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Does experience matter? Assessing user motivations to accept a vehicle-to-grid charging tariff

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ABSTRACT

Vehicle-to-grid (V2G) could be a cornerstone to ensure the efficient integration of a large number of electric vehicles (EVs) and the resulting electricity demand into the energy system. However, successful V2G adoption requires direct interaction with the EV user. To explore user preferences and requirements in the context of a V2G charging tariff, we conducted a survey (N = 1196). We assess users' minimum range requirements and willingness to pay for a V2G charging tariff and relate them to users' experience with EVs. By building a mediation model, we evaluate the importance of three charging strategies to guide users' minimum range requirements and expected monetary savings. The results reveal EV owners' preference for a climate-neutral charging strategy, leading to a higher readiness to accept lower minimum ranges and lower monetary savings. These results are especially important to aggregators, aiming to design profitable business models, while accounting for user requirements and preferences.

1. Introduction

Electric vehicles (EVs) are one essential element of worldwide political strategies to reduce CO_2 emissions in the transport sector and thus tackle climate change. Since the transport sector is responsible for about 25% of CO_2 emissions worldwide and about 20% in Germany (International Energy Agency, 2021; Federal Ministry of Economic Affairs and Energy, 2021), the coalition agreement of the newly elected German government aims for 15 million EVs by 2030 (SPD, Bündnis 90/Die Grünen and FDP, 2021). However, the further adoption of EVs will lead to increased electricity demand and consequently poses new challenges to the grid (Babrowski et al., 2014; Das et al., 2020; Blumberg et al., 2022). Yet, utilizing EV storage has the potential to provide additional decentralized flexibility for the electricity system (European Association for Storage of Energy, 2019; Doluweera et al., 2020; Gunkel et al., 2020; Blumberg et al., 2022).

Vehicle-to-grid (V2G) as a particular form of smart charging is increasingly seen as a promising technology. Due to the quick response time (Kempton and Tomić, 2005a) and the geographic and temporal flexibility of EVs (Knezovic et al., 2017), V2G allows for more efficient EV integration in the energy system (Kempton and Letendre, 1997; Kempton and Tomić, 2005b; Blumberg et al., 2022). With the aid of V2G, the battery of EVs can serve as mobile storage and have the ability to feed electricity back into the grid. Numerous

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advantages are expected from V2G, such as more reliable and efficient grid operation and, consequently, higher potential for integrating renewable energy sources (RES) into the grid (Schuller et al., 2015; Dixon et al., 2020; Blumberg et al., 2022). With this, V2G is envisioned to contribute to a more decentralized, secure, and flexible energy system (Sovacool and Hirsh, 2009).

This study focuses, in particular, on the user perspective of V2G, as the technology in question directly involves the EV user, requiring a certain level of user compliance to be successfully implemented (Bühler et al., 2014). The amount of flexibility that is provided is dependent on the user's decision to plug in the EV (Bailey and Axsen, 2015). Moreover, V2G charging might involve reduced flexibility or increased planning (Franke and Krems, 2013; Franke et al., 2018), as the charging process could interfere with the user's lifestyle and driving behavior (Sovacool et al., 2017). Besides this interference, V2G also yields a perceived loss of control over the charging process (Delmonte et al., 2020; Krueger and Cruden, 2020; Yilmaz et al., 2021). Another relevant constraint impacting users' willingness to participate in V2G is the concern of a shortened battery life due to V2G (Krueger and Cruden, 2020). Thus, V2G requires an adjusted charging behavior and, most importantly, acceptance by the user. Consequently, to promote the launch and uptake of this technology, it is necessary not only to investigate the technical feasibility, but also the preferences and requirements of future users.

Given these perceived barriers to V2G, it is important to examine under what circumstances users will accept and engage with them. Previous studies investigate adequate compensation and requirements from a user perspective by assessing the discomfort costs to provide flexibility in the context of a power supply contract (Kubli et al., 2018) or by determining the willingness to accept V2G (Lee et al., 2020). Moreover, a further common approach is to assess the monetary value of V2G attributes, such as the minimum range (Bailey and Axsen, 2015; Geske and Schumann, 2018; Huang et al., 2021). These studies allow a quantified assessment of consumer preferences for specific EV attributes and their monetary valuation. By contrast, we approach this topic by assessing users' willingness to pay (WTP) in terms of a two-level charging tariff.[2] Users' WTP not only reflects an acceptable price for providing flexibility, but also on users' expectations in respect to possible savings due to V2G. We consider the actual net-charging cost, which is the primary mechanism of the aggregator[3] to compensate for V2G (Ensslen et al., 2018). By including an individually chosen minimum range,[4] we furthermore account for minimum requirements regarding a V2G charging tariff. Minimum range and WTP are essential parameters to both EV users and aggregators as they define user conditions and requirements on the one hand and flexibility potentials on the other.

However, stating one's own WTP for a V2G charging tariff presupposes a certain prior knowledge and interest. Since knowledge and interest with regard to the energy system are in general limited (Huber et al., 2019), results of previous studies suggest that users' experience with EVs represents a critical factor in creating an informed decision about issues in the realm of V2G (Noel et al., 2019a; Chen et al., 2020) and is one relevant variable explaining adoption (Bühler et al., 2014; Larson et al., 2014; Schmalfuβ et al., 2015; Sovacool et al., 2018; Sovacool et al., 2019a; Sovacool et al., 2019b; Chen et al., 2020; Kubli, 2022). While these studies solely focus on one stakeholder group, we believe that precisely the comparison between non-experienced users and EV-experienced users might be the key to drawing conclusions on how to motivate these different target groups. We argue that it makes a difference whether individuals regularly use their EV and are familiar with the technological peculiarities, already have gained experience in driving an EV in solitary events, or have no experience at all with EVs.

Just like the level of EV experience, motivations and benefits can guide users' evaluation of minimum range and WTP for a V2G charging tariff. Previous literature highlights several factors motivating the user to participate in or accept V2G. One of the most prominent motivations is a higher integration of RES and reduced CO_2 emissions (Geske and Schumann, 2018; Noel et al., 2018; Kubli, 2022). Moreover, contributing to grid stability is another motive to consider V2G (Kubli, 2022), despite potentially higher battery degradation or loss of flexibility (van Heuveln et al., 2021). Finally, existing literature highlights the importance of monetary benefits to participate in V2G (Geske and Schumann, 2018; van Heuveln et al., 2021). From a grid operator's perspective, grid stability and RES complement each other well, especially since expensive energy storage or backup capacities for balancing intermittent RES would (mostly) be redundant (Lund and Kempton, 2008; Bailey and Axsen, 2015; Sovacool et al., 2017). These findings are supported by energy system modelling approaches including V2G as a flexibility option. Utilizing flexibility in order to manage grid congestion decreases the necessary curtailment of RES and consequently leads to a more economical and less carbon-intensive result (Staudt et al., 2018; Szinai et al., 2020).

While there is evidence that different motives (environmental, grid-beneficial, financial) exist to foster participation in V2G, the question remains whether and to what extent these aspects relate to user experience with EVs. Moreover, we are not aware of any study which has tested these motives with regard to users' WTP and minimum range requirements. Thus, we designed three charging strategies based on the most important motives, i.e. climate-neutral, grid-beneficial, and cost-minimized charging. Charging strategies are described as a bargain between the vehicle user and the aggregator (Geske and Schumann, 2018). Assessing whether and how these

[2] Emodi et al. (2022) highlight the fact, that an EV charging tariff constitutes the interface between the EV owner and the aggregator. (Potential) EV owners conclude an electricity tariff to charge their EV at home. Depending on the tariff conditions, these tariffs incentivize a specific charging behavior and thus enable the operator to raise flexibility potentials.

[3] Aggregators can be defined as a third party, combining individual EVs to participate in the electricity market (Das et al., 2020; Noel et al., 2019b). By doing so, EVs can provide complex electricity grid services (Noel et al., 2021). Thus, the main task of the aggregator is to “gather (…) information about the market situation, schedule (…) charging and discharging according to the bargained rules and expected revenues” (Geske and Schumann, 2018).

[4] According to Bauman et al. (2016), setting a minimum range is a necessary condition to users, especially in the early adoption stage, to accept controlled charging. We base our definition of the minimum range on Ensslen et al. (2018) and define it as the minimum necessary range, that EVs must always be able to cover in unpredictable cases, i.e. for example an emergency case.

motives influence users' WTP and the evaluation of the minimum range can be an important first step towards guiding prospective business models.

The novelty of our approach lies in investigating the role of user experience and underlying motivations to evaluate WTP and minimum range requirements for a V2G charging service. Based on the findings of our paper, it is thus possible to derive stakeholder-specific recommendations. With our study, we aim to contribute to the existing body of research by answering the following research question: *How does EV experience influence user requirements with respect to minimum range and required savings within a V2G charging tariff and to what extent do underlying motives influence this relationship?*

This paper offers a quantitative comparative assessment, including the perspectives of 264 EV owners, 241 people with medium EV experience, and 691 respondents with no EV experience on a V2G charging tariff. Thereby, we present one of the few studies including a comparatively large share of EV owners in Germany. It is assumed that the perceptions and knowledge of individuals with different levels of user experience differ for the V2G systems. In other words, V2G is evaluated differently by those who own an EV and those who did not yet buy or got the chance to test an EV and thus do not necessarily have an updated and informed perception of this technology and its usage. Finally, besides experience, we also test different motivations that have the potential to guide users' WTP preferences in a V2G tariff.

The remainder of this paper is structured as follows: In Section 2, we provide a literature background on previous studies assessing user's WTP. Section 3 describes the research design, including data collection, study design and the data analysis strategy. In Section 4, we present our results, which will be discussed in Section 5. We conclude with an outlook for possible future research (Section 6).

2. Literature background

In this section, we review the most important empirical studies determining users' WTP for V2G. Especially in the context of a V2G tariff, the relevance of the minimum range (SoC_{Min}) is emphasized.

In future, the purchase price for an EV that will be able to feed electricity back into the grid, as well as the possible earnings that could be generated with V2G, will be of high importance to consumers. A summary of past studies investigating users' WTP in the context of V2G is shown in Table 1. We identified two research streams: The first stream deals with the vast majority of papers investigating users' WTP for specific V2G attributes, thus assessing the importance of these attributes. The second stream focuses on the compensation that users claim in order to provide flexibility.

2.1. Assessing WTP for EV attributes in the context of V2G

Most of the studies applied stated preference methods, such as discrete or stated choice experiments to assess users' preferences and monetary valuation for different EV attributes in the context of V2G. In this regard, a sizeable body of research discusses the EV range. The vehicle range is by far the most common attribute and received high monetary values. Minimum and maximum EV ranges are thus still perceived as a possible hindrance to flexible mobility behavior and, therefore, one essential feature in order to participate in a V2G service (Hidrue et al., 2011; Geske and Schumann, 2018; Huang et al., 2021). A theoretical explanation of this circumstance is provided by Bühler et al. (2014), highlighting that range will remain important for accepting EVs and specifically V2G due to persisting perceptions of mobility requirements.[5] This insight is taken up by Bailey and Axsen (2015), who use a latent class model to identify trade-offs between different attributes (percentage of green electricity, source of green electricity, guaranteed minimum charge, monthly electricity bill) of a utility-controlled charging program. The authors find a high WTP for an increase of the guaranteed minimum charge. The high WTP for extra ranges is reconfirmed by Geske and Schumann (2018), who conclude that fear of restrictions of freedom and independence negatively affect users' willingness to participate in V2G. They acknowledge that immobility due to V2G poses, by far, the greatest risk to consumers. Similarly, a recent study by Huang et al. (2021) emphasizes that the acceptance of the minimum battery level is largely influenced by the recharge time and the availability of fast charging for the EV.

Literature thus demonstrates the significant role of the minimum range for V2G. To account for this, we included the minimum range as a feature in our two-level charging tariff (Section 3.2.1). Contrary to the previously mentioned literature, we did not assess the monetary value thereof, but a specific range. Doing so is particularly important when designing a V2G charging contract, as it marks the accepted upper limit of the flexibility potential that can be used by the aggregator. Likewise, flexibility in V2G contracts can be restricted due to contract terms that commit a certain number of hours to the aggregator (Hidrue and Parsons, 2015; Al-Obaidi et al., 2021). In both ways, flexibility can be harnessed, potentially contributing to integrating higher shares of RES into the electricity system.

One of the few studies that related preferences for V2G attributes to EV user experience was conducted by Noel et al. (2019a). This comparative study in the Nordic region elaborates on the WTP for several EV attributes and found i.a. a high marginal WTP for additional range. Even for high ranges, the marginal WTP was high. The study shows that EV experience impacts EV choice, but that previous knowledge of V2G technology does not influence users WTP for V2G (Noel et al., 2019a). By focusing on different levels of user experience with EVs, our study design allows a more detailed investigation of this aspect.

[5] Bühler et al. (2014) describe this phenomenon as societal resistance to change. According to the authors, users have a very specific understanding of car characteristics and features. Range is one of these must-have characteristics that significantly varies from that of cars with internal combustion engines.

Table 1
Review of past WTP studies in the context of V2G.

Reference	Method	Target group	Country	Sample size	WTP
Assessing WTP for EV attributes in the context of V2G					
Geske and Schumann, 2018	Discrete choice experiment	Vehicle users	Germany	611	WTP for one km of minimum range between €3.88 - €6.45 / km
Bailey and Axsen, 2015	Stated choice experiment	New vehicle buyers	Canada	1470	Increased guaranteed minimum charge by 10% was valued at CAD-$47 / year (€33 / year.)[a]
Huang et al., 2021	Stated choice experiment	EV drivers	The Netherlands	148	WTP for a guaranteed minimum battery level increase of 1% / month: €5.91; quick recharge: €2.73; additional discharge cycle: €6.81
Noel et al., 2019a	Stated preference survey	Representative randomized and non-randomized sample	Nordic region	4762	3802 – €5209 WTP for V2G capability in EV
Hidrue and Parsons, 2015	Contingent valuation survey	Car buyers	United States	3029	Median WTP ranges from $10,200 (€9005) for a V2G EV without range extender to $22,900 (€20,219) for the Civic model with range extender
Compensation for providing flexibility and accepting V2G					
Parsons et al., 2014	Stated preference survey	Representative sample	United States	243	Median cash-back: $2368 - $8622 / year (€2091 - €7613 / year)
Kubli et al., 2018	Choice experiment	PV owners, EV owners, heat pump owners	Switzerland	300	Discomfort costs due to V2G: CHF 3.85 – CHF 45.16 (€3.72 - €43.71)
Lee et al., 2020	Contingent valuation approach	Stratified random sample	South Korea	1007	Willingness to accept (WTA) $8.83 / month and vehicle (€7.79 / month and vehicle)
Kubli, 2022	Choce experiment	Current and potential EV adopters	Switzerland	202	Net willingness to accept (WTA): – Charging location: -CHF 6.45 (-€6.24) (charging from work compared to home-charging) and -CHF 10.36 (-€10.03) (charge at public space compared to home-charging) – Charging duration +CHF 3.57 (+€3.46) (4 h compared to 6 h) and +CHF 6.95 (+€6.73) (2 h compared to 6 h) – Guaranteed charging (eco charging compared to standard charging): -CHF 4.33 (-€4.19)

[a] To better compare the values, we translate all currencies into EUR and place these values in brackets behind the original value and currency. We base the translation on the exchange rate (31st of December 2021) from the European Central Bank (German Central Bank, 2022).

2.2. Compensation for providing flexibility and accepting V2G

There is abundant technical research investigating EV user revenues, for example for vehicle-to-home and arbitrage trading (e.g., Kern et al., 2022), ancillary services (e.g., Bishop et al., 2016; Gough et al., 2017), primary frequency regulation market (e.g., Bañol Arias et al., 2020) and peak-shaving (e.g., Li et al., 2020). However, investigating the adequacy of these revenues from a user perspective has been researched far less often.

When investigating adequate compensation and requirements for providing flexibility from a user perspective, empirical studies applied mostly stated choice experiments. While Lee et al. (2020) assess EV owners' willingness to accept (WTA) a V2G service, Kubli et al. (2018) focus on the co-creation of flexibility and thus compare the three technologies photovoltaic (PV) with battery storage, electric mobility, and heat pumps. One remarkable result of the latter study is that the sensitivity for the flexibility attribute is low and that the part-worth utility function dropped for guaranteed charging levels below 60%. Moreover, the authors find high discomfort costs to provide flexibility in a power supply contract (Kubli et al., 2018). In a recent study by the same author, the question of how much compensation is required to adjust the charging location, duration and range to facilitate smart charging is pursued (Kubli, 2022). The author summarizes that an attractive remuneration has to be paid to incentivize users to chose another option when home-charging is available. The same could be observed by Parsons et al. (2014), who found very high cash-back values, i.e. very high discount rates, implying that buyers attach high importance to flexibility and lifestyles. Thus, the authors recommend either offering up-front price discounts on V2G vehicles or offering a pay-as-you-go contract (Parsons et al., 2014). These studies show that potential users demand very high discounts or overestimate the value of specific attributes, such as range. It is unclear whether this circumstance is due to individual inexperience with V2G or whether buyers simply value freedom of mobility that high.

3. Materials and methods

To address the research question raised in the introduction, a study was conducted to evaluate the user perspective on tariff options and business models for V2G. In the following section, the data sampling process and the research design is presented. Moreover, we describe the methodological approach we used to assess users' willingness to pay.

3.1. Data collection and sources

We conducted an online survey in January and February 2021. For data collection, we combined randomized and purposive sampling to increase the share of EV experienced people and EV owners. These target groups are still underrepresented and thus harder to reach in Germany (cf. Sovacool et al., 2019c). In 2021, the share of EVs accounted for only ~ 1.2% of the German car fleet (Federal Motor Transport Authority, 2022), and thus, we expected little experience with EVs in the overall population. As Sovacool et al. (2019a) argue, previous studies in the context of EVs or V2G build their research on randomized samples, potentially biasing the results or limiting the validity due to the lack of experience with the technology in focus. We addressed this potential limitation by using purposive sampling (Maxwell, 2009).

The survey was designed to provide insights from people with different levels of EV experience and distributed anonymously online. Only people older than 17 years owning a driving license participated in the survey. The sample is based on three data sources: First, data was recruited from a German market research company, offering a representative national panel. Respondents were admitted to complete the questionnaire until we received a population-representative sample regarding age, gender, and federal state. Moreover, as noted previously, we expected EV owners to differ from people with little to no EV experience regarding their awareness and understanding of V2G technology (cf. Axsen et al., 2016). To test this assumption, we also placed the survey in e-mobility forums. Furthermore, the survey was distributed among the internal CENTOURIS[6] pool of potential participants who own an EV, which has been successively built up through corresponding projects. We provided an incentive to respondents participating via these pools. A list of the forums can be found in Appendix A. It is important to note that this additional data is not population-representative. After the survey period was completed, data control was conducted, eliminating data according to previously determined quality standards. A reliable indicator of low response quality is speeding (Conrad et al., 2017; Leiner, 2019). We, therefore, excluded all respondents who could be identified as speeders. Moreover, we checked all responses regarding their plausibility. The final sample is comprised of 1000 valid responses originating from the panel data, 109 valid responses from the EV online forums, and 87 valid responses from the internal CENTOURIS EV user pool (see Fig. 1).

3.2. Survey design

The survey consisted of four parts: In the first part, we assessed sociodemographic characteristics of the respondents, including questions relating to their EV experience (see Section 3.1). We evaluated the respondents' previous experience with EVs[7] based on two questions: *Is an electric vehicle available in your household?* and *Have you already driven an electric vehicle (*e.g. *test drives)?*. Based on the answers, we grouped all respondents according to their level of EV experience into three groups: "low user experience", "medium user experience" and "high user experience" (see Fig. 1). We conducted all of our further analyses for these three groups.

In the second part, a short explanatory video clip introduced the concept of V2G to the respondents, explaining the interplay between the energy system, V2G charging and the possibility to generate revenues due to flexibility provision. Afterwards, we introduced the term minimum range and outlined the V2G tariff design (see Section 3.2.2). We included several quality checks to assess whether participants understood the V2G concept and the charging tariff design, before asking participants about their preferred minimum range (see Section 3.2.1) and their willingness to pay (see Section 3.2.3) in open-ended questions. Moreover, we assessed participants' preferences concerning their preferred charging strategy (see Section 3.2.4). Furthermore, questions in the study addressed users' preferences regarding the design of possible business cases and tariff models. These questions included accepted investment cost and amortization periods and preferred compensation models and contracting parties. These results are elaborated in more detail in Kellerer et al. (2022). In the final part, we introduced five-point Likert scales to evaluate participants' environmental concern, self-efficacy and technological affinity. We closed the survey by asking questions related to household characteristics.

3.2.1. Determining the preferred minimum range

In the framework of V2G, previous research assigns particular importance to the minimum range (see Section 2.1). Therefore, in a first step, respondents provided their minimum range requirements in an open-ended question: *How many kilometers should your electric car always be able to cover in unpredictable cases, for example, in emergency situations? Please think of the range with which you would just feel safe.*

The answers were provided in km (see also Appendix B for the exact wording). For assessing users' WTP, this range determined the basis for the second tariff level.

3.2.2. V2G tariff design

A special two-level charging tariff was developed and outlined to the participants to evaluate users' preferences regarding possible business models and electricity prices in the V2G scenario (Table 2). This tariff was inspired by an EV-specific controlled charging tariff

[6] CENTOURIS – center for data-based insights is a proper noun and is an institute of the University of Passau.

[7] In this study, the term EV refers exclusively to an externally chargeable passenger car that is operated purely on battery power or in combination with an internal combustion engine as a plug-in hybrid.

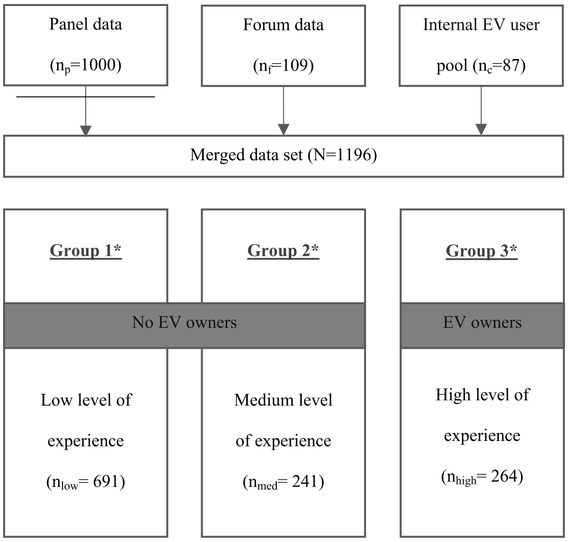

Fig. 1. Data sources. *SD04: Is an electric vehicle available in your household? Yes - No AND SD05: Have you already driven an electric vehicle (e.g. test drives, etc.)? Yes – No.

developed by Ensslen et al. (2018) and solely focuses on the net-purchasing price of electricity[8] to charge the EV in an AC charging mode.

The tariff design that we created is comprised of two levels: At the first tariff level, the EV will be promptly charged until reaching a self-selected “minimum”- state-of-charge (SoC_{Min}), which can be set individually. The electricity price for the first tariff level was predetermined to be €5.20 / 100 km, based on the average electricity price in Germany in January 2021 (€0.34 / kWh) and the Worldwide Harmonized Light-duty Vehicles Test Procedure (WLTP) consumption of a BMW i3 (15.3 kWh / 100 km). The second tariff level described the V2G phase. At this level, plugged EVs can be charged and de-charged within the individual settings for the desired range and time of departure.

3.2.3. *Willingness to pay for a V2G charging tariff*

Determining a customer’s WTP is an essential step in the pricing process when introducing a new product. This is the case for new vehicle technologies and concepts, such as V2G. Yet, determining customers’ WTP for a V2G charging tariff is a hypothetical setting where the respondents express their WTP without any actual experience with the product (cf. Jensen et al., 2013). Bühler et al. (2014) point to the fact that users tend to inaccurately predict the value of the product if no experience is available. To approach this issue, we chose a mixed-randomized and non-randomized sampling technique (see Section 3.1).

Different methods to determine users’ WTP can be found in existing literature. The main methodological distinction is made by direct or indirect measurement of customers’ WTP and by the context which asks for a hypothetical or actual WTP (Miller et al., 2011). We chose to apply the price sensitivity meter (PSM) by van Westendorp, an indirect method to identify users’ WTP (van Westendorp, 1976). The primary advantage of this method is that the focus is set on the price of a product and not on other attributes (Breidert et al., 2006). Moreover, the method is based on the assumption that a price range exists, which is bounded by the maximum and minimum that users are willing to pay (cf. Larson et al., 2014). However, a downside of this method is that respondents might over- or underestimate their WTP (Breidert et al., 2006; Hofstetter and Miller, 2009). One reason might be the lack of knowledge to estimate a price. In particular, complex and unfamiliar products lead to over- or underestimations of prices (Brown et al., 1996). In the literature, these theoretical disadvantages have been examined. Yet, the superiority of indirect methods such as the conjoint analysis could not be proven (Völckner, 2006).

Following the PSM approach, participants in the web-based survey were asked the following four open-ended questions (cf. Appendix C) to evaluate the second tariff level of the previously determined two-level charging tariff design: *At what average price per 100 km of range would you consider V2G charging….*

a) …*too expensive, i.e. you would definitely look for a cheaper tariff?*
b) …*expensive, i.e. you would only conclude the contract after careful consideration?*
c) …*cheap, i.e. the tariff would be a bargain?*

[8] Recently, a law in Germany has become effective that regulates the feeding in of electricity from the EV into the grid (Federal Ministry of Ecomonic Affairs and Climate Action, in charge, 2022). However, at the time of data collection, this law was only discussed in Germany and no law was effective in the European Union, which is why considering selling electricity in the framework of a V2G charging tariff was, from a regulatory perspective, not possible (European Association for Storage of Energy, 2019).

Table 2
Two-level charging tariff design.

Charging level	Charging mode	Definition
1st tariff level	Uni-directional charging	Instant charging until the individually chosen SoC_{Min} is reached. The price for this mode is €5.20 / 100 km.
2nd tariff level	Bi-directional (V2G) charging	Charging in the bidirectional charging mode until the individually chosen maximum range is reached.

d) *…too cheap, i.e. you have doubts about the seriousness of the tariff?*

The answers were aggregated. The intercepts between the different curves determine the different price points, which will be discussed in Section 4.3 - indifference price point (IDP), optimal price point (OPP), point of marginal cheapness (MGP) and point of marginal expensiveness (MDP).

3.2.4. Charging strategies

Finally, we assessed respondents preferred charging strategies for the second charging level. By doing so, we elaborate on underlying motivations, guiding users' WTP and SoC_{Min} requirements. Specifically, we were interested in elaborating, whether the charging strategy explains the relationship between user experience and stated SoC_{Min} and WTP. Respondents thus had to distribute a total of 100 points, mirroring their preferences for the three charging strategies – cost-minimized charging, climate-neutral charging and grid-beneficial charging. The exact questions can be found in Appendix D.

We performed a mediation analysis by using Process in SPSS, a methodology that is based on Hayes and Preacher (2014). With this method, the overall relationship between the predictor (X) and the outcome variable (Y) can be explained by both of their relationships with a third variable, the mediator (M), thus reflecting a causal sequence (Field, 2018). Mediation occurs when the effect of the independent variable X on the dependent variable Y is reduced by integrating the mediator variable M (Baron and Kenny, 1986; Dudenhöffer, 2015). To test for inference in mediation analysis, several tests can be performed. For example, one can test the occurrence of the indirect effect by using the Sobel test (Hayes and Scharkow, 2013), which performs a significance test to reject or accept the null-hypothesis (Tibbe and Montoya, 2022). Another possibility is to perform percentile or bias-corrected bootstrap confidence intervals (CIs), where a CI test is formed to see whether zero falls outside its confidence limits (Tibbe and Montoya, 2022). For an overview and comparison of these tests see Hayes and Scharkow (2013) or Tibbe and Montoya (2022). As recommended, we applied the bias-corrected bootstrap CIs (Zhao et al., 2010; Hayes and Scharkow, 2013; Hayes and Preacher, 2014; Field, 2018).

To test the sequences of interest, we used the bias-corrected bootstrap procedure with multilevel categorical variables (Haye's Model No. 4, N = 10,000) (cf. Hayes and Preacher, 2014) to estimate the direct, total and indirect (standardized) effects of the linear model. Since the mediators are derived from a constant sum query, we created a separate model for each mediator.[9] The mediation model is based on the equations below.

$$c = c^{'} + ab \tag{1}$$

Equation (1) defines the relative total effect *c*, which corresponds to the sum of the relative direct effect *c'* and the product of the coefficients *a* and *b*.

$$M = \beta_M + a_1X_1 + a_2X_2 + \varepsilon_M \tag{2}$$

$$Y = \beta_Y^{'} + c_1^{'}X_1 + c_2^{'}X_2 + bM + \varepsilon_Y \tag{3}$$

The indirect effect of X on Y through M is estimated as the product of *ab* from equations (2) and (3). With equation (2) we measure the effect of X on M. With β_M the standardized (regression) coefficient is included and ε_M defines the error. As the study setup results in a multicategorical predictor (user experience), dummy coding is applied. Consequently, we have two predictor variables a_1 and a_2 in the model. Equation (3) defines the direct effect.

$$Y = \beta_Y + c_1X_1 + c_2X_2 + \varepsilon_Y \tag{4}$$

Finally, equation (4) defines the total effect of X on Y, which is the observed difference of group means on Y. A detailed description of statistical mediation analysis with multicategorical independent variables can be found in Hayes and Preacher (2014).

4. Results

In this section, we present the most important results of our study. First, we provide a sample characterization of the three groups low, medium and high user experience. Second, we present the results of the SoC_{Min} and the WTP for a V2G charging tariff, and based on these results, discuss the role of user experience and underlying motivations.

[9] As described in Section 3.2.4 respondents had to distribute a total of 100 points to the three charging strategies – cost-minimized charging, climate-neutral charging, grid-beneficial charging – to express their preferences. Therefore, a linear dependency exists between the three charging strategies. We solved this issue by building a separate model for each mediator. Of course, this has the drawback that dependencies between the mediators are not reflected and accounted for.

Table 3
Sample characterization

		Total sample (N = 1196)	Low user experience (n_{low} = 691)	Medium user experience (n_{med} = 241)	High user experience (n_{high} = 264)	German average [a]
Age	17–29 years	17.0%	17.9%	19.5%	12.1%	20.0%
	30–39 years	16.4%	15.6%	18.3%	17.7%	17.8%
	40–49 years	18.3%	16.2%	20.3%	22.0%	16.6%
	50–59 years	23.7%	24.2%	21.6%	24.6%	22.2%
	60–74 years	24.6%	26.0%	20.3%	24.6%	23.4%
Gender	Female	43.3%	54.6%	38.6%	18.2%	50.6%
	Male	56.6%	45.4%	61.0%	81.8%	49.4%
	Other	0.1%	0.0%	0.4%	0.0%	0.0%
Level of education	Not yet graduated	0.2%	0.3%	0.0%	0.0%	3.5%
	Secondary school graduate	7.2%	10.0%	3.7%	3.0%	28.6%
	General certificate of secondary education	26.1%	30.5%	24.5%	15.9%	30.0%
	General higher education qualification	66.3%	59,0%	71.8%	80.3%	33.5%
	Other	0.3%	0.1%	0.0%	0.8%	4.2%

[a] Own calculations based on data for 2019 of the Federal Statistical Office of Germany (2019).

4.1. Sample characterization

Table 3 displays the sample characteristics and compares the sample with data from the German Census (Federal Statistical Office of Germany, 2019). The sample consists of 1196 valid responses from the dataset presented in Section 3.1, divided into three groups based on the participants' levels of experience with electromobility. The first group, with a sample size of $n_{low} = 691$, has had no experience yet with EVs. The second group ($n_{med} = 241$) gained experience with EVs during test drives, car sharing, and other non-frequent forms of interaction. The third group represents EV owners ($n_{high} = 264$).

The sample is partially representative of Germany. With regard to age, the sample distribution is similar between the three groups, with the exception of the age group 18–29 years old for the group with high user experience (12.1%), which is underrepresented compared to the other groups and the German average (20.0%). Moreover, males (56.6%) are slightly overrepresented in the total sample. The overrepresentation becomes more significant in the two groups where experience with EVs already exists. This difference can most likely be traced back to the fact that, besides the panel data, we used multiple additional sources to collect the overall dataset. Finally, a difference between the sample and the representative Census data regarding the level of education can be observed. While the share within the Census sample is nearly equally distributed between the three graduation levels, a higher percentage of the sample in this study attained a general higher education qualification (66.3%). This bias can be observed among all three groups of our sample.

Finally, we also collected data on monthly net income per household.[10] The results show, that EV experienced people (26.9% with a monthly net income of €4600 - €7499) have significantly higher monthly net incomes than people with medium EV experience (20.3% with a monthly net income per household in the range of €3600 - €4599), or without EV experience (23.3% with a monthly net income of €1600 - €2599 followed by 22% with a monthly net income per household of €2600 - €2599). Our analysis indicates that respondents of the group with higher EV experience tend to be male, have a higher level of education and have a higher monthly net income per household. Thus, our sample is biased towards early adopters (cf. Ozaki and Sevastyanova, 2011; Plötz et al., 2014; Chen et al., 2020).

4.2. Minimum range requirements for a V2G charging tariff

In this study, we were interested in elaborating on whether different levels of user experience with EVs have an impact on the evaluation of the SoC_{Min}. Respondents were asked about their minimum range requirements that must always be available during the charging process. In order to prevent highly unrealistic responses, the maximum value that could be named by the respondents was set to 500 km. In the following, we present the results of the survey.

The results shown in Fig. 2 reveal that approx. 30% of the respondents would accept a SoC_{Min} of 50 km and approx. 70% of the respondents a SoC_{Min} of 100 km. The saturation begins at a SoC_{Min} of about 200 km, which covers about 90% of the respondents (cf. Fig. 2). Table 4 gives an overview of the minimum range requirements over the whole sample. The mean value over the total sample is 119 km. These numbers appear to be high considering that this range should suffice in emergency cases.

What can also be observed from Fig. 2 is that EV experience does not seem to have a significant impact on participants' evaluation of the SoC_{Min}. An analysis of variance (ANOVA) confirmed that group means are not significantly different. In order to elaborate the relationship between the SoC_{Min} and the level of user experience in more detail, we performed a mediation analysis. Specifically, we were interested in investigating on whether the charging strategy, which can be seen as one possible motivation for higher or lower SoC_{Min}, explains the relationship between user experience and stated SoC_{Min}.

We tested the following sequence: level of user experience -> charging strategy - > SoC_{Min}. We chose the group of low user experience as the reference group, meaning all following results are interpreted in comparison to this reference group. Table 5 presents the indirect effects of the mediation analysis and Fig. 3 (a-b) the standardized B-values of the mediation analysis.

We can observe from Fig. 3 b that the effect of high user experience on climate-neutral charging ($\beta = 0.35$) is positive. The effect on cost-minimized charging is negative and slightly smaller ($\beta = -0.33$). This indicates that the importance of climate-neutral charging increases and of the cost-minimizing charging strategy declines for EV owners when compared to users with no EV experience. Both values are moreover highly significant, whereas the effect of high user experience on grid-beneficial charging is not significant. High user experience thus significantly predicts cost-minimized and climate-neutral charging. Medium user experience, however, does not significantly predict one of the charging strategies. When analyzing the relationship between the charging strategies and the SoC_{Min}, we can see that these relationships are highly significant, except for the relationship between grid-beneficial charging and SoC_{Min}. Moreover, the effect of cost-minimized charging on SoC_{min} is negative, while the opposite is true for the relationship between climate-neutral charging and SoC_{min}, emphasizing that minimum range requirements increase for a higher preference for cost-minimized charging, while they decrease in case of a higher preference to charge the EV in a climate-neutral manner. Finally, the direct effects of medium ($\beta = -0.06$, 95% CI [-8.13; 20.73], $p = 0.392$) and high ($\beta = -0.09$, 95% CI [–23.07; 4.85], $p = 0.201$) user experience on the SoC_{Min} are not significant.

To account for a possible bias due to diverging sociodemographic characteristics between the groups (see Section 4.1), we tested the mediation analysis with the three covariates: gender, income and education. Gender was significant, yet, including sociodemographic variables as covariates didn't change the results of the indirect effects. The results can be found in Appendix E.

Table 5 shows that pursuing a climate-neutral and a cost-minimizing charging strategy both mediate the relationship between high user experience and minimum range requirements. By contrast, the indirect effect due to grid-beneficial charging is not significant, nor

[10] We report these results only in the text but not in the table, since the categories we retrieved are not comparable with the categories from the data from the Federal Statistical Office of Germany (2019).

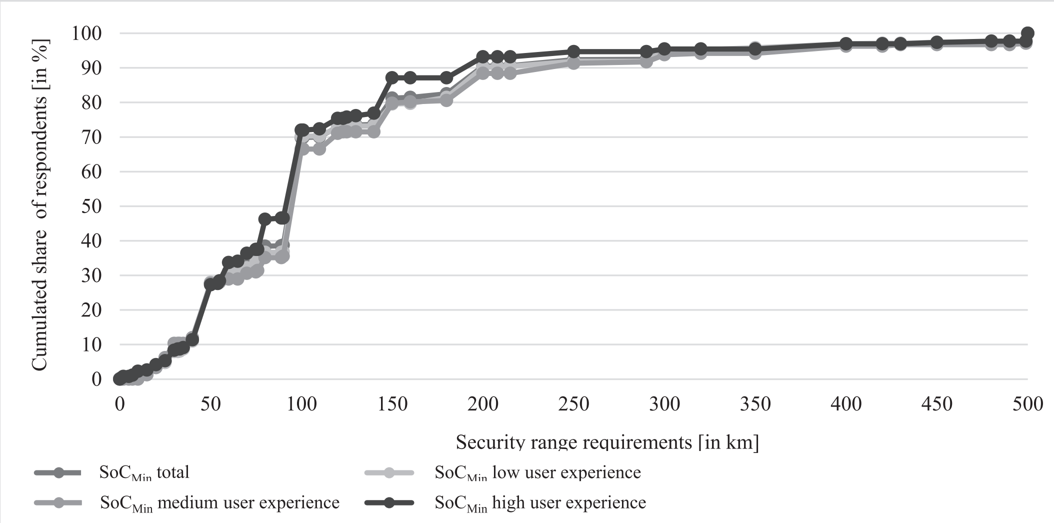

Fig. 2. Cumulated share of answers regarding the minimum range according to the level of user experience, N = 1195.

Table 4
Minimum range requirements in total.

Sample	[in km]							
	M	SD	SE	Min	Max	$q_{0,25}$	$q_{0,5}$	$q_{0,75}$
N = 1195	119.01	98.37	2.84	0	500	50.0	100.0	150.0

Table 5
Indirect effect of level of user experience, on SoC_{Min}, mediated by the three charging strategies.

	Cost-minimized charging			Climate-neutral charging			Grid-beneficial charging		
	β (*SE*)	Bootstrap 95% CIs Lower to Upper		β (*SE*)	Bootstrap 95% CIs Lower to Upper		β (*SE*)	Bootstrap 95% CIs Lower to Upper	
Medium user experience	0.003 (*0.010*)	−0.016	0.025	−0.006 (*0.012*)	−0.029	0.017	0.004 (*0.005*)	−0.004	0.016
High user experience	−0.042 (*0.014*)	−0.075	−0.018	−0.050 (*0.015*)	−0.082	−0.024	−0.004 (*0.005*)	−0.016	0.0037

Note: Confidence Intervals (CIs) are bias corrected; 10.000 bootstrap samples.

could we identify any indirect effect that significantly mediates the relationship between medium user experience and minimum range requirements. Thus, there seem to be significant differences between users with a high EV experience and without experience, but no differences between those having medium and no user experience with EVs.

Interestingly, pursuing a climate-neutral charging strategy increases the willingness of high experienced users to accept lower SoC_{Min} values. We can thus conclude that the promise to charge in a climate-neutral way leads to decreasing minimum range requirements, thus allowing for the exploitation of higher flexibility potentials. Pursuing a cost-minimizing charging strategy has the opposite effect. Charging in a cost-minimizing manner does not motivate users to require lower ranges, i.e., to provide more flexibility in order to generate higher revenue potentials.

4.3. WTP for a two-level V2G charging tariff

The second goal of our survey was to determine users' WTP for a V2G charging tariff. The results of the PSM are displayed in Table 6. The graphical presentation of the results of the PSM can be found in Appendix F. Table 6 shows that the optimal price for a V2G tariff is €3.05 / 100 km. Compared to the reference price, this is relatively low (−42%), i.e. users demand a high price reduction when charging in a V2G mode.

Moreover, the WTP decreases with higher levels of user experience, while the price sensitivity, which is the difference between the IDP and the OPP, increases. The points of marginal cheapness and of marginal expensiveness describe the acceptable price range. Corresponding to the price sensitivity, the acceptable price range is greater for low and medium experienced participants (€2.00 - €5.00) than for highly experienced participants (€2.00 - €4.16). These results neglect our assumption that EV experienced participants would be willing to pay more for a V2G service, since they would be aware of possible advantages.

To test the hypothesis that the WTP can be explained by the level of user experience, we performed an analysis of variance

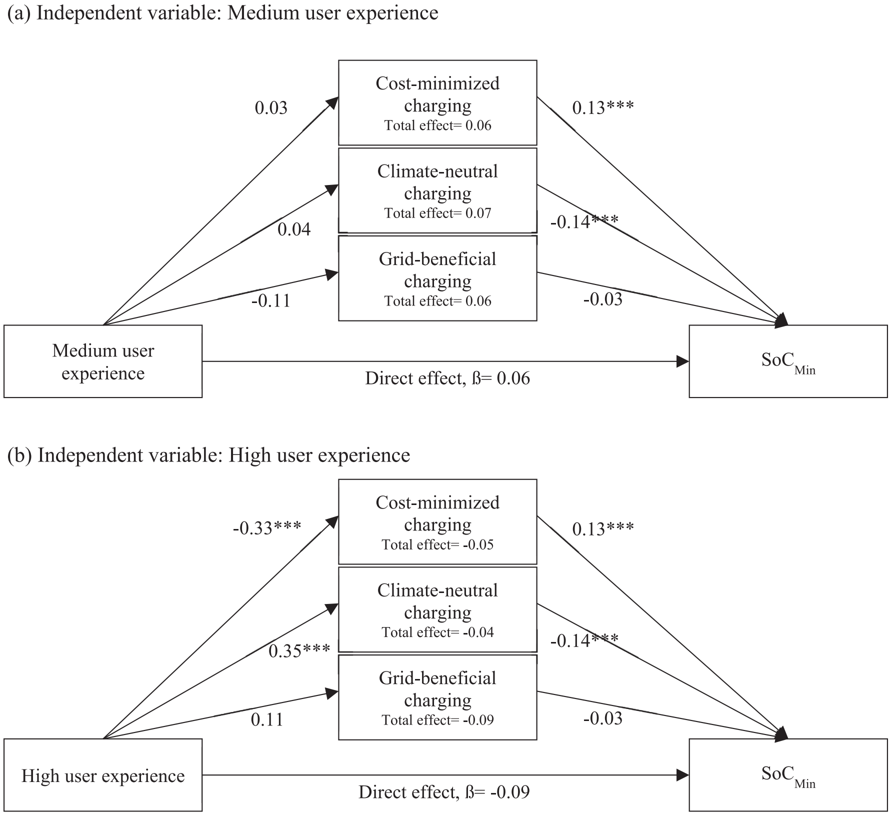

Fig. 3. (a-b) Mediation analysis for X = level of user experience, M = charging strategy, Y = minimum range; N = 1196. *Note*: Even though the mediators are displayed in one model, we carried out three separate models – for each mediator one model.

Table 6
Price for a bidirectional charging tariff depending on the level of user experience.

Sample	2nd price level of a two-price level tariff [in EUR / 100 km]			
	IDP[1]	OPP[2]	MPG[3]	MDP[4]
Reference price (uncontrolled charging) €5.20 / 100 km				
Total (N = 1169)	3.50 (–33%)	3.05 (-42%)	2.01	4.60
Low experience (n_{low} = 678)	3.60 (-31%)	3.40 (-35%)	2.00	5.00
Medium experience (n_{med} = 233)	3.20 (-39%)	3.00 (-43%)	2.00	5.00
High experience (n_{high} = 258)	3.10 (-41%)	3.00 (-43%)	2.00	4.16

[1] Indifference price point (IDP): Equal number of respondents rate the price point as either “cheap” or “expensive”.
[2] Optimal price point (OPP): The price exceeds either the upper or lower limits of an equal number of respondents.
[3] Point of marginal cheapness (MGP): Number of respondents experiencing the tariff as “too cheap” is larger than the number of those who experience it as cheap.
[4] Point of marginal expensiveness (MDP): Number of respondents experiencing the tariff as “too expensive” is larger than the number of those who experience it as expensive.

(ANOVA). We tested this relationship for the value of WTP expensive (WTP_{exp}) originating from the PSM. This value reflects the users' upper limit to buy the service even though it is perceived as being expensive. The ANOVA showed that there is only a significant effect ($p = < 0.001$) for high user experience on the WTP_{exp} for a V2G tariff compared to those having a low level of user experience with EVs. Moreover, the F-statistic shows with $F(2, 1175) = 10.93$, $p = < 0.001$ that this relationship can significantly be explained by the level of user experience (Fig. 4).

To elaborate on the relationship between WTP and the level of user experience in more detail, we performed a second mediation analysis, following the procedure described in Section 4.2. We tested the following sequence: level of user experience -> charging strategy -> WTP_{exp}. Fig. 5 (a-b) depicts the effects of the mediation analysis as β-values and values and Table 7 the indirect effects of the mediation analysis.

The standardized B-values in Fig. 5 (a-b), which demonstrate the relationship between the levels of user experience and the charging strategies, were analyzed in Section 4.2. When analyzing the relationship between the charging strategies and WTP_{exp}, we can

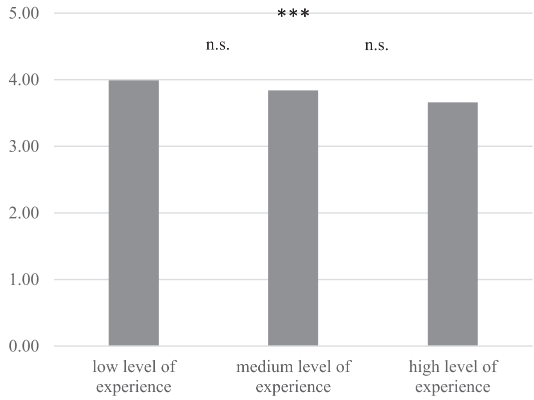

Fig. 4. Willingness to pay for bidirectional charging tariff (N = 1178).

see that this relationship is highly significant for all three charging strategies. While increasing interest for the cost-minimizing charging strategy leads to lower WTP, i.e. the wish for higher compensation, an increase in interest in a climate-neutral or grid-beneficial charging strategy leads to a higher WTP. As such, offering a cost-minimizing charging strategy raises expectations of higher revenues. There is a clear tendency that climate-neutral, and, to a lesser extent, grid-beneficial charging strategies both foster the willingness of users to pay more for such a service.

The indirect effects of the three mediation models show that two out of three charging strategies mediate the relationship between user experience and WTP_{exp}. Like the previous model (cf. Table 6), the cost-minimized (β= 0.05, 95% BCa CI [0.02, 0.08]), as well as the climate-neutral charging strategy (β= 0.05, 95% BCa CI [0.02, 0.08]), both appear to be significant mediators for the relationship between high user experience and WTP_{exp}. The grid-beneficial charging strategy, however, neither mediates the relationship between

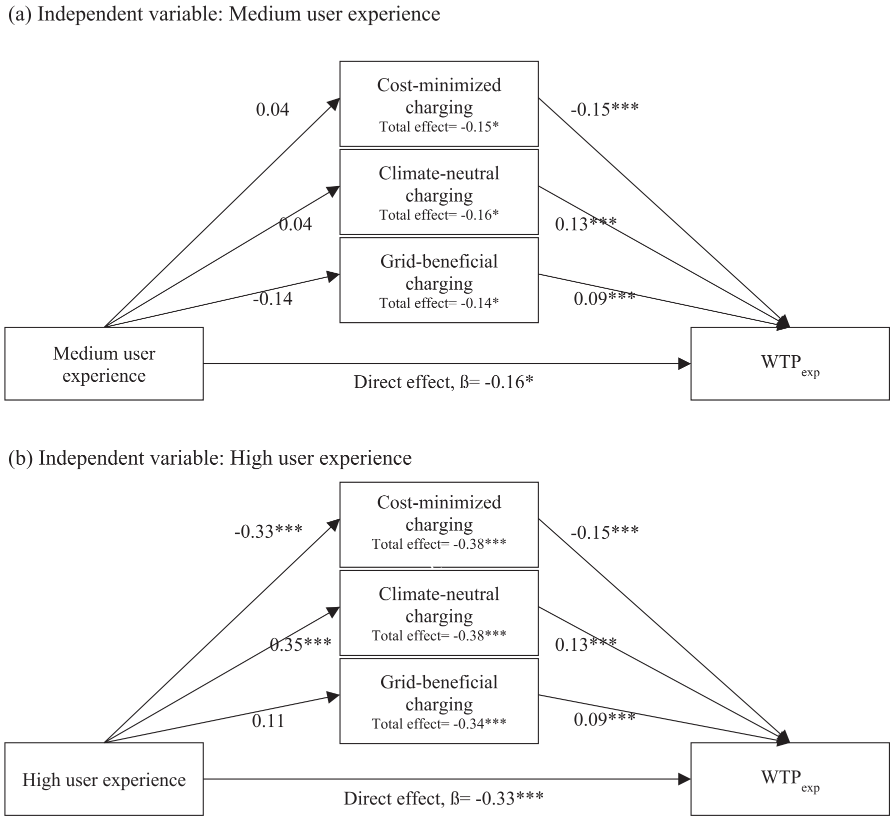

Fig. 5. (a-b) Mediation analysis for X = level of user experience, M = charging strategy, Y = willingness to pay (expensive) for N = 1178. *Note*: Even though the mediators are displayed in one model, we carried out three separate models, for each mediator one model.

Table 7
Indirect effect of level of user experience on WTP_{exp} mediated by the three charging strategies.

	Cost minimized-charging			Climate-neutral charging			Grid-beneficial charging		
		Bootstrap 95% CIs			Bootstrap 95% CIs			Bootstrap 95% CIs	
	β (*SE*)	Lower to Upper		β (*SE*)	Lower to Upper		β (*SE*)	Lower to Upper	
Medium user experience	−0.006 (*0.012*)	−0.030	0.017	0.006 (*0.011*)	−0.015	0.027	−0.013 (*0.008*)	−0.033	0.001
High user experience	0.049 (*0.016*)	0.021	0.083	0.045 (*0.015*)	0.020	0.076	0.011 (*0.008*)	−0.003	0.030

Note: Confidence Intervals (CIs) are bias corrected; 10.000 bootstrap samples.

medium user experience and WTP_{exp}, nor for high user experience. Since we identified a sociodemographic bias between and within the groups (Section 4.1), we tested the models under consideration of these variables as covariates. Noteworthy, while the covariates did not have any considerable effect on the mediation by the climate-neutral and the cost-minimizing charging strategy, the inclusion of gender, education and income separately as covariates impacted the indirect effect of the grid- beneficial charging strategy. The coefficients improve and the confidence intervals indicate that mediation takes place. The results are displayed in Appendix E.

5. Discussion

Although users' WTP for V2G and the SoC_{Min} have been examined by past studies, so far, hardly any studies have differentiated between levels of user experience and analyzed users' underlying motivations. Doing so provides information on users' expectations towards this new service, thus indicating minimum requirements. Underlying motivations assist in creating business models for future V2G tariffs. To close this gap, the paper aimed to answer the following research question: *How does EV experience influence user requirements with respect to minimum range and required savings within a V2G charging tariff and to what extent do underlying motives influence this relationship?*

The initial assumption that differences between the levels of user experience would be apparent could not be validated by the study's results. The results revealed that the SoC_{Min} values are, with an average of 199 km over the complete sample, high. Thus, expectations for the minimum charging level were high, independently of the level of user experience. The values appear especially high against the background that the average driving ranges in Germany range from 22 km in urban to 37 km in rural areas (Nobis and Kuhnimhof, 2018). On the one hand, these results are in line with previous studies, demonstrating that potential EV users are willing to pay more for additional ranges (Hidrue and Parsons, 2015; Geske and Schumann, 2018; Huang et al., 2021), emphasizing the SoC_{Min} as a precondition for participation in V2G tariffs (Ensslen et al., 2018; Huang et al., 2021). On the other hand, it raises the question as to what underlying factors drive these high estimates. We can think of four explanations: First, people expressed their objection towards V2G by stating very high values. Second, people clearly overestimated their SoC_{Min} requirements or were not able to estimate realistic values. This explanation is especially in line with the observed societal resistance to change in Bühler et al. (2014) (see Section 2.1). Third, people truly have very high SoC_{Min} requirements, or fourth, people did not understand the concept of the SoC_{Min}. Independent of the possible reasons for these high values, from an aggregator's point of view, considering users' minimum range requirements implies that only low flexibility potentials can be raised due to generally high minimum range requirements.

While user experience itself cannot explain differences in SoC_{Min}, underlying motivations do. Pursuing a climate-neutral charging strategy or a cost-minimizing charging strategy mediate high user experience compared to low user experience. While a climate-neutral charging strategy leads to accepting lower SoC_{Min} values, a cost-minimizing charging strategy has the opposite effect. Whether survey participants realized the interconnection between higher flexibility potentials due to lower minimum ranges and monetary or environmental benefits is unclear. Regardless of the interconnection, environmental benefits are much more valued by EV owners, while financial benefits are less attractive to this group.

Previous studies provide different insights on the importance of the various motives that we tested to increase the user acceptance of V2G (cf. Will and Schuller, 2016; Geske and Schumann, 2018). Besides environmental, monetary or grid-related motives, the possibility to fast charge the EV can be a means to significantly achieve acceptance of lower guaranteed minimum ranges (Huang et al., 2021). This may increase the acceptance of V2G. Yet, it may also antagonize the overall objective of V2G to provide flexibility for a future reliable energy system. Complementary, Ardeshiri and Rashidi (2020) show a high acceptance, i.e. high WTP for a state-initiated fee to accelerate the installation of fast charging stations. The study by Ardeshiri and Rashidi (2020), however, did not consider V2G and the results are relevant on a policy-level, while our results are a primary concern for the energy system. Our results thus complement the existing body of literature by demonstrating that more flexibility potentials can be raised by offering a climate-neutral charging strategy which motivates EV users to accept lower minimum ranges. This insight is especially relevant from an aggregator's perspective.

Besides range requirements, we also assessed user's WTP for a V2G charging service. Assessing users' WTP for an innovative, not-yet-available service is always limited by its hypothetical character. We tried to overcome this shortcoming by including EV-experienced people in the sample, expecting more realistic estimations from this target group. Regarding WTP, the results revealed that the WTP over the complete sample is with an optimal price of €3.05 low compared to the reference price of €5.20 / 100 km. The generally low WTP (-42% over the whole sample compared to the reference price) is in line with previous research, assessing WTP for V2G attributes, finding high WTP for extra services, such as longer minimum ranges (cf. Bailey and Axsen, 2015; Axsen et al., 2016; Geske and Schumann, 2018; Huang et al., 2021). This suggests that users assign a great value to flexibility, leading to a significantly lower WTP or to a higher readiness to pay more in order to gain additional flexibility.

However, when assessing compensation to provide flexibility, the results of existing research are less consistent. In an early study, Parsons et al. (2014) found very high cash-back demands ranging from \$2368 - \$8622 / year (€2091 - €7613 / year) depending on the contract conditions, whereas a recent study by Lee et al. (2020) estimate a willingness to accept of \$8.83 / month (€7.79 / month). A comparison of these results with our findings is limited, as vast improvements in EV and (smart) charging technology have taken place in the past years. Additionally, electricity prices and regulations differ enormously between countries. A more direct comparison is possible with the study by Kubli et al. (2018). Their results show implicit discomfort costs for varying degrees of flexibility between CHF 3.85 - CHF 45.16 / month (€3.72 - €43.71 / month) compared to an option without flexibility. The authors classify these results as moderate, which are lower than our findings for Germany.

Additionally, with regard to user experience, the results were unexpected, in that proficient users were willing to pay significantly lower electricity prices (-43%) to charge their EV than inexperienced users (-35%). EV users thus required higher compensation or, to turn the argument around, EV users expect the monetary benefits arising from V2G to be higher than inexperienced users. Bailey and Axsen (2015) obtained similar results, and point out that experienced users might be better able to estimate the value of engaging in such a charging program.

To put our results in context, a review by Sovacool et al. (2017) highlight that economic modeling studies specify monetary benefits to vary between \$100 - \$300 / year (€88 - €264 / year) and vehicle. Studies estimating earnings for providing regulation services state values from \$85 - \$2500 (€75 - €2207) (Bailey and Axsen, 2015), up to \$5000 / year (€4414 / year) and vehicle (Sovacool et al., 2017). A recent study estimated a yearly revenue of €530 by combining vehicle-to-home and arbitrage trading (Kern et al., 2022). Thus, there seems to be a wide range regarding possible monetary benefits depending on the application and underlying assumptions (for a *meta*-analysis see Heilmann and Friedl, 2021), implying that the amount of monetary benefits harbors a great deal of uncertainty. The expectation horizon of our respondents is with regard to monetary compensation rather at the lower end, not accounting for taxes and fees, compared to the previously mentioned literature.

Furthermore, the mediation analysis revealed that a climate-neutral and a cost-minimizing charging strategy can significantly influence EV users' WTP_{exp} for a V2G charging tariff. EV users are thus willing to pay more when a climate-neutral charging strategy is pursued, while the opposite effect can be observed for a cost-minimizing charging strategy. EV users' WTP thus decreases when applying a cost-minimizing charging strategy, i.e. EV users require higher compensation compared to inexperienced users. A grid-beneficial strategy proves to be non-significant for all groups. Given these results, the question arises, how can aggregators in the future energy system account for these preferences? Generally, as Krueger and Cruden (2020) point out, accounting for user requirements puts further constraints on the aggregator, and even more so when user requirements are high, which is the case when considering the effect of the cost-minimizing charging strategy on both the SoC_{min} and WTP_{exp}. This indicates a potential conflict for aggregators to fulfill user requirements on one hand, and master the increased complexity of the power grid on the other.

Yet, fostering a climate-neutral charging strategy is preferable for both parties. EV owners clearly prefer to charge in a climate-neutral way. Moreover, this strategy incentivizes this user group to provide more flexibility and simultaneously accept lower revenues. From the perspective of an aggregator, these conditions provide more flexibility to develop a suitable business model. Moreover, from a system perspective charging in a climate-neutral way is preferable to a cost-minimizing charging strategy. This is especially due to the fact that explicit consideration of grid constraints on the transmission grid level results in less curtailment of RES compared to an economically oriented tariff design and to an economically and ecologically improved system outcome (Gunkel et al., 2020; Szinai et al., 2020). Our findings thus support previous literature suggesting to communicate and promote more intuitive advantages which subsequently benefit the grid, such as environmental benefits (Bailey and Axsen, 2015; Sovacool et al., 2017; Gunkel et al., 2020; Szinai et al., 2020; Sloot et al., 2022; Will et al., 2022).

6. Conclusion, policy implications and future work

Our study aimed to improve our understanding of how user experience with EVs influences users' WTP for a V2G charging tariff and SoC_{Min} requirements in Germany. Moreover, we investigated the role of underlying motivations, guiding users' evaluation thereof. Our research design allowed us to compare the perspectives of EV-experienced users, medium-experienced users, and people who did not have any experience yet with EVs.

Our results show that SoC_{Min} requirements are high compared to average daily driving distances in Germany. Furthermore, WTP values were low compared to the reference price. These results are true for all three levels of user experience. In general, people seem to have high mobility requirements on the one hand and high discount expectations on the other, making it difficult for aggregators to offer profitable business models. Differences between the levels of user experience and WTP and SoC_{Min} became visible, when including underlying motivations as a mediating variable in our analysis. While charging in a climate-neutral way leads to a higher readiness of EV owners compared to people with no EV experience to accept higher prices and lower minimum ranges, charging in a cost-minimized manner has the opposite effect. We thus recommend that future charging tariffs should especially promote climate-neutral charging strategies, as these are clearly the most accepted strategies by users and provide the best possible benefit and highest flexibility potential to aggregators. Moreover, by pursuing climate-neutral charging strategies, operators would be able to better align the integration of RES and grid stability.

Our results thus provide further insights into user motivations to participate in a V2G tariff, highlighting the importance of fostering RES integration to agree to lower SoC_{Min} and higher WTP. Concerning the grid-beneficial charging strategy, no mediating effects are observable. Yet, this charging strategy is of high importance to increase the overall system reliability, which is especially true against the background of the government's plans to further increase the RES capacity in Germany within the next decade. The users' indifference towards the grid-beneficial charging strategy, however, challenges policy makers who aim to foster system-integrative and sustainable solutions to meet the government's goals. The same is true for other countries pursuing the pathway to decarbonisation. Therefore, raising awareness of V2G's potential to benefit grid congestion and carbon intensity appears essential. Based on our results, we recommend communication and promotion of more intuitive advantages that indirectly also benefit the grid infrastructures, such as environmental benefits. A lot of effort is required to challenge the balancing act to fulfil system services and comply with regulatory frameworks while meeting user requirements when designing convincing charging strategies. To this end, stakeholder-specific communication and services are needed, as well as clear regulatory frameworks.

To overcome the hypothetical character of assessing V2G charging tariffs, we specifically targeted EV-experienced people, expecting more realistic estimations. To assess users' real WTP for a V2G charging tariff, future research could conduct field studies with pilot customers. Moreover, considering battery aging within a V2G service would be another interesting aspect for future research when assessing questions on range and willingness to pay. Finally, due to a regulatory gap in Germany on selling electricity within a V2G service, we solely focused on the net-purchasing price to charge the EV. Recently, as part of a newly passed law to promote RES in Germany, the German parliament also decided on §14a EnWG, which regulates how to deal with the grid-serving control of controllable consumer devices and controllable grid connections, including bidirectionally chargeable EVs (Federal Ministry of Economic Affairs and Climate Action, in charge, 2022). Future work could thus integrate and evaluate this new regulatory framework in a V2G tariff scheme.

Finally, our results revealed that experienced EV users' motivations could be raised by offering a climate-neutral charging strategy. Further research needs to specifically target the group of people without EV experience in order to achieve the ambitious EV goals worldwide. Moreover, the importance of different charging strategies could be evaluated in more detail. The question of which benefits could be raised from an aggregator's perspective by pursuing different V2G charging strategies while accounting for user requirements with low EV experience could be subject for further research.

CRediT authorship contribution statement

NORA BAUMGARTNER: Conceptualization, Formal analysis, Methodology, Software, Validation, Visualization, Writing – original draft. **FRANZISKA KELLERER:** Conceptualization, Data curation, Investigation, Methodology, Validation, Writing – review & editing. **MANUEL RUPPERT:** Project administration, Supervision, Writing – review & editing. **SEBASTIAN HIRSCH:** Methodology, Writing – review & editing. **STEFAN MANG:** Funding acquisition, Project administration, Resources, Supervision, Writing – review & editing. **WOLF FICHTNER:** Funding acquisition, Project administration, Supervision, Writing – review & editing.

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.

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APPENDIX A. Forums and platforms for purposive sampling

Forum and platform	Group name	Web address
GoingElectric		https://www.goingelectric.de/forum/
Motor Talk		https://www.motor-talk.de/
Tesla Fahrer und Freunde		https://tff-forum.de/
Elektromobilität Diskussionsforum		https://www.elektromobilitaet-forum.de/
Elektroauto Community		https://www.elektroauto.community/
Elektroauto Forum		https://elektroauto-forum.de/
Photovoltaik Forum		https://www.photovoltaikforum.com/
Facebook	- BMW i3 Freunde - Elektromobilität D/A/CH - Elektromobilität heute - Ich fahre Elektroauto - Pro Elektromobilität. Pro BEV - Elektroauto 2.0	https://www.facebook.com/
AutoExtrem		https://www.autoextrem.de/forums/
Forum für alternative Antriebe		https://forum-alternative-antriebe.de/
eVW-Forum - E-Fahrzeuge von VW		https://evw-forum.de/

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(*continued*)

Forum and platform	Group name	Web address
XING	- Neue Mobilität - Europäisches Netzwerk Elektromobilität - Elektromobilität - Die Zukunft fährt elektrisch - Ladeinfrastruktur Elektromobilität - Elektromobilität	https://goto.xing.com/mach-dein-xing?experiment=abacus-108
BHKW-Forum - Das Prosumer Netzwerk für mehr Effizienz im Heizungskeller		https://www.bhkw-forum.de/diskussion/

APPENDIX B. Survey questions for assessing users' minimum range (SoC_{SR}) requirements

Question F01. Mr. Meier now sets the desired minimum range using his charging app.

Please put yourself in Mr. Meier's position. How many kilometers should your electric car always be able to cover in unpredictable cases, for example in emergency situations?

Please think of the range with which you would just feel safe.

__ Kilometer.

APPENDIX C. Survey questions for assessing users' willingness to pay for a V2G charging tariff according to the price sensitivity meter (PSM)

Question F02. Please put yourself in Mr. Meier's place at contract conclusion. In the first charging phase (uncontrolled immediate charging), the price for charging your electric car is 5.20 euros per 100 km range. You are now considering how much charging in the second charging phase, bidirectional charging, will cost you.

Please enter a price in the format *.** € below. Assume that the maximum costs per 100 km range can be as high as in the first charging phase (€5.20).

At what average price per 100 km of range would you consider bi-directional charging…

…	find it too expensive, i.e. you would definitely look for a cheaper tariff? __ € per 100 km range (charging phase 2)
…	feel expensive and you would only conclude the contract after careful consideration? __ € per 100 km range (charging phase 2)
…	feel cheap, i.e. the tariff would be a bargain? __ € per 100 km range (charging phase 2)
…	feel too cheap, i.e. you have doubts about the seriousness of the tariff? __ € per 100 km range (charging phase 2)

APPENDIX D. Survey questions for assessing users' preferred charging strategy

Question F03. Mr. Meier has the additional option, as part of the tariff agreement, of specifying criteria to be used for charging in the second, bidirectional phase.

Please decide how important the following criteria would be to you.

Please allocate a total of 100 points to the corresponding aspects. Give the most points to the criterion that you consider most important.

- Charging as cost-minimized as possible __ Points
- Charging as climate-neutral as possible (=high share of renewable energy sources) __ Points
- Making the greatest possible contribution to grid stabilization __ Points

APPENDIX E. Comparison of results of mediation analysis with and without covariates

Variable names	
X	user experience (SD05_auf)
x1	medium user experience
x2	high user experience
Y	min SoC (F01)
M	cost-minimized charging (F03_1), climate-neutral charging (F03_2), grid-beneficial charging (F03_3)
Covariate	salary (SD10), education (SD08_neu), gender (SD01)

Mediation analysis for cost-optimized charging

			Mediation with covariate SD10		Mediation with covariate SD08_neu		Mediation with covariate SD01	
Model summary: outcome variable M								
	R^2=0.019, F=11.657, p<0.000		R^2=0.019, F=7.824, p<0.000		R^2=0.019, F=7.768, p<0.000		R^2=0.025, F=10.328, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	0.026	0.726	0.026	p=0.725	0.026	p=0.726	0.001	p=0.989
x2	-0.326***	0.000	-0.326***	p=<0.000	-0.326***	p<0.000	-0.386***	p<0.000
Covariate			0.012	p=0.678	-0.003	p=0.923	-0.082**	p=0.006
Model summary: outcome variable Y								
	R^2=0.019, F=7.673, p<0.000		R^2=0.020, F=5.985, p<0.000		R^2=0.019, F=5.763, p<0.000		R^2=0.225, F=6.857, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	0.061	p=0.414	0.061	p=0.412	0.061	p=0.415	0.042	p=0.576
x2	-0.051	p=0.485	-0.051	p=0.478	-0.052	p=0.476	-0.098	p=0.196
M	0.129***	p<0.000	0.129***	p<0.000	0.129***	p<0.000	0.124***	p<0.000
Covariate			0.028	p=0.337	0.070	p=0.818	-0.063*	p=0.037
Total effect model								
	R^2=0.003, F=1.593, p=0.204		R^2=0.0035, F=1.3997, p=0.2413		R^2=0.0027, F=1.0769, p=0.3578		R^2=0.0075, F=3.0082, p=0.0294	
	ß	p	ß	p	ß	p	ß	p
x1	0.064	p=0.3924	0.064	p=0.390	0.064	p=0.393	0.042	p=0.578
x2	-0.093	p=0.201	-0.093	p=0.197	-0.094	p=0.197	-0.146*	p=0.054
Covariate			0.029	p=0.315	0.006	p=0.829	-0.073*	p=0.016

Indirect effect

	ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper	
x1	0.003	-0.016	0.025	0.003	-0.016	0.024	0.003	-0.016	0.024	0.000	-0.019	0.079
x2	-0.042	-0.075	-0.018	-0.419	-0.073	-0.017	-0.042	-0.073	-0.017	-0.048	-0.083	-0.020

Mediation analysis for climate-neutral charging

	Mediation with covariate SD10	Mediation with covariate SD08_neu	Mediation with covariate SD01

Model summary: outcome variable M

	R^2=0.020, F=11.892, p<0.000		R^2=0.020, F=7.956, p<0.000		R^2=0.020, F=8.077, p<0.000		R^2=0.025, F=10.347, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	0.040	p=0.592	0.040	p=0.591	0.040	p=0.594	0.064	p=0.390
x2	0.345***	p<0.000	0.345***	p<0.000	0.342***	p<0.000	0.404***	p<0.000
Covariate			0.009	p=0.750	0.019	p=0.503	0.080**	p=0.008

Model summary: outcome variable Y

	R^2=0.023, F=9.372, p<0.000		R^2=0.024, F=7.312, p=0.000		R^2=0.023, F=7.049, p<0.000		R^2=0.265, F=8.011, p=0.000	
	ß	p	ß	p	ß	p	ß	p
x1	0.067	p=0.346	0.070	p=0.344	0.070	p=0.347	0.051	p=0.496
x2	-0.043	p=0.554	-0.044	p=0.548	-0.044	p=0.450	-0.089	p=0.237
M	-0.144***	p<0.000	-0.145***	p<0.000	-0.144***	p<0.000	-0.140***	p<0.000
Covariate			0.034	p=0.288	0.009	p=0.753	-0.062*	p=0.040

Total effect model

	R^2=0.003, F=1.593, p=0.204		R^2=0.004, F=1.400, p=0.241		R^2=0.003, F=7.077, p=0.358		R^2=0.008, F=3.008, p=0.029	
	ß	p	ß	p	ß	p	ß	p
x1	0.064	p=0.321	0.064	p=0.390	0.064	p=0.393	0.042	p=0.578
x2	-0.093	p=0.201	-0.093	p=0.197	-0.094	p=0.197	-0.146*	p=0.054
Covariate			0.029	p=0.315	0.006	p=0.829	-0.073*	p=0.016

Indirect effect

	ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper	
x1	-0.006	-0.029	0.017	-0.002	-0.029	0.016	-0.006	-0.029	0.017	-0.009	-0.031	0.012
x2	-0.050	-0.082	-0.024	-0.050	-0.082	-0.024	-0.049	-0.081	-0.023	-0.056	-0.092	-0.028

Mediation analysis for grid-beneficial charging

	ß without Covariate		**Mediation with covariate SD10**		**Mediation with covariate SD08_neu**		**Mediation with covariate SD01**	
Model summary: outcome variabel M								
	R^2=0.005, F=3.103, p=0.045		R^2=0.007, F=2.594, p=0.051		R^2=0.006, F=2.279, p=0.080		R^2=0.007, F=2.62, p=0.049	
	ß	p	ß	p	ß	p	ß	p
x1	-0.108	p=0.147	-0.109	p=0.146	-0.108	p=0.148	-0.097	p=0.200
x2	0.113	p=0.118	0.114	p=0.115	0.117	p=0.106	0.141	p=0.061
Covariate			-0.036	p=0.210	-0.023	p=0.426	0.039	p=0.198

Model summary: outcome variable Y

	R^2=0.004, F=1.489, p=0.216		R^2=0.005, F=1.350, p=0.249		R^2=0.004, F01.125, p=0.343		R^2=0.008, F=2.529, p=0.039	
	ß	p	ß	p	ß	p	ß	p
x1	0.061	p=0.419	0.061	p=0.416	0.060	p=0.420	0.039	p=0.605
x2	-0.089	p=0.230	-0.090	p=0.216	-0.090	p=0.216	-0.142	p=0.061
M	-0.033	p=0.258	-0.032	p=0.274	-0.033	p=0.261	-0.030	p=0.297

Covariate			0.028	p=0.334	0.006	p=0.849	-0.072*	p=0.018

Total effect model

	R^2=0.003, F=1.593, p=0.204		R^2=0.004, F=1.400, p=0.241		R^2=0.003, F=1.077, p=0.358		R^2=0.008, F=3.008, p=0.029	
	ß	p	ß	p	ß	p	ß	p
x1	0.064	p=0.392	0.064	p=0.390	0.064	p=0.393	0.042	p=0.58
x2	-0.093	p=0.201	-0.093	p=0.197	-0.094	p=0.196	-0.146*	p=0.054
Covariate			0.029	p=0.315	0.006	p=0.829	-0.073*	p=0.016

Indirect effect

	ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper	
x1	0.004	-0.004	0.016	0.004	-0.004	0.016	0.004	-0.004	0.016	0.003	-0.460	0.015
x2	-0.004	-0.016	0.004	-0.004	-0.016	0.004	-0.003	-0.016	0.004	-0.004	-0.018	0.005

p: Significance level: *p < 0.05; **p < 0.01; ***p < 0.001

Variable names

X	user experience (SD05_auf)
x1	medium user experience
x2	high user experience
Y	WTP expensive (F02_2)
M	cost-minimized charging (F03_1), climate-neutral charging (F03_2), grid-beneficial charging (F03_3)
Covariate	salary (SD10), education (SD08_neu), gender (SD01)

Cost-optimized charging

	ß without Covariate		**Mediation with covariate SD10**		**Mediation with covariate SD08_neu**		**Mediation with covariate SD01**	
Model summary: outcome variable M								
	R^2=0.020, F=11.913, p<0,000		R^2=0.020, F=7.956, p<0,000		R^2=0.020 F=7.938, p<0,000		R^2=0.026, F=10.516, p<0,000	
	ß	p	ß	p	ß	p	ß	p
x1	0.042	p=0.576	0.042	p=0.576	0.042	p=0.560	0.017	p=0.818
x2	-0.326***	p<0.000	-0.326***	p<0.000	-0.325***	p<0.000	-0.387***	p<0.000
Covariate			0.007	p=0.804	-0.003	p=0.932	-0.083**	p=0.006
Model summary: outcome variable Y								
	R^2=0.040, F=16.405, p<0,000		R^2=0.041, F=12.678, p<0.000		R^2=0.040, F=12.358, p<0.000		R^2=0.050, F=15.487, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	-0.152*	p=0.041	-0.152*	p=0.041	-0.151*	p=0.042	-0.121	p=0.105
x2	-0.380***	p<0.000	-0.378***	p<0.000	-0.377***	p<0.000	-0.300***	p<0.000
M	-0.150***	p<0.000	-0.149***	p<0.000	-0.150***	p<0.000	-0.142***	p=0.000
Covariate			-0.035	p=0.224	-0.014	p=0.617	0.105***	p<0.000

Total effect model

	R^2=0.018, F=10.938, p<0.000		R^2=0,020, F=7.807, p<0.000		R^2=0.019, F=7.365, p<0.000		R^2=0.031, F=12.371, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	-0.158*	p=0.036	-0.158*	p=0.036	-0.158*	p=0.036	-0.123	p=0.101
x2	-0.331***	p<0.000	-0.330***	p<0.000	-0.328***	p<0.000	-0.246***	p=0.001
Covariate			-0.036	p=0.215	-0.014	p=0.630	0.115***	p<0.000

Indirect effect

	ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper	
x1	-0.006	-0.303	0.017	-0.006	-0.031	0.016	-0.006	-0.031	0.0162	-0.002	-0.025	0.0194
x2	0.049	0.022	0.083	0.049	0.022	0.082	0.049	0.021	0.082	0.055	0.026	0.0923

Climate-neutral charging

	ß without Covariate		**Mediation with covariate SD10**		**Mediation with covariate SD08_neu**		**Mediation with covariate SD01**	
Model summary: outcome variable M								
	R^2=0.020, F=11.808, p<0.000		R^2=0.020, F=7.924, p<0.000		R^2=0.020, F08.011, p<0.000		R^2=0.025, F=10.215, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	0.042	p=0.576	0.042	p=0.576	0.042	p=0.578	0.066	p=0.385
x2	0.346***	p<0.000	0.346***	p<0.000	0.343***	p<0.000	0.404***	p<0.000
Covariate			0.012	p=0.678	0.079	p=0.513	0.079**	p=0.009
Model summary: outcome variable Y								
	R^2=0.035, F=14.145, p<0.000		R^2=0.036, F=11.040, p<0.000		R^2=0.035, F=10.684, p<0.000		R^2=0.045, F=13.887, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	-0.163*	p=0.028	-0.163*	p=0.028	-0.163*	p=0.029	-0.131	p=0.079
x2	-0.376***	p<0.000	-0.375***	p<0.000	-0.373***	p<0.000	-0.295***	p<0.000
M	0.130***	p<0.000	0.131***	p<0.000	0.131***	p<0.000	0.122***	p<0.000
Covariate			-0.037	p=0.192	-0.017	p=0.567	0.0107***	p<0.000

Total effect model

	R^2=0.018, F=10.938, p<0.000		R^2=0.020, F=7.807, p<0.000		R^2=0.019, F=7.365, p<0.000		R^2=0.031, F=12.371, p<0.000	
	ß	p	ß	p	ß	p	ß	p
x1	-0.158*	p=0.036	-0.158*	p=0.036	-0.158*	p=0.036	-0.123	p=0.101
x2	-0.331***	p<0.000	-0.330***	p<0.000	-0.328***	p<0.000	-0.246***	p=0.001
Covariate			-0.036	p=0.215	-0.014	p=0.630	0.116***	p<0.000

Indirect effect

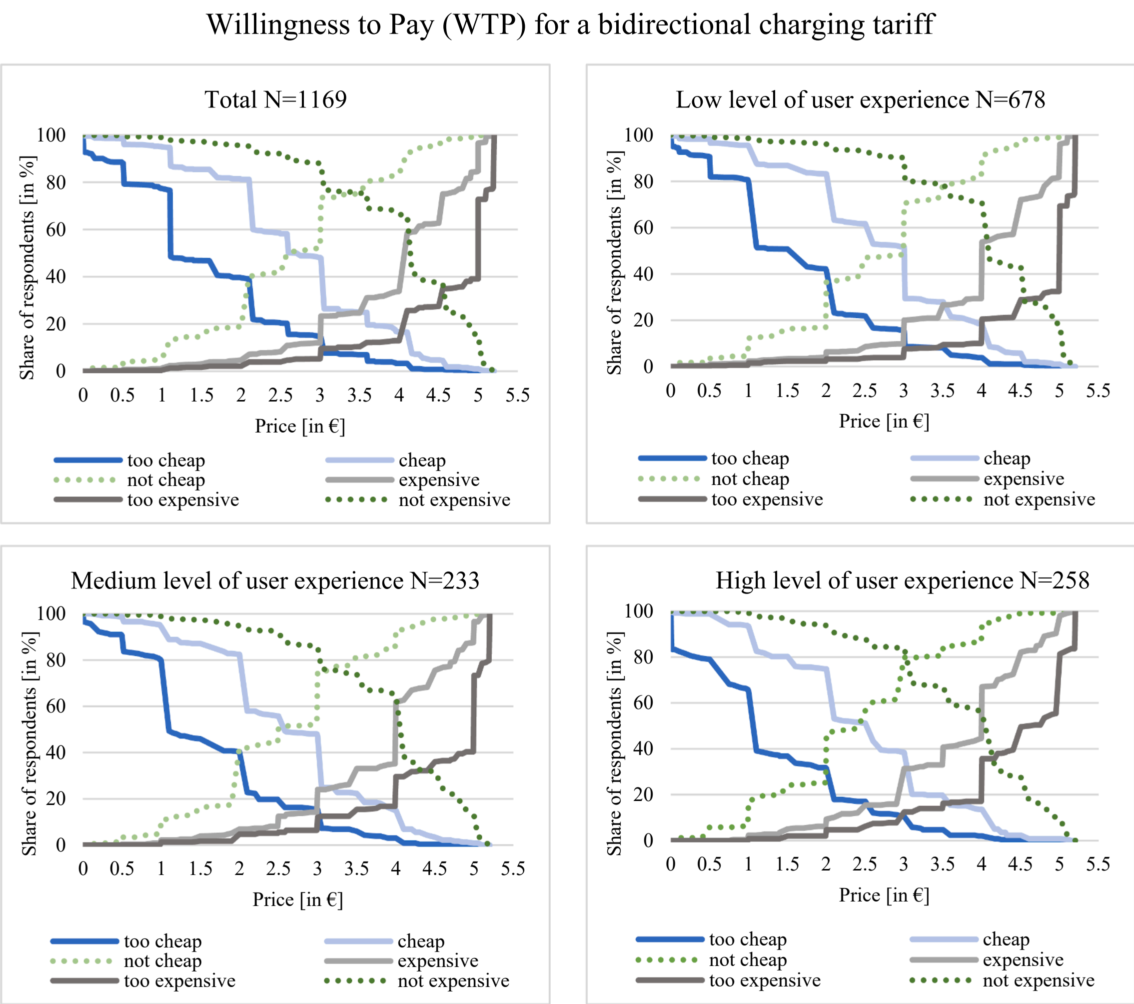
	ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper	
x1	0.006	-0.015	0.027	0.006	-0.015	0.028	0.005	-0.016	0.0273	0.008	-0.011	0.030
x2	0.045	0.020	0.076	0.045	0.020	0.077	0.045	0.019	0.076	0.049	0.022	0.083

Grid-beneficial charging

	ß without Covariate			Mediation with covariate SD10			Mediation with covariate SD08_neu			Mediation with covariate SD01		
Model summary: outcome variable M												
	R^2=0.007, F=4.051, p=0018			R^2=0,020, F=7.956, p<0.000			R^2=0.020, F=7.938, p<0.000			R^2=0.026, F=10.516, p<0.000		
	ß	p		ß	p		ß	p		ß	p	
x1	-0.142	p=0.060		0.042	p=0.576		0.042	p=0.576		0.017	p=0.818	
x2	0.113	p=0.120		-0.326***	p<0.000		-0.325***	p<0.000		-0.387***	p<0.000	
Covariate				0.007	p=0.804		-0.003	p=0.932		-0.083**	p=0.006	
Model summary: outcome variable Y												
	R^2=0.027, F=10.795, p<0.000			R^2=0.041, F=12.678, p<0.000			R^2=0.040, F=12.358, p<0.000			R^2=0.050, F=15.487, p<0.000		
	ß	p		ß	p		ß	p		ß	p	
x1	-0.145*	p=0.054		-0.152*	p=0.041		-0.151*	p=0.043		-0.121	p=0.105	
x2	-0.341***	p<0.000		-0.378***	p<0.000		-0.377***	p<0.000		-0.300***	p<0.000	
M	0.093***	p=0.001		-0.149***	p<0.000		-0.150***	p<0.000		-0.142***	p<0.000	
Covariate				-0.035	p=0.224		-0.0144	p=0.617		0.105***	p<0.000	
Total effect model												
	R^2=0.018, F=10.938, p<0.000			R^2=0.020, F=7.0807, p<0.000			R^2=0.019, F=7.365, p=0,001			R^2=0.031, F=12.371, p<0.000		
	ß	p		ß	p		ß	p		ß	p	
x1	-0.158*	p=0.036		-0.158*	p=0.036		-0.158*	p=0.036		-0.123	p=0.101	
x2	-0.331***	p<0.000		-0.330***	p<0.000		-0.326***	p<0.000		-0.246***	p=0.001	
Covariate				-0.036	p=0.215		-0.014	p=0.630		0.116***	p<0.000	
Indirect effect												
	ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper		ß	Bootstrap 95% CIs Lower to Upper	
x1	-0.013	-0.033	0.0013	-0.006	-0.030	0.016	-0.006	-0.031	0.017	-0.003	-0.025	0.019
x2	0.011	-0.003	0.0302	0.049	0.022	0.083	0.049	0.021	0.083	0.055	0.026	0.092

p: Significance level: *p < 0.05; **p < 0.01; ***p < 0.001

APPENDIX F. Willingness to pay for a V2G charging tariff according to the Price Sensitivity Meter (PSM)



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