thus 'building' their understanding, rather than overloading them with new information.

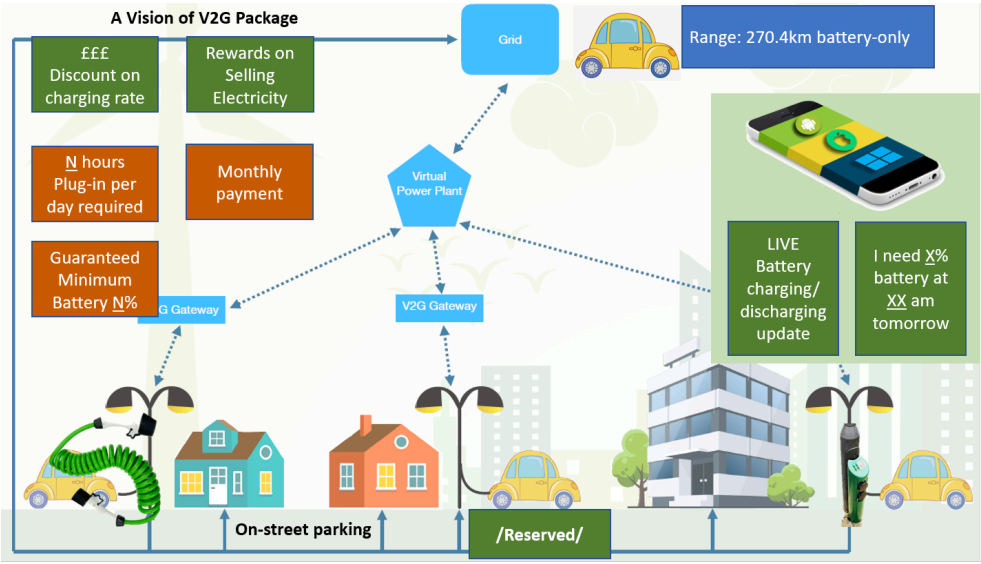

Figure 3. Design fiction of V2G-EV concept used in Part 2.

4.2 Participants

20 participants were recruited (male = 10, female = 10). The participants were from the area of Loughborough in Leicestershire, UK. A screening survey was used to select participants with a range of characteristics. It was challenging to recruit participants who had 'on-street parking only' and were 'interested in buying an EV'. This study was carefully designed to be accessible to participants who had little experience with EVs and/or related energy technologies.

Table 2 Participant information

Current vehicle	Conventional: 19	95%
	Electric vehicle (hybrid and pure battery): 1	5%
Drive to commute	Yes: 16	80%
	No: 4	20%
On-street parking only	Yes: 6	30%
	No: 14	70%
Interested in buying an EV	Would consider buying one: 18	90%
	Have not given it a thought: 2	10%
Knowledge about EVs	Nothing about EVs: 1	5%
	A little about EVs: 10	50%
	Fair amount about EVs: 6	30%
	A lot about EVs: 3	15%

4.3 Study procedure and data analysis

Face-to-face interview was employed, plus a Likert scale, to elicit participants' attitudes and intention-to-buy towards the V2G-EV charging system. This method allowed dynamic

interaction between the researchers and participants. Each interview was completed within one hour. All interviews were conducted between January 2019 and March 2019. The interview protocol included two sections (see table 3). The attitudes towards a new technology and intention-to-use a technology have been examined in related works, such as using E-learning (Park, 2009) and using automated cars (Pavre et al., 2014). In terms of the data from the questionnaire, descriptive analysis was employed since the sample size was too small to allow statistical analysis. To see the statements used to measure attitudes and intention-to-buy, please refer to Table 4.

Table 3 Part 2 study protocol and data information

Study 2 Protocol		Variable	Data type	Analysing method
Section 1	Scenario	See figure 3	N/A	N/A
Section 2	Questionnaire	i. attitudes ii. intention-to-buy	Likert scale	Descriptive analysis

4.4 Results

A V2G package was presented to participants to give them a view of a future V2G-EV concept. This paper only reports the results of the survey. 5 point-Likert scale questions (1 – strongly disagree to 5 – strongly agree) were asked. Table 4 shows the survey statements and the results of the descriptive analysis. The participant sample size was relatively small and the collected data did not show normal distribution, so the median value was used in data analysis since it is less affected by outliers and a skewed dataset.

Overall, consumers' attitudes towards EVs and V2G scheme (statements 1-6) were positive (median values = 4 or > 4), that they liked the idea of having more EVs in the future and believed that the V2G scheme had more advantages than disadvantages. However, the intention-to-buy showed variations. Participants were cautious about buying EVs (median values = 3 in statements 7-9). It could be explained from the brief interview that participants had uncertainties about EVs, such as the driving range, the ease of getting access to charging points, and whether EVs are as 'green' as advertised. On the other hand, participants showed an intention to sign up to V2G packages and a willingness to use V2G features to some extent (median values = 4 in statement 10 and 12). Most participants expressed an intention to sign up to V2G, that they liked the idea of using EV batteries as distributed electricity storage to reduce the overall use of fossil fuels to generate electricity. However, participants also expressed that V2G would bring inconvenience and they would need to re-plan their driving patterns before-hand to function better with such V2G packages.

Table 4 Attitudes and Intention-to-buy towards V2G-EV system

	Statements	Median
Attitude – EV	1. I like the idea of encouraging more pure battery EV adoptions.	4.5
	2. To me, increasing of pure battery EV adoption has more advantages than disadvantages.	4
	3. I like the idea of having a pure battery EV.	4
Attitude – V2G	4. I like the concept of V2G scheme.	4
	5. To me, the concept of V2G scheme has more advantages than disadvantages.	4
	6. I like the idea of having a pure battery EV and signing up to V2G scheme.	4
Intention-to-buy – EV	Imagine, When I do not have a pure battery EV:	
	7. I intend to buy one for my next vehicle.	3

	8. I intend to buy one that supports V2G for my next vehicle.	3
	9. I intend to pay more for a pure battery EV that supports V2G, compared to a pure battery EV that does not support V2G.	3
Intention-to-buy – V2G	Imagine, When I have a pure battery EV that supports V2G:	
	10. I intend to sign up to V2G scheme.	4
	11. I intend to use V2G features to the fullest.	3
	12. To the extent possible, I would use some V2G features when my situation allows.	4

5 Discussion

5.1 Study methods

With regard to the method used in Part 1 to reach the shared vision, the diagram (figure 1) was an effective starting point to stimulate discussion. Different components and structures in the diagram were mentioned amongst groups, such that it was challenging to combine the three group diagrams and create a universal version of the holistic vision. This reflects the complexity of this V2G-EV charging system and this workshop with stakeholders helped to reveal the different possibilities of V2G-EV. With regard to the method we used in Part 2 to examine consumers' attitudes and intention-to-buy, a visualised V2G-EV concept (figure 3) that illustrated a potential V2G package played an effective role in sensitising participants and enabling them to express opinions. The outcome from Part 1 acted as a foundation to feed into the design of this vision of V2G-EV concept.

5.2 Design implications

With relation to how the findings from this paper can guide practitioners to design user experiences of a future V2G-EV charging system, this section summarises the following implications:

(1) Consumer segments and needs should be studied at the beginning of consumer research, because individuals have different attitudes and lifestyles and what they need from a V2G-EV package may vary. Based on the existing research (Axsen et al., 2017) and the findings from this workshop, four types of consumers are identified according to motivations. The four types of consumers are cost-, convenience-, environment-, and technology-motivated. What they need from a V2G-EV package will differ. Cost-motivated consumers consider financial benefit as the top priority. They would potentially choose a V2G-EV package that will give them the maximum financial reward. Convenience-motivated consumers care about whether charging or parking is convenient, and they might be willing to pay more for a reserved parking space to plug in their EVs. Environment-motivated consumers care more about the biophysical environment and they might be sensitive to sources of the electricity they consume and whether it is 'green' (renewable). Technology-motivated consumers pursue the 'cool' factor of new technology, so they might want to be updated with live EV data, such as charging status, battery status, etc.

(2) Part 1 also enabled the identification of a number of *neglected dimensions for V2G transition*. These are: an effective approach to tackle consumers fears that they will lose control of their EV's charge level if they sign up to V2G-EV packages; a reserved parking space if V2G-EV packages require EV owners to plug in for a fixed length of time per day; a good education scheme so that more people are aware of how V2G works and its

capabilities; and a positive word-of-mouth about V2G, which is the best free advertising tool. We recommend considering and incorporating these dimensions into future practice.

(3) Part 2 found that consumers tended to be quite open in terms of using V2G scheme but feel cautious about signing up to contracts and making a full commitment to V2G packages. We recommend considering the factor of flexibility in V2G packages, such as allowing consumers to switch between packages or to change driving plans with very short notice. The V2G system should also have the ability to learn from consumers' driving patterns and link this to the consumers' schedule, so that the V2G system can automatically plan out the reasonable level of battery needed and provide information such as available charging points en route.

6 Conclusion

This paper presents a study with a mixed-methods approach that aimed to investigate consumers' views towards a new electric vehicle charging system with street furniture chargers. Since it was challenging to verbalise the concept of V2G to participants, a holistic vision of how V2G will be embodied was created among stakeholders in Part 1. This vision was re-designed in Part 2 to create a V2G-EV concept with a hypothetical V2G package for the purposes of sensitising participants. In Part 1 of the study, we organised a discussion among stakeholders and identified five 'motivations' to consumer's adoption of V2G-EV system: financial benefit, user experience, environment, technology, and social influence; five 'enablers': competitive package, reliability & convenience, future regulation, technical challenges, and user experience; and five 'barriers': user unawareness, fear/uncertainty, EV market, current & future regulation, user engagement.

In Part 2 of the study, we measured 20 consumer's attitudes and intention-to-buy towards the V2G-EV charging system. Given the limited number of participants of this part of the study, caution should be taken in generalising results to a wider population. Our results show that consumers had positive views towards more EV adoptions, while the intention-to-buy towards V2G-EV system varied. Consumers tended to be cautious about making 100% commitment to V2G packages because they needed to consider other factors, such as convenience of the use of car, financial incentives, flexibility of V2G packages, and the policing of reserved charging points. The findings from Part 2 revealed the perceptions of end consumers and they complemented the findings from Part 1, which viewed consumer needs from the perspective of stakeholders.

In the future studies, we intend to examine how potential consumers perceive V2G packages, in terms of overall perception, positive and negative aspects of V2G, uncertainties of V2G, and suggestions to improve V2G services.

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