Flexible energy systems Leveraging the Optimal integration of EVs deployment Wave

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Factors influencing user acceptance of smart charging and V2X concepts

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List of Acronyms

Acronym	Meaning
BEV	Battery Electric Vehicle
PHEV	Plug-in hybrid electric vehicle
PEV	Plug-in Electric Vehicle (BEV and PHEV)
MNL	Multinomial Logit
EMSP	E-Mobility Service Provider
SOC	State of charge (for BEV)

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Executive Summary

This delivery documents the work and results obtained in Task 2.2. The objective of the task was to explore user requirements, preferences, and concerns when it comes to smart charging, with a specific focus on vehicle-to-grid concepts.

In subtask T2.2.1, two separate advanced stated choice experiments were conducted to explore acceptance levels across various segments of users across 6 European countries. A car purchase experiment was developed to investigate long-term aspects of smart-charging, i.e., whether a user would consider such features relevant in the car-purchase situation. Another experiment was developed to investigate aspects of smart charging routines when it comes to daily charging activities, i.e., a focus on charging costs, charging time restrictions, driving range restrictions, and how much a user should be compensated to allow for such restrictions. Both experiments were included in an online survey which was coded and distributed through a professional market research firm, and the collected data was analysed with advanced quantitative modelling. The results of the car purchase experiment indicated no willingness to pay extra for a battery electric car with V2G capabilities, while the experiment focusing on daily charging found a preference for restrictions to charge during the night and that higher-income drivers require more compensation for V2G contracts than low-income drivers, with preferences varying by region and demographics.

In subtask T2.2.2, a broader acceptance of smart charging solutions through an online questionnaire was examined, revealing strong support across different demographic groups. However, concerns over privacy and data security emerged as significant barriers to participation. Respondents were particularly wary of unauthorized access to personal data, highlighting the need for trust in stakeholders managing the smart charging ecosystem. The level of trust significantly influenced participants' willingness to share information and engage in smart charging practices.

Focus group discussions with V2X-experienced drivers further emphasized the importance of addressing privacy concerns. Experts proposed regulatory strategies and user-friendly contract designs to mitigate data-sharing risks and enhance trust. The findings point to the need for clear guidelines and transparent practices to foster consumer participation in smart charging solutions.

Overall, the project provides valuable insights for stakeholders aiming to develop user-centric V2G services and policies that address consumer preferences and privacy concerns to ensure high participation.

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1. Background and Objectives

The advantages of smart charging are most apparent when widespread adoption occurs, electric vehicles are integrated into the grid as often and for as long as possible, and users share critical data, such as consumption patterns. To maximize participation, smart charging technologies and policies must be designed with careful consideration of user concerns, preferences, and needs.

Therefore, task T2.2 explores acceptance across various segments of users. The objective is to identify user preferences with respect to

- attributes of the (electric) vehicle, to assess the impact of car characteristics and smart charging features such as V2X in the purchase process;
- smart charging in everyday life, to estimate preferences for smart charging features such as time of day restrictions, flexibility, and compensation;
- the stability of preferences across different countries and contexts, to potentially highlight barriers and opportunities;
- data protection and privacy, to identify user-friendly principles for handling user data and provide acceptable regulatory strategies.

The focus of this deliverable D2.2 is on the acceptance of smart charging concepts and user preferences for their conceptual implementation, rather than on interface design, which is the topic of D2.3.

2. Factors influencing user acceptance of smart charging and V2X concepts

Acceptance is a key variable in the psychological process users undergo when deciding on the adoption of technology. Despite extensive research, a precise definition of acceptance remains intangible (Dillon & Morris, 1996; Schmalfuß, 2017). User acceptance can be defined as the willingness within a user group to utilize information technology for its intended tasks (Dillon & Morris, 1996). However, many authors consider two to three dimensions of acceptance: attitudinal, behavioural, and sometimes normative (Schäfer & Keppler, 2013). Attitudinal acceptance represents the mind set of individuals or groups toward a given technology (Fett et al., 2021). Attitudes should be further categorized into instrumental (e.g., desirable/undesirable) and experiential (e.g., pleasant/unpleasant) components to deepen its assessment (e.g., Ajzen & Fishbein, 2005; Crites et al., 1994). The behavioural dimension captures the active component of acceptance (Fett et al., 2021). For example, indicators for behavioural acceptance of BEVs include purchase or usage intention (Schmalfuß, 2017). The normative dimension assesses technology based on norms and values (Schäfer & Keppler, 2013).

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There is no single-variable answer to explain the level of acceptance any technology will receive among its intended users (Dillon, 1996). Five characteristics could determine technology acceptance: relative advantage, compatibility, complexity, trialability, and observability (Dillon, 2001). In other words, the extent to which technology offers improvements over available tools, its consistency with social practices and norms among its users, its ease of use or learning, the opportunity to try an innovation before committing to use it and the extent to which the technology's gains are clear to see will determine user acceptance (Dillon, 2001). To predict long-term acceptance, acceptance models are used by measuring early affective responses to new technology. The first model to predict user acceptance is the Technology Acceptance Model (TAM; Davis et al., 1989), proposing that perceived usefulness (PU) and perceived ease of use (PEOU) are the main determinants of technology acceptance (i.e., behavioural intention to use; BIU; Davis et al., 1989; Fett et al., 2021).

The definitions of smart charging (i.e., Vehicle-to-Everything; V2X) vary depending on the initiative, but the goal is an efficient energy distribution, taking into account grid conditions and avoiding congestion (Huber et al., 2019; Kämpfe et al., 2022). Within this deliverable, we understand smart charging as dynamically third party (supplier) managed charging that benefits the grid, the use of renewable energy, the market, and the users. Smart charging is based on grid status, renewable energy generation, as well as user demands and refers to coordinated charging systems that manage the charging process to optimize it for collective needs (e.g., maintaining grid stability) and/or individual user preferences (e.g., charging when electricity prices are low). With smart charging, the user gives up the control of the charging process to a third party but can be sure that the charging process of the electric car will be optimal for the energy grid and with the maximum amount of green energy available. In addition, the user can charge at a particularly favourable charging rate. In order to be able to charge in a managed manner, the user has to set a minimum battery capacity via the charging app or the display of a charging station/wallbox, which can be managed by a third party. The lower the user sets the minimum battery capacity, the greater is the potential for smart charging. The minimum battery capacity can be set individually by the user.

2.1 Overview of influencing factors

2.1.1 Financial incentives

Many studies reveal that monetary incentives are the most attractive drivers for smart charging (Kämpfe et al., 2022; Marxen et al., 2022; Schmalfuß et al., 2017). Monetary incentives related to smart charging often refer to a discount per kWh or the monthly base price (Daziano, 2022). For example, consumers expected a monthly discount of around 20% on charging costs (Kämpfe et al., 2022) or an average monthly financial compensation of €26 (Gardien et al., 2020). Higher incentive amounts led to higher participation rates in smart charging programmes (Delmonte et al., 2020; Wong et al., 2023; Yilmaz et al., 2021). Wong et al. (2023) found that incentives of $300 to $400/year were sufficient for most EV owners/lessees or EV interested buyers/lessees to participate in smart charging programmes. However, the study also showed that the intention to participate depends on the attributes of the smart charging programme. Incentives, free equipment, and a guaranteed minimum SOC increased willingness, while penalty fees decreased willingness. In addition, due to demographic effects on

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willingness, Wong et al. suggested that a smart charging programme should be targeted at specific groups.

These results point to the importance of financial incentives. Besides, other research supports renewable energy as a key factor for user acceptance of smart charging (Kämpfe et al., 2022; Kubli et al., 2018; Schmalfuß et al., 2015; Will & Schuller, 2016). Nevertheless, Bailey and Axen (2015) argue that financial incentives have a stronger impact than renewable energy incentives on motivation to participate in smart charging.

Signer et al. (2024) compared the charging costs of simulated households at different tariffs with the users' willingness to pay (WTP). The results show the potentially significant impact that different tax regimes could have on the uptake of V2G charging. Double taxation of battery charging and discharging is an issue in several European countries, including Denmark, France, and Germany (Gschwendtner et al., 2021). In this context, Dreisbusch et al. (2020) demonstrated that reduced grid charges would have a positive influence on users' choice of charging tariffs with flexible charging capacity. However, Signer et al. (2024) argue that reducing grid charges would only have marginal impacts on electricity purchase costs and, consequently, would not sufficiently encourage users to participate in a V2G charging tariff. Consequently, in order to encourage the uptake of V2G, it is essential that the tariff is designed in a way that presents a viable business case for EV adopters.

In conclusion, financial incentives are a crucial factor in encouraging users to engage in smart charging. It is recommended that these incentives are incorporated into the design of charging tariffs and business models, considering the implications of taxation. Secondly, taxation systems should be adjusted to make smart charging a successful business case for private users.

Furthermore, the results from FLOW task T2.3 (see D2.3) demonstrate that the design of the user interface plays a pivotal role in motivating users to engage in smart charging.

2.1.2 Charging preferences

The literature has identified several aspects of charging the battery as barriers to PEV adoption. For V2X concepts to be successful, it is important to know how such a system interacts with existing preferences for these different charging aspects. For example, in their systematic review and meta study, Wicki et al. (2023) report charging times and charging availability to be key determinants of BEV acceptance.

Several studies have identified that charging overnight is the most preferred method of charging (Dunckley & Tal, 2016; Skippon & Garwood, 2011) which might be a reason that access to private charging at home is a significant factor in the decision to buy an electric vehicle (Jensen et al., 2021; Visaria et al., 2022). In a small exploratory study reports that BEV users are only willing to make modest investments to upgrade their home supplies to achieve faster charging (Skippon & Garwood, 2011). Dunckley and Tal (2016) report that American BEV users would like better guidance on how to optimize their charging in order to reduce their bills. The study concludes that utilities may play an important role in ramping up the PEV market by educating potential buyers and supporting the public charging infrastructure.

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Public charging is a key point of interest in the literature as well as of BEV users. Jensen et al. (2021) found that each meter of the distance to public charging from the home of a BEV driver is worth between 20 and 122 DKK (Euro 2.7-16.3) and each extra kilometre of driving range a BEV can obtain from 10 minutes of public fast charging is worth between 491 and 824 DKK (Euro 65.5-109.9). Based on a very high number of consumer reviews, (Liu et al., 2023) found that BEV drivers are primarily concerned with location features or amenities related to public charging stations, reliability, as well as whether there are available charging stations at the location. Availability was also found highly important in (Jensen et al., 2021). Furthermore, drivers are also concerned about the complexity of (Hardman et al., 2018; Visaria et al., 2022) of charging the vehicles, which can e.g., be finding the charging stations and payment.

2.1.3 User concerns and preferences regarding data protection and data privacy

User research showed that privacy concerns could be a barrier to smart charging participation (Kämpfe et al., 2022). This may be because smart charging requires granular information about the consumption needs of BEV users. In addition, detailed consumption data is collected and shared between many stakeholders (Demuth et al., 2024). Smart data processing makes it possible to identify precise indicators of activity patterns, ranging from energy consumption and charging information to movement profiles and daily routines.

A questionnaire study (Döbelt, Kämpfe & Krems, 2014) revealed that the willingness to share information about smart charging varies depending on the degree of data aggregation: While consumers would certainly provide information that is generated and processed in a smart charging scenario (level 1 information = raw data, which is processed in the backend system and level 2 information = already processed data aggregated to long-term data), the willingness to share information that contains a threat potential is significantly lower (level 3 information deduced from level 1 and 2, focusing on possible threats of long-term generated and processed data) and consumers are not willing to give this kind of information.

Similar results emerged from a highly naturalistic five-month smart charging field trial in Germany (Döbelt et al., 2023). Again, participants were least likely to provide personal information at level 3 (e.g., "Whether my household is unattended when I leave the house") compared to information at level 2 (e.g., "Rating the amount of energy I charge per week") and level 1 (e.g., "Location of the charging station where I charge"). The overall pattern in terms of serious concerns about derived information remained stable over time and was rarely influenced by real-world experience. Preferred data recipients and trust in them were also constant. As level 1 and 2 information is considered less critical, it may be readily made available to all stakeholders. In contrast, level 3 information should not be shared with any stakeholder. However, participants' willingness to share personal information can be significantly increased if trust in the involved stakeholders grows. That the recipient of the data plays an important role for customers was also shown by research in the smart home context (Yang, Lee, & Zo, 2017).

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2.1.4 User-friendly principles in the handling of user data and acceptable regulatory strategies

Besides the technical feasibility of smart charging systems, the inclusion of the user perspective regarding data protection is essential to achieve active consumer participation (Haider, See, & Elmenreich, 2016), especially in the initial phase. This will encourage consumer trust and thus participation in the smart grid. However, the strong and stable rejection of sharing level 3 information indicates that regardless of their experience, users perceive a long-term risk potential for their privacy in the context of smart charging. Therefore, when developing smart charging systems, privacy should be embedded top-down from the beginning (Döbelt et al., 2023), e.g., by:

(1) Applying a holistic approach, such as Privacy by Design (Cavoukian, Polonetsky, & Wolf, 2010)

(2) Integrating automated mechanisms for data encryption, anonymization, decentralised data storage, etc. into the design of the ICT architecture for smart charging to protect users' privacy by default Heuer (2013)

(3) Incorporating data minimisation and avoidance principles (Raabe et al., 2011) to reduce the threat potential of smart systems per se

Then, from the bottom up, users must be able to decide to what extent (1) they want to be informed, and (2) they want to control the sharing of data with trusted actors. Therefore, it is important to ensure that the involved stakeholders and all processes are presented in a transparent manner. In addition, the possibility of personal customer support fosters trust building. Further, it has been shown that experience under real-world conditions has a significant positive influence on acceptance (Schmalfuß et al., 2015). Therefore, consumer concerns have to be investigated and described to serve as requirements for the technical implementation.

2.2 Aim of the present studies

Emerging from the literature, the consideration of empirically gathered user perspectives on smart charging systems is rare. Yet results are essential to address them during the system design and therefore foster later participation in smart charging use cases.

The first objective of the present research is through empirical analyses to investigate **user perspectives on smart charging in car purchase situations** and the **potential use of smart charging in everyday life**. To consolidate knowledge and fill gaps in the literature, we focus on the following research questions:

RQ1.1: How does smart charging, e.g., V2X, influence car purchase compared to traditional attributes such as cost, range, and charging options?

RQ1.2: How do preferences related to electric vehicle purchase and smart charging vary across European countries?

RQ1.3: How can user preferences for everyday smart charging be quantified? And how do these preferences vary across European countries?

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RQ1.4: What are the barriers and opportunities for smart charging adoption in car purchase situations and everyday life?

The second objective was to i**nvestigate (potential) smart charging users' privacy concerns** and derive **user-friendly principles** in the handling of user data and acceptable regulatory strategies within two focus groups. To address this objective, we focus on the following research questions:

RQ2.1: What are the risks in sharing your data?
RQ2.2: How can the perceived risks be mitigated?
RQ2.3: How should the contract and the contract conclusion be designed so that you feel well informed about what data is collected and where it is shared?
RQ2.4: How can data use and data protection provisions be designed in a way that customers can understand?
RQ2.5: How can data protection (implementation of the GDPR) be integrated into the service?
RQ2.6: What would you advise an energy company to do to strengthen customer trust?

3. Methodology

3.1 Quantitative modelling of V2G preferences

The objective in this task was to study and model the potential of smart charging solutions both for long-term decisions, e.g., in the choice of a car, and also for short-term decisions, e.g., for daily use of the car. To conduct these analyses, it was decided to develop two different choice experiments and model the preferences for V2G preferences from a large sample across 6 European countries.

Choice experiments

A choice experiment is a research method used to understand and quantify the preferences of a choice maker. In a choice experiment, a respondent is presented with a series of scenarios describing two or more alternatives, and the respondent is asked to indicate a choice or a ranking of the presented alternatives given the provided information. Each of these alternatives is described by variables, called attributes. Across each scenario, these attributes vary according to an experimental design developed specifically for the experiment, which ensures that optimal information about the choice maker's preferences can be extracted from the experiment.

Since the respondent is asked to indicate a choice in a hypothetical situation, the data obtained from a choice experiment is called stated preference (SP) data. This is different from data measured from actual behaviour, which is called revealed preference (RP) data. Even though a more realistic description of behaviour would be expected from revealed preference data, obtaining such data can be challenging in several situations. For example, if an emerging product is analysed, there might be no or very few actual users to obtain data from but even for established products or services, it can be difficult to measure all relevant variables or there might be insufficient variation in certain key factors to allow estimation with RP data (Louviere et al., 2000). Previous research has shown that a well-designed experiment can provide good estimates of consumer trade-offs (Ortúzar & Willumsen, 2011),

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but it requires preparation in terms of creating scenarios that are realistic, relevant, and not too complex for the respondent to answer.

As there are currently no commercial V2G products in the market in the participating countries, it would not be possible to base our analysis on actual choices and thus a choice experiment is the preferred method in the current analysis.

Quantitative modelling

Data collected from the choice experiments will be analysed with discrete choice models to quantify the preferences of the decision makers. The logit model is a well-established statistical model that can be used to analyse choices from a finite choice set (Ben-Akiva & Lerman, 1985).

In a logit model, the utility of each alternative j is described as a function of independent variables:

$$U_{nj} = V_{nj}(x_{nj}) + \varepsilon_{nj} \tag{1}$$

The utility is decomposed into V_{nj} which is a function of variables in x describing the alternative j and the decision maker n and a random variable ε_{nj} describing the difference between true and observed utility.

The most common logit model, the Multinomial Logit (MNL) model is obtained if the random term ε_{nj} is assumed to be independent and identically Gumbel distributed. In this case, the probability P_{ni} that a choice maker n will choose alternative i from a choice set C_j including a group of j alternatives becomes:

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_{j=1,\dots,J} e^{V_{nj}}} \tag{2}$$

When a dataset includes several responses per decision maker, it is particularly important to handle correlations within responses from the same decision maker, which can be done with a Mixed Logit (ML) model. With a linear utility in the parameters β such that $V = \beta \cdot x$, where β follows any distribution, ML can be written as:

$$P_{ni} = \int \left(\frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}}\right) f(\beta) d\beta \tag{3}$$

As discrete choice models are not linear, it is not possible to assess the value of the parameters directly as it e.g., is with regression type models. To quantify and compare preferences for different variables of the model, it is common to calculate willingness-to-pay (WTP) measures, which is usually the trade-off between the preference for a specific attribute and an attribute describing a cost of the alternative.

$$WTP_x^i = \frac{MU_x^i}{MU_C^i} \tag{4}$$

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Where MU_x^i and MU_C^i are the derivatives of the utility of alternative i with respect to the attribute x and a cost attribute C respectively. Please note that in case of a simple linear specification, these derivatives are simply the ratio between the estimated parameters.

3.1.1 Car choice experiment

The first choice experiment was highly based on (Jensen et al., 2021).A specific purpose of the previous study was to support analysis of demand for the various combinations of fuel type and car class and thus the experiment includes a joint decision between 3 car types and 5 car classes as presented in Table 1: Overview and definition of car types and car classes considered in the study We decided to use the same categories and definitions in the current study.

Table 1: Overview and definition of car types and car classes considered in the study

Car types	Car classes
Internal combustion vehicles (ICV)	Mini
Electric vehicles (EV)	Small
Plug-in Hybrid Electric Vehicles (PHEV)	Medium
	Large
	Premium

Clearly, it would be problematic to present respondents with all 15 combinations. To reduce the complexity, we use a setup, where for each fuel type, only two car classes are presented for each car type and thus a total of six alternatives are presented in each scenario. The two car classes were determined for each individual based on an initial question about the likelihood of choosing each of the five car classes. If there are more than two car classes that are equally likely, then two of these will be picked randomly.

The choice experiment in the previous study included a very detailed representation of type-specific attributes (e.g., for BEV charging attributes). We used the same representation in the current study, except that we removed the distance between fast chargers as this attribute was not important for the general sample (Jensen et al., 2021). Instead, we included an attribute describing whether it is possible to use the car for bidirectional charging, which is necessary to have a V2G product at home. Also following the previous study, the attributes describing the distance and availability of public charging near the home of the decision maker is only presented to those who indicate that they do not have access to a private parking place where a private charger can be installed. For the current survey, we decided that the V2G attribute should only be presented to those who do have access to a private parking place, where a private charger can be installed as this is more likely to be an option for those using private chargers. An overview of all included attributes in the present study on car choice is included in Table 2.

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Table 2: Attributes included in the choice experiment

Cost-attributes	Purchase price	The one-off expense of purchasing the car including any applicable taxes, fees, and discounts.
	Yearly cost	The expected fixed yearly upkeep cost of owning the vehicle which includes any applicable taxes, fees (e.g., road or environmental taxes), and discounts as well as other fixed expenses such as insurance and mandatory car service and inspection.
	Operation costs	A km-based running cost of using the car, which includes fuel/electricity expenses and wear and tear of driving. Since car mileage varies from person to person this is presented as a variable driving cost per kilometer.
Car characteristics	Range	The average driving range of the vehicle when tank or battery is full.
	Acceleration	Performance attribute describing the acceleration time from 0-100 km/h.
	Boot size	Utility attribute describing the total storage capacity of the trunk of the vehicle.
	Carbon emissions	Pollution attribute describing CO2 emissions per km. For battery electric vehicles, this variable is dependent on the assumed level of renewable energy in the electricity production that varies across the scenarios.
Charging infrastructure:	Distance to home charging (Only respondents who cannot charge at home)	Indicates the distance to the nearest public (slow) charger from home. The a*ttribute is only included for individuals who do not have access to private charging at home. Relevant for BEV and PHEV and restricted to be the same for all alternatives within a scenario.*
	Home charging availability (Only respondents who cannot charge at home)	Indicates the probability that the nearest public (slow) charger(s) has a vacation spot. *Attribute only included for individuals who do not have access to private charging at home and only for BEV and PHEV. Relevant for BEV and PHEV and restricted to be the same for all alternatives within a scenario.*
	Charging speed	Indicates the charging speed at the public fast chargers. In order to be applicable for all EV car classes and varying battery sizes, it is shown as an average driving distance which can be achieved through 10 minutes of charging. *Only relevant for BEV*
	V2G	Describes whether bidirectional charging is possible. *Attribute only included for individuals who have access to private charging at home.*

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Experimental design

As previously mentioned, an experimental design should ensure that the attributes in the choice experiment are varied across the presented scenarios in a way that optimal information about the choice maker's preferences can be extracted from the experiment. This task involves from the analyst's perspective often a trade-off between providing scenarios that seems realistic and relevant from the point of view of the decision makers and at the same time ensures enough variation in the attribute values. A good strategy is to pivot the stated choice experiment around reference values (Rose & Bliemer, 2009).

In Table 3, the reference values for attributes that are the same across all countries are presented. The values are based on specifications of car models available in the market at the time the study was designed. Specifically for carbon emissions for driving on electricity, which is the case for all BEV driving and a share of PHEV driving, the reference values reflect a situation where none of the electricity production is based on renewable energy. As explained later, the experiment includes another attribute that varies the share of renewable energy across the scenarios which means that the presented value in the table will only be shown to respondents in a situation with no renewable energy in the electricity production.

Table 3: Reference values for car characteristics

Car class	Acceleration			Boot size	Carbon emissions			Driving range				Max charging speed
	[seconds]			[Litres]	[g/km]			[km]				[km/10min]
	ICV	BEV	PHEV	ICV/BEV/PHEV	ICV	BEV	PHEV	ICV	BEV	PHEV (bat)	PHEV (gas)	BEV
Mini	13	10	10	246	104	95	99	750	183	20	750	90
Small	13	9	9	349	125	110	117	750	333	30	750	90
Medium	13	8	8	420	135	125	130	750	349	40	750	90
Large	11	8	8	549	145	134	139	750	427	45	750	108
Premium	9	6.5	6.5	497	145	165	155	750	427	47	750	108

For some attributes, we found that it was necessary to allow the reference values to vary between countries. These are all monetary attributes that vary considerably for each specific car type between countries due to price and taxation levels. We based country-specific reference values for the cost attributes on online sources[1] followed by a discussion with FLOW partners in each country. Then DTU gathered the information which was used in the process of generating country-specific scenarios for the choice experiment. Several iterations of adjustments of the final design and reference values were necessary to ensure a good trade-off between realism and coverage. The final reference values are presented in Table 4.

[1] www.statista.com/statistics/425095/eu-car-sales-average-prices-in-by-country, www.tolls.eu/fuel-prices

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Table 4: Country-specific reference values across car types and car classes

	Cur	Car class	Purchase Price [Currency]	Operation Cost [Currency/km]			Annual costs [Currency/year]
			ICV/BEV/PHEV	ICV	BEV	PHEV	ICV/BEV/PHEV
IR	EUR	Mini	23,286	0.10	0.05	0.07	757
		Small	27,239	0.11	0.05	0.08	773
		Medium	30,435	0.12	0.05	0.08	851
		Large	38,282	0.13	0.05	0.09	929
		Premium	108,250	0.16	0.06	0.11	1,164
CZ	CZK	Mini	415,502	2.31	1.24	1.77	17,750
		Small	533,307	2.46	1.29	1.88	18,111
		Medium	661,582	2.68	1.38	2.03	19,947
		Large	924,531	2.87	1.39	2.13	21,763
		Premium	1,783,137	3.66	1.52	2.59	27,284
IT	EUR	Mini	26,084	0.11	0.05	0.08	947
		Small	32,917	0.12	0.06	0.09	966
		Medium	42,613	0.13	0.06	0.10	1,064
		Large	70,510	0.14	0.06	0.10	1,161
		Premium	101,855	0.18	0.06	0.12	1,455
DK	DKK	Mini	181,502	0.90	0.59	0.74	7,100
		Small	279,214	0.96	0.61	0.79	7,244
		Medium	357,875	1.04	0.66	0.85	7,979
		Large	479,920	1.12	0.66	0.89	8,705
		Premium	1,242,256	1.43	0.72	1.07	10,913
ES	EUR	Mini	31,029	0.10	0.05	0.08	1,136
		Small	38,990	0.11	0.06	0.08	1,159
		Medium	49,308	0.12	0.06	0.09	1,277
		Large	64,618	0.12	0.06	0.09	1,393
		Premium	89,371	0.16	0.06	0.11	1,746
DE	EUR	Mini	28,587	0.11	0.06	0.09	947
		Small	36,692	0.12	0.06	0.09	966
		Medium	45,517	0.13	0.06	0.10	1,064
		Large	63,608	0.14	0.06	0.10	1,161
		Premium	122,680	0.18	0.07	0.13	1,455

The final design structure for the experiment is found in Table 5. We used Ngene software (ChoiceMetrics, 2011) to generate an efficient design with a total of 60 choice situations where the attributes vary across four levels. Clearly, 60 scenarios would be too much to present to each respondent and thus a blocked design with 15 levels is included to distribute four scenarios to each respondent. One design table will thus control what is shown to each batch of 15 respondents. A separate design table is created for the experiment where respondents will likely be able to charge at home at private charger and for the experiment where respondents will likely *not* be able to charge at home at a private charger as there is a small difference in the attributes included.

Table 5: Design structure of the experiment

Attribute	Value presented in scenario	Levels			
		1	2	3	4
Purchase Cost	Level * ref_country	0.75	0.92	1.08	1.25
Operation Cost	Level * ref_country	0.80	0.93	1.07	1.20
Yearly Cost	Level * ref_country	0.80	0.93	1.07	1.20
Range (gas): ICV, PHEV	Level * ref	0.80	0.93	1.07	1.20
Range (battery): BEV, PHEV	Level * ref	0.60	0.87	1.13	1.40
Acceleration: ICV	Level * ref	0.70	0.90	1.10	1.30
Acceleration: BEV, PHEV	Level * ref	0.60	0.87	1.13	1.40
Boot size	Level * ref	0.80	0.93	1.07	1.20
Carbon emission, ICV	Level * ref	0.70	0.90	1.10	1.30
Carbon emission, BEV	Level * ref *(1-Ren. energy)	0.70	0.90	1.10	1.30
Carbon emission, PHEV	Level * ref *(1-Ren. energy*0.5)	0.70	0.90	1.10	1.30
Share of renewable energy in electricity production	Not presented directly	0.25	0.50	0.75	1.00
Max charging speed	Level * ref	0.40	0.80	1.20	1.60
Distance to home charging: BEV, PHEV (only those who cannot charge at home)	Level * ref	50 m	250 m	450 m	650 m
Home charge availability out of 4 times: BEV, PHEV (only those who cannot charge at home)	Level	1	2	3	4
V2X (only those who can charge at home)	Level	Vehicle can power your home and export to the electricity grid	Vehicle can only power your home	Vehicle can only export to the electricity grid	None

In each scenario presented to a respondent, the alternatives are described by representations of these attributes which can either be the direct level value as is the case for distance to home charging, or it

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can be a combination of the level value (which is then a factor) multiplied to the reference value that in some cases are country specific. Specifically for BEV and PHEV carbon emissions, the presented values are a combination of the level for the base carbon emission and the level describing the share of renewable energy. As PHEV partly runs on battery and partly on gas, we assume that only half of the share of renewable energy affects the final carbon emissions.

3.1.2 Experiment on charging preferences

In the experiment on charging preferences, we ask the respondents to imagine they have the option to make a contract for vehicle-to-grid charging at their main charging location, which can be either at home or public chargers nearby, at work or public chargers nearby or it can be public chargers not located nearby home or work. As part of the contract, the respondents will need to make sure their electric vehicle is connected to the electricity network during a period defined by several variables that describe the level of flexibility of the contract. The attributes included in the experiment are described in Table 6.

Table 6: Attributes of the choice experiment on charging preferences

Charging cost	The cost per kilowatt hour for charging the vehicle at the indicated main charging location.
Compensation	Monthly compensation for making the battery of the electric vehicle available for the electricity grid within the contract terms
Duration	The minimum duration the car must be available within the V2G time-period.
Frequency	The minimum number of days the car must be connected to live up to the V2G time restrictions.
Range - During period	Guaranteed driving range available during the V2G time-period, e.g., driving range available if the owner suddenly needs to go to the hospital during the time-period.
Range – End of period	Guaranteed driving range available by the end of the V2G time-period, e.g., driving range available in the morning if the car has been available for V2G during the night.
Additional battery degradation per year	This attribute reflects that the battery will degrade with time (have lower driving range) as V2G cause more charging cycles.

As with the first choice experiment, the respondent is asked to indicate a choice in a total of four scenarios, where these variables vary across each experiment according to a pre-defined experimental design. In each scenario, there are 6 alternatives and there will always be two alternatives where the period is during the day (10-15), during the evening (17-22) or during the night (22-06). In exchange for providing battery capacity to the electricity network, the respondent will be receiving a compensation. As the income level varies across the participating countries, we varied the compensation according to the level of pricing previously found on car prices, operation costs and electricity prices as well as on discussions with partners in each country. Electricity prices were based

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on statistics from Eurostat[2]. We have presented the country-specific reference values in Table 7. For the respondent to have a better understanding of the costs of charging their car, we also provide a suggestion for the average charging cost at the main charging location which also depends on the country.

Table 7: Country-specific reference values in the choice experiment for charging preferences

Country	Currency	Charging cost at main charging location	Compensation (Currency per Month)		
Ireland	EUR	0.28	40	30	20
Czech Republic	CZK	7.36	1048	786	524
Italy	EUR	0.32	46	34	23
Denmark	DKK	3.51	500	375	250
Spain	EUR	0.32	45	34	22.5
Germany	EUR	0.34	48	36	24

The final design structure is found in Table 8.

Table 8: Design structure of experiment on charging preferences

Attribute	Value presented in scenario	Levels				
		1	2	3	4	5
Charging cost (fixed across all alternative)	Level * ref_country	0.5	0.75	1	1.25	1.5
Compensation: Day	Level * ref_country	0.5	0.75	1	1.25	1.5
Compensation: Evening	Level * ref_country	0.5	0.75	1	1.25	1.5
Compensation: Night	Level * ref_country	0.5	0.75	1	1.25	1.5
Duration: Day, Evening	Level	1 hour	3 hours	5 hours	-	-
Duration: Night	Level	4 hours	6 hours	8 hours	-	-
Frequency: Day, Evening	Level	5 days of 10 days	7 days of 10 days	9 days of 10 days	-	-
Frequency: Night	Level	7 days out of 10 days	8 days out of 10 days	9 days out of 10 days	-	-
Range at end of period: Day, Evening	Level	50 km	75 km	100 km	125 km	150 km
Range at end of period: Night	Level	50 km	100 km	150 km	200 km	250 km
Range during period	Level	25 km	37.5 km	50 km	62.5 km	75 km
Range during period	Level	25 km	50 km	75 km	100 km	125 km
Additional battery degradation per year	Level	0 %	0.5 %	1 %	1.5 %	2 %

[2] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Electricity_price_statistics)

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Again, we use Ngene software to generate an efficient design with a total of 60 choice situations where the attributes in this case vary across three to five levels. An additional blocking attribute with 15 levels is used to distribute four scenarios to each respondent. In each scenario presented to a respondent, the alternatives are described by representations of these attributes which can either be the direct level value, or it can be a combination of the level value (which is then a factor) multiplied by the reference value that in some cases are country specific.

3.1.3 Survey tool

Data was collected with an online survey tool coded by Epinion. DTU provided the requested structure of the survey questions and the tables with design and reference values and during the development of the tool, several tests of the tool were conducted to both test the technical setup and the clarity of the survey.

The overall survey structure is indicated in Table 9 and follows a standard structure for a choice experiment. After general information, the respondent is asked to indicate the minimum amount of information necessary to customize the choice experiments. In this case, it is relevant to get information about the car class the respondent would be most interested in for her next potential car purchase and whether she will be able to charge an electric car (BEV or PHEV) at home or not. The respondent will then continue to the two choice experiments. As the choice experiments are complex, the choice experiments are included as early in the survey as possible to avoid respondent fatigue. Before each experiment, an introduction page introduces the choice experiment in detail so that the respondent is well prepared for the task. In the final part of the survey, the respondent is asked for further information about e.g., their age, gender and car usage.

Table 9: Structure of the survey tool

Section	Description
Information and introduction	General information about the survey, project and GDPR.
Introduction and initial questions for framing the stated choice experiments	Survey questions about respondent occupation status, whether it is (potentially) possible to charge at home or not, their future expectations about car purchase including car class.
Choice experiment related to vehicle purchase	Introduction to the choice experiment and four choice tasks about car purchase.
Choice experiment related to smart charging	Introduction to the choice experiment and four choice tasks about V2G charging.
Information about the respondent, car usage, and attitudes	Further questions describing the respondent, household, car usage and attitudes.

A particular important question in the initial phase of the survey relates to the potential possibility to charge a BEV or PHEV in a private charger at the home location. Previous research has indicated that home charging options affect consumer preferences for electric vehicles and thus for the choice experiment on car purchase, it is important to collect information about this. Moreover, as described in Table 2: Attributes included in the choice experiment, attributes describing public charging options

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near the home should only be presented to those who cannot charge at home while the attribute on V2G charging should only be presented to those who *can* charge at home. In most cases, respondents who live in a house will have access to a private parking space more often than respondents who live in an apartment, but since this is not always the case, it was decided to ask more directly about the possibility of installing a private charger at the respondent's property or residence. The survey question and the possible answers are indicated in Table 10. If a respondent indicated the options with code 1 or 2, the respondent is presented with the choice experiment for respondents who will likely be able to charge at home, whereas if the a respondent indicated the options with codes 3 or 4, the respondent is presented with the choice experiment for respondents who will likely not be able to charge at home.

Table 10: Question about (potential) charging options at home and the provided answer categories.

Code (ChPriv)	Description
1	Yes, I have a private charger (or can charge through a general outlet).
2	No, but it is possible to set up a private charger at my property/residence.
3	No, and it is not possible to set up a private charger at my property/residence.
4	Don't know.

Experiment on car choice

The layout of the choice experiment on car purchase was based on the layout used in (Jensen et al., 2021) but with some adjustments. In Figure 1**Fehler! Verweisquelle konnte nicht gefunden werden.** an example is provided, where a respondent indicated that small and medium car classes would be most relevant in a future car purchase situation. The respondent is asked to imagine that the presented cars are the best options available, and they should choose one of them.

The top row presents the car class followed by groups of attributes. The group of cost attributes is always placed just below the car class, whereas the order of the groups with car characteristics and charging characteristics can differ at respondent level. This means that for some respondents, car characteristics will be presented just below the cost characteristics (as in Figure 1), whereas for other respondents, the charging characteristics can be placed right below cost characteristics (as in Figure 2). Please note that for the same respondent, the location of the groups of characteristics will always be the same in all choice situations.

Another feature of the survey tool is that the two Petrol alternatives are sometimes presented all the way towards the left (as in Figure 1) or all the way towards the right (as in Figure 2). We considered to have all possible locations of car types, but due to the fact that BEV and PHEV share the attributes describing public charging options at home, it was necessary to always keep these two alternatives next to each other. Similar to the location of groups of attributes, the car types are in the same location across scenarios presented to the same respondent.

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Epinion
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Imagine these new cars for sale as the best options in each class. Please choose a car assuming that you will finance it yourself.

Explanation of car classes:

- **Small:** fx Peugeot 208, Toyota Yaris, Renault Zoe
- **Medium:** Ford Focus, Volkswagen Golf, Nissan Leaf

	Petrol car	Petrol car	Electric car	Electric car	Plug-in Hybrid car	Plug-in Hybrid car
Car class	Small	Medium	Small	Medium	Small	Medium
Costs						
Purchase price	34,000 EUR	33,000 EUR	25,000 EUR	38,000 EUR	20,400 EUR	22,800 EUR
Yearly cost (tax/fees, insurance, car inspection)	928 EUR	1,021 EUR	825 EUR	908 EUR	618 EUR	681 EUR
Operation cost (Expenses per 10,000 km)	0.1 EUR/km (1,008 EUR)	0.13 EUR/km (1,259 EUR)	0.04 EUR/km (384 EUR)	0.06 EUR/km (612 EUR)	0.06 EUR/km (624 EUR)	0.1 EUR/km (1,020 EUR)
Car Characteristics						
Boot size	279 litre (Small)	504 litre (Extra large)	372 litre (Medium)	448 litre (Large)	418 litre (Large)	336 litre (Medium)
Acceleration (0-100 km/h)	16.9 sec.	9.1 sec.	7.8 sec.	6.9 sec.	12.6 sec.	6.9 sec.
Driving range	800 km	600 km	288 km	489 km	Electric: 26 km Petrol: 900 km	Electric: 35 km Petrol: 700 km
CO_2 emissions (emissions per 10,000 km)	87 g/km (870 kg)	148 g/km (1,480 kg)	107 g/km (1,070 kg)	66 g/km (660 kg)	92 g/km (920 kg)	148 g/km (1,480 kg)
Charging						
Charging possibilities near home			Public charger 250 meter from home Available 4 out of 4 times			
Range gained per 10 min fast charging			108 km	72 km		
Which car would you prefer in this situation?	○	○	✓	○	○	○

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Figure 1: Car choice experiment shown to a respondent who indicated interest in small and medium size cars and who cannot charge at home

In Figure 2, a similar example of a scenario shown to a respondent who indicated that small and medium cars would be most relevant in a future car purchase situation. But this respondent indicated that home charging is possible and is thus presented with the attribute on V2G charging instead of the public charging options near home. Please also note that for this respondent, the group of charging attributes is located before the group of car characteristic attributes.

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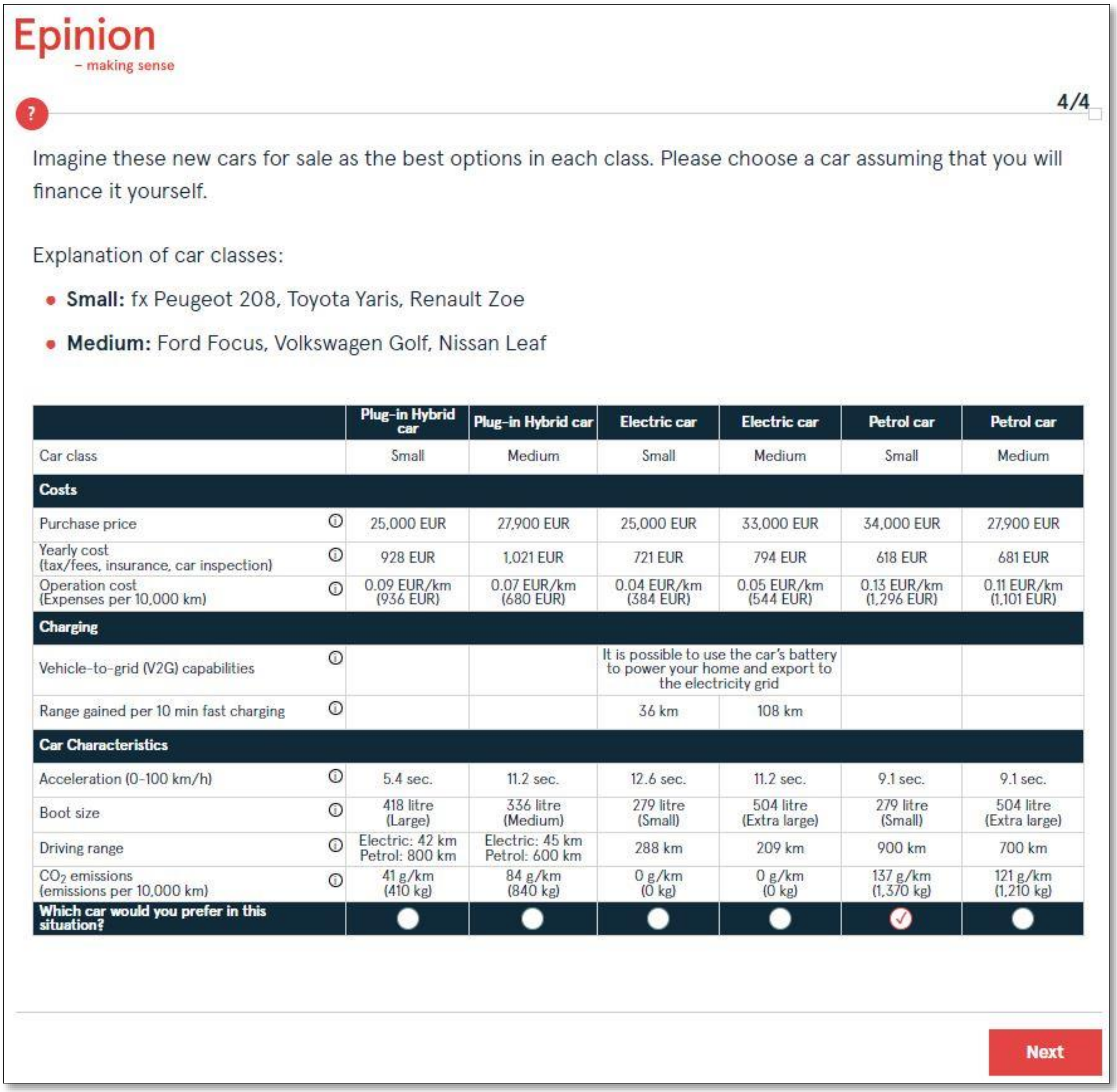

Epinion
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Imagine these new cars for sale as the best options in each class. Please choose a car assuming that you will finance it yourself.

Explanation of car classes:

- **Small:** fx Peugeot 208, Toyota Yaris, Renault Zoe
- **Medium:** Ford Focus, Volkswagen Golf, Nissan Leaf

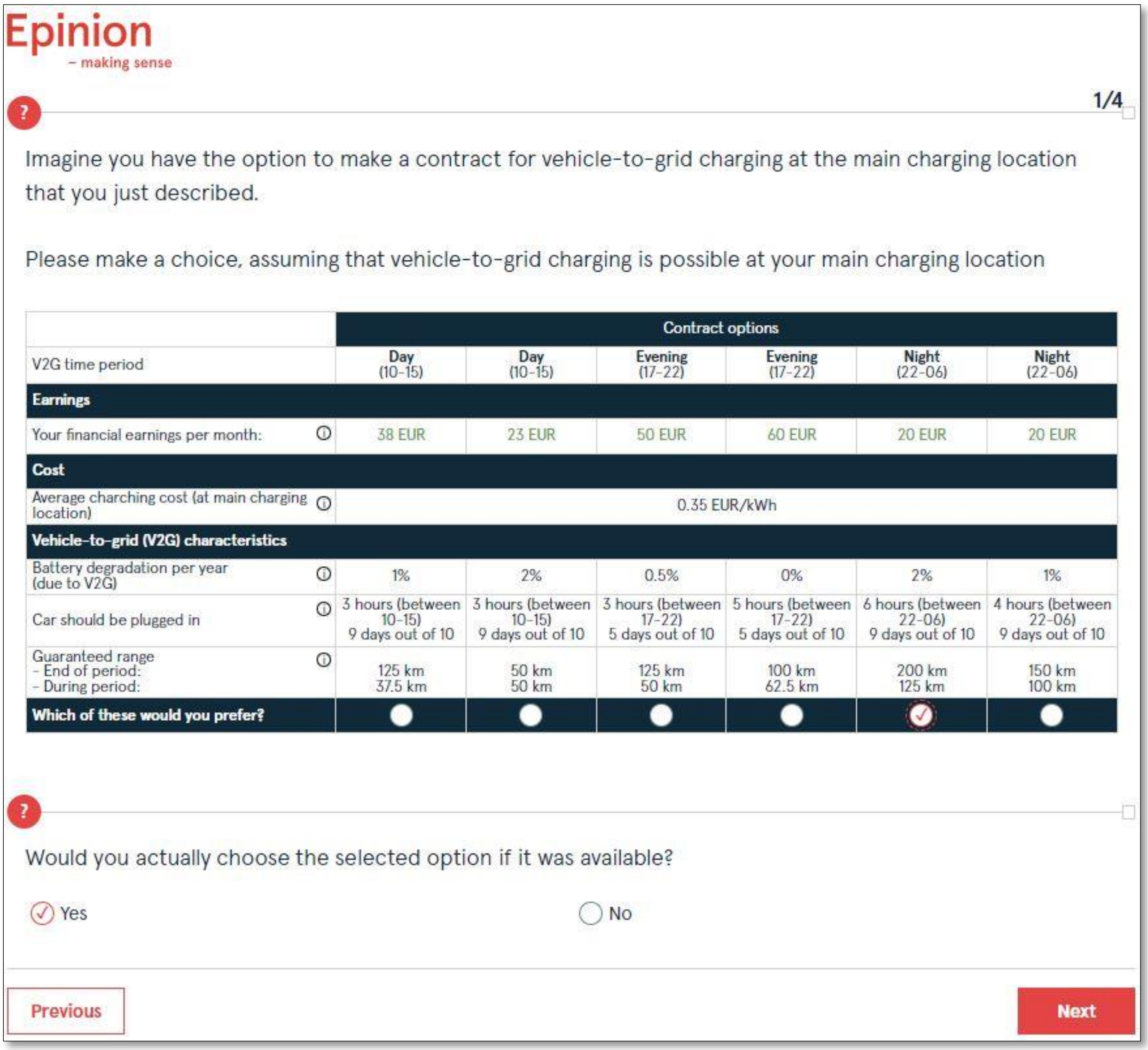
	Plug-in Hybrid car	Plug-in Hybrid car	Electric car	Electric car	Petrol car	Petrol car
Car class	Small	Medium	Small	Medium	Small	Medium
Costs						
Purchase price	25,000 EUR	27,900 EUR	25,000 EUR	33,000 EUR	34,000 EUR	27,900 EUR
Yearly cost (tax/fees, insurance, car inspection)	928 EUR	1,021 EUR	721 EUR	794 EUR	618 EUR	681 EUR
Operation cost (Expenses per 10,000 km)	0.09 EUR/km (936 EUR)	0.07 EUR/km (680 EUR)	0.04 EUR/km (384 EUR)	0.05 EUR/km (544 EUR)	0.13 EUR/km (1,296 EUR)	0.11 EUR/km (1,101 EUR)
Charging						
Vehicle-to-grid (V2G) capabilities			It is possible to use the car's battery to power your home and export to the electricity grid			
Range gained per 10 min fast charging			36 km	108 km		
Car Characteristics						
Acceleration (0-100 km/h)	5.4 sec.	11.2 sec.	12.6 sec.	11.2 sec.	9.1 sec.	9.1 sec.
Boot size	418 litre (Large)	336 litre (Medium)	279 litre (Small)	504 litre (Extra large)	279 litre (Small)	504 litre (Extra large)
Driving range	Electric: 42 km Petrol: 800 km	Electric: 45 km Petrol: 600 km	288 km	209 km	900 km	700 km
CO_2 emissions (emissions per 10,000 km)	41 g/km (410 kg)	84 g/km (840 kg)	0 g/km (0 kg)	0 g/km (0 kg)	137 g/km (1,370 kg)	121 g/km (1,210 kg)
Which car would you prefer in this situation?	○	○	○	○	✓	○

Next

Figure 2: Car choice experiment shown to a respondent who indicated interest in small and medium size cars and who are able to charge at home

Experiment on V2G charging

The layout of this experiment is presented in Figure 3. The top row includes the time period of the alternative followed by a description of the average charging cost at the main charging location and a group of V2G characteristics. As this choice experiment is a bit more difficult for a respondent to relate to and since some respondents would not like to enter a V2G contract in any of these terms, the respondent is given an opportunity to indicate whether she would choose the option if it was available.


Epinion
– making sense

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Imagine you have the option to make a contract for vehicle-to-grid charging at the main charging location that you just described.

Please make a choice, assuming that vehicle-to-grid charging is possible at your main charging location

	Contract options					
V2G time period	Day (10-15)	Day (10-15)	Evening (17-22)	Evening (17-22)	Night (22-06)	Night (22-06)
Earnings						
Your financial earnings per month:	38 EUR	23 EUR	50 EUR	60 EUR	20 EUR	20 EUR
Cost						
Average charching cost (at main charging location)	0.35 EUR/kWh					
Vehicle-to-grid (V2G) characteristics						
Battery degradation per year (due to V2G)	1%	2%	0.5%	0%	2%	1%
Car should be plugged in	3 hours (between 10-15) 9 days out of 10	3 hours (between 10-15) 9 days out of 10	3 hours (between 17-22) 5 days out of 10	5 hours (between 17-22) 5 days out of 10	6 hours (between 22-06) 9 days out of 10	4 hours (between 22-06) 9 days out of 10
Guaranteed range - End of period: - During period:	125 km 37.5 km	50 km 50 km	125 km 50 km	100 km 62.5 km	200 km 125 km	150 km 100 km
Which of these would you prefer?					✓	

Would you actually choose the selected option if it was available?

✓ Yes ◯ No

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Figure 3: V2G experiment shown to a respondent

3.1.4 Participants

The data collection was conducted over two periods where the first one aiming at obtaining a minimum of 750 respondents in each country was conducted between 25. January 2024 and 7. February 2024. Despite two rather detailed pilot data collections in Denmark that indicated promising results for both choice experiments, unfortunately, it was not possible to obtain similarly good results in the V2G experiment across several countries in this round of data collection. The problem was solved by changing the colour of the values indicating the level of compensation to green and the description was changed to underline that this is a financial earning to the respondent. Within the project, there was budget to distribute the survey to another 250 respondents in each country which was conducted between 16. April 2024 and 2. May 2024. This means that it is possible to analyse and model results

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based on all 1000 respondents per country for the car choice experiment whereas it was only possible to analyse and model results based on the 250 respondents per country for the V2G data experiment.

A description of the sample across the countries is presented in Table 11. Within each country, there is a fairly good gender distribution, and the average age is between 45 years and 52 years. The average income is lowest in Czech Republic and highest in Denmark and Ireland.

Table 11: Sample information across countries

Country	Number of Respondents	Share Female	Avg. Age	Avg. Household Income pr. month
Czech Republic	1077	51.3%	48 Years	2399€
Denmark	1087	49.9%	48.8 Years	5287€
Germany	996	48.1%	52.2 Years	3590€
Ireland	990	50.8%	46.5 Years	5148€
Italy	1020	52.7%	50.3 Years	3060€
Spain	1244	47.5%	45.4 Years	3229€

3.2 Online questionnaire study

To assess users' acceptance of smart charging as well as their privacy concerns and preferences regarding data protection in electric vehicle charging, an online questionnaire study was conducted. The study adopted a cross-sectional design, employing a single test condition completed by each participant. Data collection was carried out from March 30 to May 21, 2023, in Germany, and all measures were taken to ensure confidentiality and protect participant identities through anonymization.

3.2.1 Study design

The survey utilised a composite questionnaire structure (see Figure 4). Emphasising the paramount importance of privacy, a clear statement regarding the survey's privacy policy was incorporated. The introduction section provided a comprehensive description of the different charging concepts. These encompassed public charging, occurring at designated public stations, home charging, taking place at private residences, and smart charging, an adaptive approach optimizing charging based on grid conditions and user preferences. The survey then delved into understanding the motivations behind participants' interest in smart charging. The third segment focused on evaluating the participants' preferences for various charging concepts. Participants were requested to indicate their choice between unmanaged (i.e., conventional) and smart public charging options, as well as express their preference between unmanaged and smart home charging. Moreover, they were invited to elucidate the reasons underlying their preferences and provide an assessment of the criticality of diverse public charging scenarios. Addressing the theme of privacy and trust, the fourth section of the survey inquired about the participants' willingness to share data related to their charging habits, alongside their beliefs concerning potential risks associated with data sharing. Furthermore, the survey sought to discern the level of trust participants placed in various actors within the electric vehicle charging ecosystem,

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including electric mobility service providers (EMSP), energy suppliers, and aggregators. Finally, participants were invited to furnish general information about themselves, encompassing details concerning their overall privacy concerns, experience with E-Mobility, and demographic variables. Concluding the survey, participants were thanked for their valuable contributions, recognizing their essential role in enriching the study's insights.

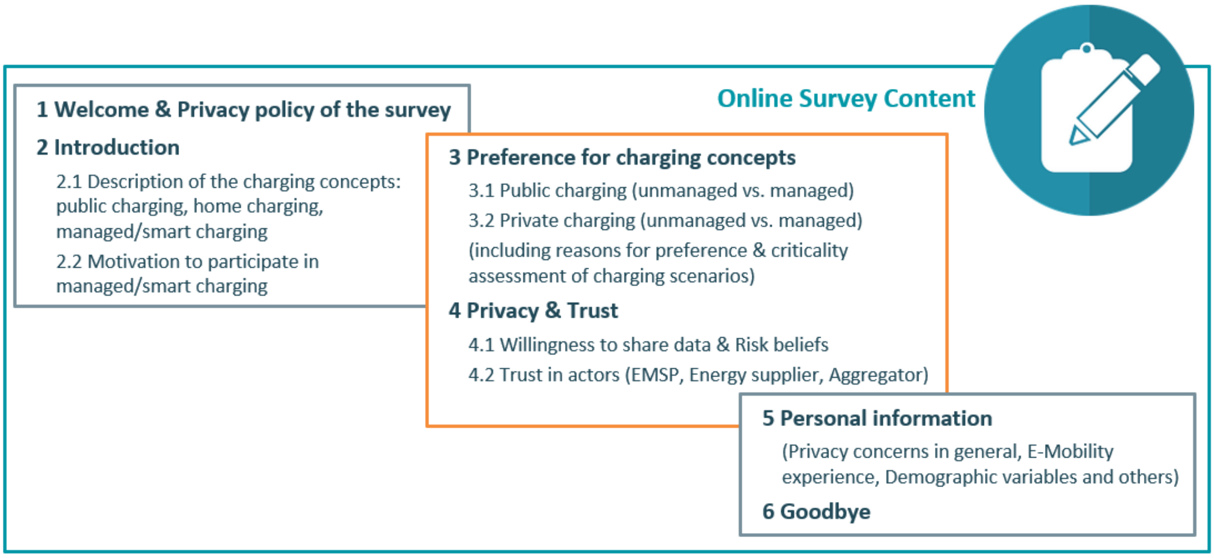

Figure 4. Overview of the content of the conducted online questionnaire study.

3.2.2 Participants

Only individuals aged 18 years or older participated in the study. The study included a total of 103 participants, of which 62 self-identified as female, constituting 60% of the total respondents, while 41 individuals identified as male, accounting for 40% of the participant pool. Regarding age, the participants' average age was 31 years, with the youngest participant being 18 years old and the oldest participant aged 67 years. In terms of educational attainment, most participants (60%) reported having completed high school education. Approximately 33% of respondents held a university degree, while the remaining 7% fell into the category of "other" educational backgrounds.

Participants' experience of active BEV use was assessed by their reported total distance travelled with a BEV and the total number of (smart) charging events engaged in the last 12 months. Based on their BEV experience the sample could be divided into the 3 experience groups *low-level*, *medium-level*, *high-level* (see Table 12). Among the study participants, 53% fell into the *low-level* group, lacking BEV ownership and prior driving experience with BEVs. They travelled 0 km (no kilometres) with a BEV and practised no public charging, home charging, or any other charging. The *medium-level* group (23%) comprised individuals with driving experience but no BEV ownership, travelling an average of 2,541 km with a BEV. The average number of charging events reported for public charging was 1.19, for home charging 17.94 and for other charging 1.53. No smart charging was used for any of the charging scenarios. The *high-level* group (24%), BEV owners with smart charging experience, travelled an average of 13,001 km with a BEV. The number of public charging was 30.41 of which 20% were smart

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charging events. Participants reported an average of 112.48 charging events for home charging, of which 46% were smart charging events. In alternative charging contexts, the average number of charging events was 4.33, of which 14 % were smart charging (see Table 12). In summary, the *high-level* participants exhibited the highest average kilometres travelled with a BEV, showcasing their significant experience and active usage of electric vehicles.

Table 13. Participants' stated BEV and (smart) charging experience within the last 12 months.

	%	ø Km travelled with a BEV	ø Number of charging events (% smart)		
			public	home	other
Low-level (No BEV-owners, no driving exp.)	53%	0km	0	0	0
Medium-level (No BEV-owners, driving exp.)	23%	2,541km	1.19 (0%)	17.94 (0%)	1.53 (0%)
High-level (BEV owners, smart charging exp.)	24%	13,001km	30.41 (20%)	112.48 (46%)	4.33 (14%)

Note. *N* = 103

3.3 Focus groups with V2X experienced users

To identify user-friendly principles in the handling of user data and acceptable regulatory strategies, a total of seven V2X experienced users were recruited, with five users forming the first focus group and two users comprising the second focus group. Structured interviews were conducted for each focus group. Focus group one (n = 5) took place on November 17, 2023, in person at the premises of TUC (Chemnitz, Germany). The session lasted 2.5 hours and encompassed six questions aimed at identifying user-friendly data handling practices and strategies for user-friendly data disclosure. Focus group two (n = 2) was conducted online on November 21, 2023, through the open-source web conferencing system BigBlueButton. This session lasted two hours and built upon the findings from the first focus group, with an additional objective of identifying features of a user-friendly, transparent, and confidential contractual relationship. The interview with the second group also comprised six questions. Both interviews were complemented by filling out a parallel online questionnaire for further data collection.

Following the structured interview guides in both focus groups, the interviews were recorded and transcribed. The interview data was analysed according to Mayring (2000) using the inductive category development methodology. Participants' statements were coded by two independent coders and thus, a system of categories was developed. Six distinct coding schemes with respective subcategories were formulated, aligning their logical structure with the interview questions (refer to section 3.3.2). The categories and codes were not predetermined but emerged exploratively from the responses of experienced participants from both focus groups, with the aim of quantitatively presenting the given qualitative responses of the participants.

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3.3.1 Study design

A structured interview was conducted within the focus groups (see Figure 5). Both focus groups also completed an online questionnaire simultaneously. In the introduction, participants were presented with details about the interviews, including the topic, duration, methods, and approach. Emphasizing privacy, a clear statement about the interview's privacy policy was included. Subsequently, the interviewer used the interview guide for questions, and participants responded in a relaxed setting, discussing differing views.

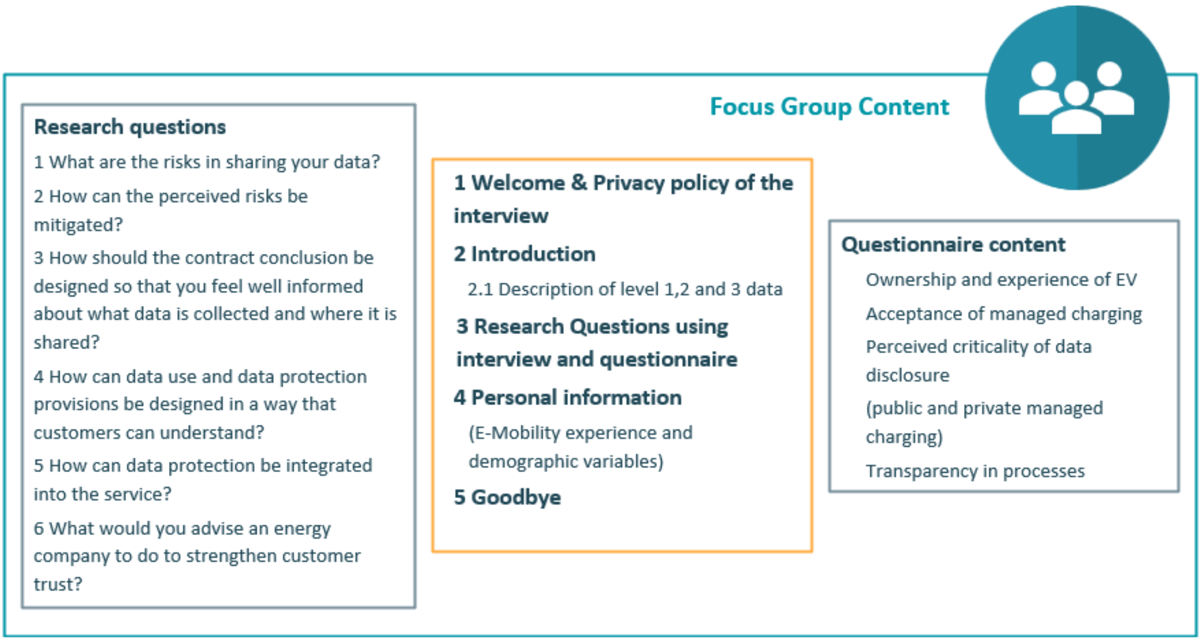

Figure 5. Overview of the content of the conducted focus group interview and additional online questionnaire.

The first part of focus group one focused on knowledge and usage of smart charging. Participants were then briefed on level one, two, and three data. The second interview section explored participants' beliefs on potential risks associated with data sharing (Research question (RQ) 1). The third part discussed how perceived risks in data sharing could be reduced (RQ 2). Building on the results of the interview of the first focus group, the second focus group interview included additional questions. The first part of the second focus group focused on understanding how contracts with providers for bidirectional charging were regulated (RQ 3). Information on level one, two, and three data was provided next, followed by questions about additional potential risks in data sharing (RQ 1 & RQ 2). The third part explored customer-friendly contract design, service, and data protection (RQ 4 & RQ 5). The interview concluded with a section addressing the strengthening of customer trust (RQ 6). At the end of both interviews, the interviewer summarized participants' key statements. Finally, participants provided general demographic information in the online questionnaire, and appreciation was extended for their contributions, recognizing their essential role in enriching the study's insights.

The RQs were also the guiding questions for the interviews and structured the guidelines accordingly. The relevant research questions (RQ) from focus group one were:

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- RQ1: What are the risks in sharing your data? (labelled as “Risks in data sharing”)
- RQ2: How can the perceived risks be mitigated? (labelled as “Mitigation of risks in data sharing”)
- RQ3: How should the contract and the contract conclusion be designed so that you feel well informed about what data is collected and where it is shared? (labelled as “Design of contract”)

The relevant research questions (RQ) from focus group two were:

- RQ1: What are the risks in sharing your data? (labelled as “Risks in data sharing”)
- RQ2: How can the perceived risks be mitigated? (labelled as “Mitigation of risks in data sharing”)
- RQ4: How can data use and data protection provisions be designed in a way that customers can understand? (labelled as “Understandable design”)
- RQ5: How can data protection (implementation of the GDPR) be integrated into the service? (labelled as “Integration of data protection & service”)
- RQ6: What would you advise an energy company to do to strengthen customer trust? (labelled as “Strengthening customer trust”)

3.3.2 Participants

Exclusive participation was confined to individuals aged 18 years or older in the focus groups. The study comprised a total cohort of seven participants, distributed across the first and second focus groups, with five and two participants, respectively. Among the total participants, 57% identified as male, constituting four participants, while 43% identified as female, representing three individuals. Participants had an average age of 52 years, with the youngest participant being 18 years old and the oldest 67 years old. Regarding educational achievements, a majority of participants (57%) held a university degree, 29% reported completing high school education, and one participant (14%) held a master craftsperson, technician, or equivalent degree.

The study assessed participants’ active utilisation of electric vehicles by examining reported metrics, including the total distance covered with a BEV and the aggregate count of (smart) charging processes conducted over the last twelve months. Among the seven participants, six had access to a BEV within the family, while the remaining participants could use another BEV. On average, the participants had owned a BEV for 4.3 years. The average distance travelled with a BEV was 15,000 km. The average number of public charging events was 278, with no reported smart charging sessions. The participants reported an average of 1,235 charging processes for home charging, of which 25% (308) involved the utilisation of smart charging technology. In alternative charging contexts, the average number of charging processes was 296, but none of them incorporated smart charging practices.

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4. Results

4.1 Vehicle choice

A total of 6,414 respondents answered four scenarios each on car purchase, which resulted in 25,656 observations for the analysis on car preferences. Table 14 presents an overview of the scenario variables as well as the attributes included in the scenarios.

Table 14: Overview of data from the car choice experiment

Description	mean	min	max	Unit
Task ID	2.5	1	4	-
Alternative ID	3.5	1	6	-
Car Type ID	2	1	3	-
Car class ID	3.04	1	5	-
ID of Chosen alternative	3.48	1	6	-
Driving range on gasoline	749.94	600	900	km
Driving range on battery	194.67	12	598	km
Time to 100km/h	9.51	3.9	16.9	sec
Size of the boot	423.85	197	658	Liter
Carbon emissions	89.42	0	189	g/km
Range from 10 min charging	97.03	36	173	km/10min
Dist. to nearest charger from home	354.72	50	650	meters
Home charger availability	2.49	1	4	X of 4 times
Vehicle-to-grid capability	2.5	1	4	Cat
Purchase price	49,818	13,136	207,067	EUR
Operation costs	0.1	0.04	0.23	EUR/km
Annual costs	1072.9	596.89	2095	EUR/year

The share of car type choices across countries is seen in Figure 6. The shares give an indication of the overall preference for the car types in each country as on average the respondents across the countries have been presented with similar scenarios. Indeed, the reference values for cost attributes are country specific, but the relative cost across the car types are similar and for the most important attribute, purchase cost, the reference value is identical across car types. We show the shares classified on the variable describing whether it is possible to charge a car at home as this has been shown to be particularly relevant for the choice of car technology and as this differs highly across the countries included in the study.

One reason for the differences across the countries could be that even though charging infrastructure is part of the survey, it does not in detail describe the level of charging infrastructure available when the users are away from their main charging location and even though such infrastructure is only rarely necessary for most car users, it can still be a great concern. Furthermore, the preferences of residents in different countries might be dependent on general experience with electric vehicles, i.e., if there is

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not a simple solution for charging payment, it is perceived as a difficult task to charge the car when away from home.

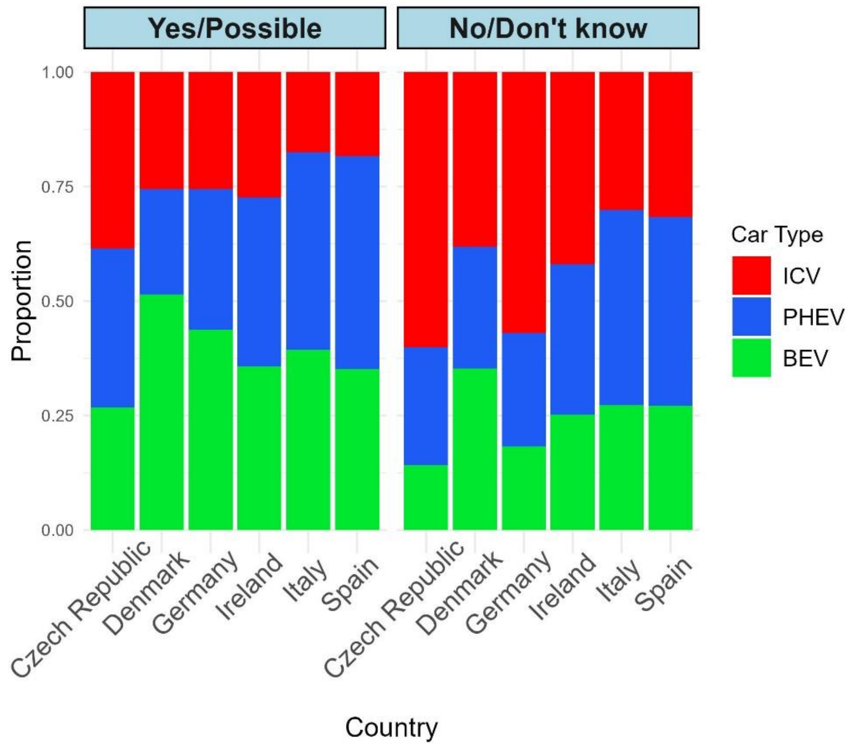

Figure 6: The share of car type choices across countries is classified by the answer to the question: "Is it possible to charge an electric vehicle/plugin-hybrid vehicle at your property/residence?"

The country with the lowest BEV and overall PEV (BEV + PHEV) share is Czech Republic whereas Denmark has the highest. Interestingly, Germany is just after Denmark for those who can charge at home but only a bit ahead of Czech Republic for those who cannot. Across Ireland, Spain and Italy, the shares are similar. As expected and confirming previous literature, the BEV and PHEV shares are in general higher for those who will likely be able to charge their car at home.

4.1.1 Model estimation

In this section, we provide model results estimated on the full datasets with indicated choices from all 25,656 observations from 6,414 respondents in all countries. Only with a joint estimation, it is possible to directly quantify and compare the preferences for specific attributes of the car types presented in the scenarios of the stated choice experiment. We tested interaction effects of respondent age groups, gender and country using dummy coding for whether a respondent belongs to a specific segment or not or whether a respondent lives in a specific country or not. However, we did not test higher order interactions (i.e., whether women in one country have other preferences than women in another country) as this would require testing and evaluating a much higher number of effects and since the number of observations within several of the interaction groups (e.g., number of respondents in a certain age group in a specific country) would be too low.

The model specification is shown below. Consider an individual n who makes a decision in scenario t.. The utility she obtains from car type i in car class j is:

$$
\begin{aligned}
V_{nijkt} \; = \; & ASC_i \cdot i + ASC_j \cdot j + ASC_{ik} \cdot i \cdot j + \eta_{ni} \\
+ \; & +ASC_{i,AGE} \cdot i \cdot AGE + ASC_{i,FEM} \cdot i \cdot FEM \\
+ \; & \beta_{PurchaseCost} \cdot PurchaseCost_{nijkt} \\
+ \; & \beta_{YearlyCost} \cdot YearlyCost_{nijkt} \\
+ \; & \beta_{OperationCost} \cdot OperationCost_{nijkt} \\
+ \; & \beta_{Acceleration} \cdot Acceleration_{nijkt} \\
+ \; & \beta_{BootSize} \cdot BootSize_{nijkt} \\
+ \; & \beta_{RangeBatBEV(k,AGE,FEM)} \cdot RangeBat_{nijkt} \cdot 1_{i=BEV} \cdot (k + AGE + FEM) \\
+ \; & \beta_{RangeBatPHEV(k,AGE,FEM)} \cdot RangeBat_{nijkt} \cdot 1_{i=PHEV} \cdot (k + AGE + FEM) \\
+ \; & \beta_{RangeGasICV(k,AGE,FEM)} \cdot RangeGas_{nijkt} \cdot 1_{i=ICV} \cdot (k + AGE + FEM) \\
+ \; & \beta_{RangeGasPHEV(k,AGE,FEM)} \cdot RangeGas_{nijkt} \cdot 1_{i=PHEV} \cdot (k + AGE + FEM) \\
+ \; & \beta_{CO2(k,AGE,FEM)} \cdot CO2_{nijkt} \cdot (k + AGE + FEM) \\
+ \; & \beta_{ChFastBEV(k,AGE,FEM} \cdot ChFast_{nijkt} \cdot 1_{i=BEV} \cdot (k + AGE + FEM) \\
+ \; & \beta_{ChHomeAV34} \cdot 1_{ChHomeAV \in \{3,4\}} \cdot 1_{i \in \{BEV,PHEV\}} \cdot 1_{ChPriv \in \{3,4\}} \cdot (k + AGE + FEM) \\
+ \; & \beta_{ChHomeDistBEV} \cdot ChHomeDist \cdot 1_{i=BEV} \cdot (k + AGE + FEM) \\
& \beta_{ChHomeDistPHEV} \cdot ChHomeDist \cdot 1_{i=PHEV} \cdot (k + AGE + FEM) \\
+ \; & \beta_{V2G,k} \cdot 1_{V2G \in \{2,3,4\}} \cdot 1_{i=BEV} \cdot 1_{ChPriv \in \{1,2\}} \cdot k \\
+ \; & \beta_{ChPrivBEV,k} \cdot 1_{ChPriv \in \{1,2\}} \cdot 1_{i=BEV} \\
+ \; & \beta_{ChPrivPHEV,k} \cdot 1_{ChPriv \in \{1,2\}} \cdot 1_{i=PHEV}
\end{aligned}
\qquad (5)
$$

where k is a list of countries, AGE is a list of age categories and FEM is a dummy describing if the respondent is female or not. Please note that for identification, one category will always need to be included in the reference category and the estimated interaction effect will thus show how the preference of the tested segment deviates from the segments in the reference category. It is seen that for driving range, carbon emissions, distance obtained from 10 min fast charging, home charging availability, home charging distance, all interaction effects for country, age and gender were tested in the model. For V2G and ChPriv, all interaction effects for country were tested whereas we did not test interaction effects for the cost attributes, acceleration and boot size.

We first estimated a base model with all attributes and then in several iterations included respondent characteristics and interaction effects while we carefully evaluated the parameters based on stability in the output and statistics significance of the parameters. We reduced the model if results did not seem stable and if parameters over many iterations were not significant. After this process, we ended up with a model with 57 parameters. The model is a mixed logit model taking into account random heterogeneity for car types and correlation among observations from the same respondents. The model was estimated with 1000 draws using Biogeme software (Bierlaire, 2023).

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Willingness-to-pay

We added a WTP column to the output results that shows the ratio of the current parameter, divided by the purchase cost parameter. Due to the size of the model, we first present the results describing preferences for car characteristics in Table 15, followed by car types in Table 16 and charging features in Table 17.

The results in Table 15 show that a respondent is willing to pay 29.6 Euro extra to save 1 Euro per year in annual (fixed) costs. This is higher than (Jensen et al., 2021) which already had a high WTP for annual cost at 18.9DKK/(DKK/Year). WTP for operation costs are also higher with an estimated value of 125,000 Euro to save 1 Euro per km compared to values in the Danish study at 88,000 DKK / (DKK/km).

Table 15: Parameters and willingness-to-pay for car characteristics

Description	Value	Rob. t-test	WTP	Unit
Purchase price	-2.68	-21.71	-1.00	EUR
Operation costs	-3.36	-6.24	-125523	EUR/km
Annual costs	-0.79	-11.97	-29.60	EUR/year
Time to 100km/h	-0.01	-3.38	-364.20	sec
Size of the boot	0.01	0.84	3.68	Liter
Carbon emissions, REF	-0.10	-1.82	-38.01	g/km
Carbon emissions, Female	-0.13	-2.14	-48.97	g/km
Carbon emissions, age_3	-0.11	-1.48	-41.80	g/km
Carbon emissions, age_4	-0.21	-2.78	-76.87	g/km
Driving range on battery BEV, REF	0.33	11.56	123.54	km
Driving range on battery BEV, Female	-0.11	-5.53	-40.14	km
Driving range on battery BEV, Czech	-0.21	-5.06	-79.35	km
Driving range on battery BEV, Germany	-0.11	-2.89	-42.65	km
Driving range on battery BEV, Ireland	-0.15	-4.72	-56.90	km
Driving range on battery BEV, Italy	-0.22	-5.63	-82.17	km
Driving range on battery BEV, Spain	-0.16	-5.11	-61.66	km
Driving range on battery BEV age 3 and 4	-0.06	-3.22	-23.95	km
Driving range on battery PHEV, REF	0.29	2.20	107.55	km
Driving range on battery PHEV, Kvinde	-0.49	-3.22	-182.91	km
Driving range on battery PHEV, Ireland	0.74	3.32	276.73	km
Driving range on gasoline ICV	0.05	3.81	18.43	km
Driving range on gasoline PHEV	0.00	-0.11	-0.50	km

For each extra gram CO_2 a car emits per kilometre, the respondents are willing to pay about 40 euro less and for women 50 Euro should be further added. Surprisingly, we also see a tendency that older age groups are more affected by carbon emissions than younger age groups. Respondents are on average willing to pay 124 Euro per extra km of driving range on battery for a BEV, but interaction effects indicate that respondents in Czech, Germany, Ireland and Spain are willing to pay much less than Denmark and Italy which are included in the reference group. Also, Female respondents value

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driving range lower than men. The willingness to pay for electric driving range for a PHEV is slightly lower on average except for Ireland where they indicate a great focus on this attribute.

The table describing willingness-to-pay for car types and car classes is shown in Table 16. There is a general tendency that respondents are willing to pay less for car classes that are smaller than the medium size car class (reference) and more for premium. One should, however, be careful analysing too much directly from the alternative-specific constants (ASCs) as these parameters are highly dependent on the other parts of the specification. For example, a negative ASC for BEV does not indicate an average negative preference for BEV if there are many charging parameters with positive sign that are only included in the specification for BEV. Still, it is relevant to look at interactions between ASC and characteristics of the respondents.

Table 16: Parameters and willingness-to-pay for car types and car classes

Description	Value	Rob. t-test	WTP
ASC Mini	-0.57	-10.42	-21,250
ASC Small	-0.48	-12.24	-17,791
ASC Large	-0.24	-6.19	-9,055
ASC Premium	0.59	7.60	22,173
ASC BEV, REF	-0.98	-4.89	-36,511
Std. for ASC_BEV	3.92	43.33	146,659
ASC BEV, Czech	-2.10	-8.47	-78,562
ASC BEV, Germany	-2.31	-7.06	-86,281
ASC BEV, Italy	0.78	3.55	29130
ASC BEV, age_1	0.26	2.51	9,703
ASC PHEV, REF	-0.02	-0.07	-563
Std. for ASC_PHEV	2.17	42.39	8,1137
ASC PHEV, Czech	-1.54	-7.47	-57,404
ASC PHEV, Germany	-1.50	-6.01	-55,940
ASC PHEV, Italy	1.20	7.30	44,722
ASC PHEV, Spain	0.75	3.89	27,939
Private Charging possible BEV, REF	1.85	11.15	69,118
Private Charging possible BEV, Germany	1.81	4.86	67,796
Private Charging possible PHEV, REF	1.23	8.13	45,998
Private Charging possible PHEV, Czech Republic	0.56	2.41	20,869
Private Charging possible PHEV, Germany	1.45	4.78	54,327
Private Charging possible PHEV, Spain	0.46	2.22	17,084

If respondents have (potential) access to private charging at home, the respondents are willing to pay almost 70,000 Euro more for a BEV and 46,000 Euro more for a PHEV compared to those that do not. These numbers should not be interpreted strictly as WTP since they are more a reflection of differences between subsamples of with and without private charging access. For Germany, the respondents are willing to add a further 68,000 Euro for a BEV and 54,000 for a PHEV which really shows a huge

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difference in preferences among those who have access to private charging and those who do not. The only significant interaction effect with age groups indicates that the youngest segment in the population is willing to pay almost 10,000 Euro more for a BEV compared to the rest of the sample. We did not find any significant gender effects.

For BEV, we found a more negative preference in Czech Republic and Germany, compared to Denmark, Ireland and Spain (reference). For Germany, this negative preference is offset by the very high positive preference for respondents with access to private charging, which means that only for those without access to private charging at home, Germany is on average different than other countries when it comes to BEV preferences.

In **Table 17**, we describe the results for the charging features in the presented scenarios. The reference parameter indicates that a respondent is willing to pay 192 Euro for each extra kilometre their BEV can gain from a 10-minute charge, but only Denmark is included in the reference group. For Germany, Spain and Ireland, the value is 60-80 Euro lower and for Czech Republic and Germany the value is more than 100 Euros lower. We also see a lower willingness-to-pay for fast charging for the oldest age group, compared to the other age groups. Even though we joined the preference for BEV and PHEV users, we did not find a significant effect for the availability of local public chargers when they are not able to charge their car in a private parking place. For each meter these chargers are further away from the respondent's home, the respondent is willing to pay 24 Euros less for a BEV, but this parameter is only significant at 10% significance level. The model indicates that the effect is more important for Czech respondents than respondents in other countries.

Table 17: Parameters and willingness-to-pay for charging features

Description	Value	Rob. t-test	WTP	Unit
Range from 10 min charging BEV, REF	0.51	8.22	192.01	km/10min
Range from 10 min charging BEV, Czech	-0.28	-2.76	-104.83	km/10min
Range from 10 min charging BEV, Germany	-0.17	-1.76	-63.49	km/10min
Range from 10 min charging BEV, Ireland	-0.21	-2.33	-77.95	km/10min
Range from 10 min charging BEV, Italy	-0.31	-3.44	-116.81	km/10min
Range from 10 min charging BEV, Spain	-0.17	-2.02	-63.64	km/10min
Range from 10 min charging BEV, age_4	-0.26	-4.24	-96.78	km/10min
Home ch av BEV/PHEV at least 3/4	0.10	1.37	3,562.05	Dum
Dist. to nearest charger from home BEV, REF	-0.03	-1.66	-12.03	meters
Dist. to nearest charger from home BEV, Czech	-0.06	-1.59	-23.78	meters
Vehicle to grid option possible, REF	0.04	0.60	1,446.62	Dum
Vehicle to grid option possible, Germany	0.29	1.82	10,657.08	Dum

Finally, we focus on the effect of different V2G possibilities. As we did not find any significant effects when testing the different options individually, we combined all options in one dummy variable describing whether some option is available or not. Still, it seems like the respondents do not have any preference for these options in the vehicle purchase situation. The only effect we found is that the

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interaction effect for Germany indicates that respondents here are willing to pay a fairly large amount, but the effect is only significant at the 10% level.

4.2 Smart charging preferences in everyday life

The dataset available for the analysis on daily charging consists of 6,016 observations from 1,504 respondents across all countries. Table 18 presents an overview of the scenario variables as well as the attributes included in the scenarios.

Table 18: Overview of data from the daily charging experiment

Description	mean	min	max	Unit
Task ID	2.5	1	4	-
Alternative ID	3.5	1	6	-
ID of chosen alternative	3.66	1	6	-
Time the car has to be plugged in	4.01	1	8	Hours
X/10 days the car has to be plugged in	7.33	5	9	Days
Guaranteed range after V2G period	124	50	250	km
Guaranteed range during V2G period	56.8	25	125	km
Additional battery degradation	1	0	2	%
Electricity cost	0.34	0.14	0.7	Euro/kWh
Monthly compensation	36.2	10	100	Euro

Figure 7 shows the share of choices in the daily charging experiment. For those who cannot charge at home, the share of charging during the day is in general higher than those who can charge comfortably at home at a private charger during the evening or the night. This effect seems particularly relevant in Denmark, Germany, Ireland and Italy. Interestingly, the share of night charging for those who cannot charge at home is as high as those who are able to charge at home in Czech Republic and Spain.

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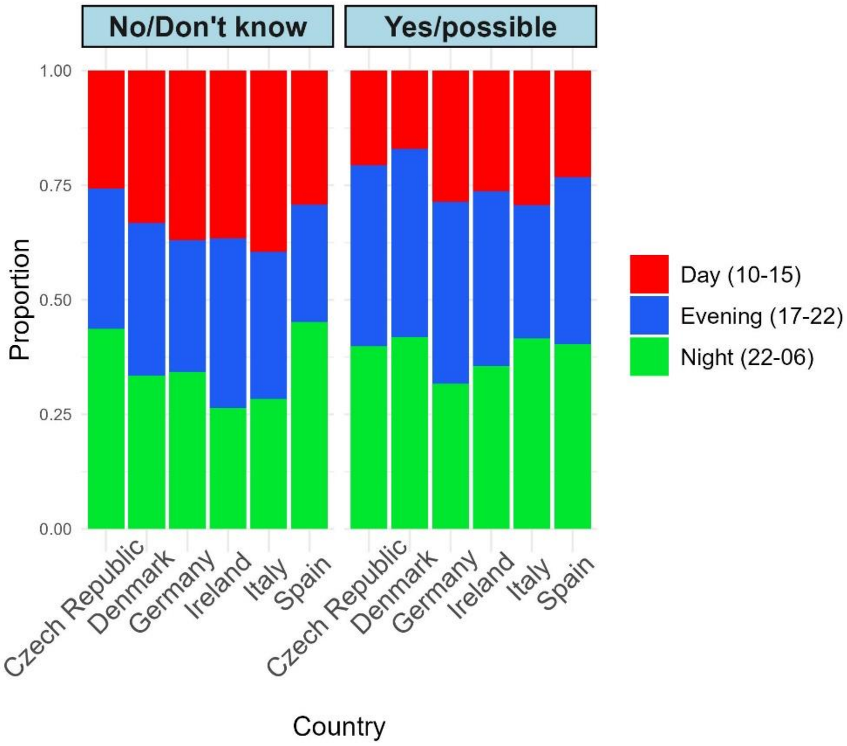

Figure 7: The share of choices in the daily charging experiment across countries is classified by the answer to the question: "Is it possible to charge an electric vehicle/plugin-hybrid vehicle at your property/residence?"

4.2.1 Model estimation

In this section, we provide model results estimated on the full datasets with indicated choices from all 6,016 observations from 1,504 respondents in all countries. As for the car choice experiment, we tested interaction effects of respondent age groups, gender and country using dummy coding for whether a respondent belongs to a specific segment or not, and whether a respondent lives in a specific country or not, but, we did not test higher order interactions (i.e., whether women in one country have other preferences than women in another country). For simplicity in the output, we define a dummy called "apartment" for those who cannot charge at home although not everybody in this segment lives in an apartment.

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The model specification is shown below. Consider an individual n who makes a decision in scenario t. The utility she obtains from contract type i is:

$$\begin{aligned} V_{nikt} \; = \; & ASC_i + ASC_{i,Apartment} \cdot Apartment + ASC_{ik} \cdot i \cdot k + \eta_{ni} \\ + \; & +ASC_{i,AGE} \cdot i \cdot AGE + ASC_{i,FEM} \cdot FEM + ASC_{i,EDU} \cdot EDU \\ + \; & \beta_{BatDeg,(k,INC)} \cdot BatDeg_{nikt} \cdot (k + INC) \\ + \; & \beta_{Duration(k,AGE,FEM,EDU)} \cdot Duration_{nikt} \cdot (k + AGE + FEM + EDU) \\ + \; & \beta_{Frequency(k,AGE,FEM,EDU)} \cdot Frequency_{nikt} \cdot (k + AGE + FEM + EDU) \\ + \; & \beta_{GuarRangeDur(k,AGE,FEM,EDU)} \cdot GuarRangeDur_{nikt}(k + AGE + FEM + EDU) \\ + \; & \beta_{GuarRangePost(k,AGE,FEM,EDU)} \cdot GuarRangePost_{nikt}(k + AGE + FEM + EDU) \end{aligned} \tag{6}$$

The result of the model is found in Table 19. We find that respondents require a compensation to enter a V2G contract, which is also expected as a contract might put some restrictions to the daily use of their car. We further find, that for each 1000 Euro in higher income an individual has, an additional 14 Eurocent in compensation is required. As also expected, daytime charging is less preferred than nighttime and evening charging. On average, an additional monthly compensation of 223 Euro is required to charge during the day compared to charging during the night, but if you cannot charge at home, the compensation required is lower, which is likely since such a respondent will need to find public charger and these might as well be present where they park during the day. The required compensation for daytime charging is also on average significantly lower in Germany, Ireland and Italy as well as for the youngest segment of the sample. Interestingly, we did not find a significant difference between night charging and evening charging, except for Ireland and Germany where respondents seem to prefer evening charging.

For each percentage of additional battery degradation the respondents will experience from being part of a V2G contract, they require an additional monthly compensation of 42.5 Euro (for Denmark, Italy, Spain and Czech Republic in the reference group) whereas respondents in Germany and Ireland will only need about 19 Euro.

The choice experiment included attributes describing the flexibility of the V2G contract, which is defined by how many hours during a time period the car needs to be plugged in per day, how many days out of a 10 day period the car must be plugged in in this time period as well as how much range the owner of the car is always guaranteed during the contract period and after the contract period. Our results show that a respondent would require an additional 10 Euro compensation per month for each extra hour of required availability but only about 3 Euros (6.9 Euros less) for respondents in Ireland and Germany. On the other hand, the youngest segment requires about 17 Euros per additional hour per day. On average the respondents require 7.6 Euros per additional day in a 10-day period the car has to be plugged in. Interestingly, the interaction effect with Czech Republic and Italy indicates a negative compensation, but likely the sum is not significantly different from zero and the assumption must be that respondents in these countries do not care about the number of days.

Overall, a lower compensation is needed for each extra km of driving range that the driver of the vehicle is guaranteed both during (0.28 Euro less per km) and after the contract time period (0.31 Euro less per km) and it is more important for the driver to have an extra kilometre of driving range guaranteed after the contract time period than to have an extra kilometre of driving range guaranteed during the period. Women do not care about guaranteed driving range during the contract time period

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but individuals in the lowest education segment value this feature much higher than the average. The guaranteed driving range at the end of a contract time period is much more important for individuals in Germany and age group 3 compared to the reference category.

Table 19: Parameters and willingness to pay estimated for daily charging

Description	Value	Rob. t-test	WTP	Unit
ASC for daytime charging, REF	-1.50	-6.92	223.3	-
Std. Dev. for ASC day	2.59	20.12	-384.8	-
ASC for daytime charging, Apartment	0.84	3.10	-123.9	-
ASC for daytime charging, Germany	1.46	4.07	-216.5	-
ASC for daytime charging, Ireland	1.00	2.92	-148.1	-
ASC for daytime charging, Italy	0.88	3.45	-130.0	-
ASC for daytime charging, age_1	0.46	2.34	-68.0	-
ASC for evening charging, REF	-0.14	-0.86	20.6	-
Std. Dev. for ASC evening	3.39	22.09	-503.4	-
ASC for evening charging, Apartment	-0.02	-0.09	3.0	-
ASC for evening charging, Germany	0.83	2.67	-122.9	-
ASC for evening charging, Ireland	0.60	2.02	-89.6	-
Additional battery degradation, REF	-0.29	-9.05	42.5	Percentage
Additional battery degradation, Ireland and Italy	0.16	2.91	-23.7	-
Additional compensation at higher income	9.52E-05	1.67	-0.14	Euro/Month/ 1000 Euro
Monthly compensation at avg. income	0.67	4.08	-1.0	Euro/Month
Monthly compensation for no income	-0.15	-0.35	0.2	Euro/Month
Time the car has to be plugged in, REF	-0.07	-5.07	10.1	Hours
Time the car has to be plugged in, Germany and Ireland	0.05	2.10	-6.9	-
Time the car has to be plugged in, age_1	-0.05	-1.94	6.9	Hours
Days the car has to be plugged in, REF	-0.51	-3.41	7.6	Days
Days the car has to be plugged in, Czech and Italy	0.66	2.50	-9.8	-
Guaranteed range during V2G period, REF	0.19	2.04	-0.28	km
Guaranteed range during V2G period, Female	-0.25	-2.15	0.37	km
Guaranteed range during V2G period, edu_1	0.30	2.46	-0.44	km
Guaranteed range after V2G period, REF	0.21	4.86	-0.31	km
Guaranteed range after V2G period, Germany	0.36	3.51	-0.53	km
Guaranteed range after V2G period, age_3	0.20	2.35	-0.30	km
Correlation	2.96	13.76	-439.4	-

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4.3 User concerns and preferences regarding data protection and data privacy

4.3.1 Acceptance of smart charging

The acceptance of smart charging was assessed within the online questionnaire study using six items, which portray three subscales: *perceived usefulness*, *behavioural intention to use*, and *perceived ease of use*. The presented Figure 8 depicts a stacked chart illustrating the level of agreement with the six items. The light shading represents the gradations *completely disagree*, *disagree to a large extent*, and *rather disagree*. Conversely, the dark blue shading corresponds to the gradations *rather agree*, *agree to a large extent*, and *completely agree*. A stronger intensity of the blue shading indicates higher levels of agreement among the study participants regarding each item. The level of agreement was computed based on the gradations *rather agree*, *agree to a large extent*, and *completely agree*. The results indicate that most participants (93.2%) expressed agreement with the statement affirming the goodness of smart charging for electric vehicles, and 77.7% acknowledged its significant added value compared to unmanaged charging. Consequently, perceived usefulness received the highest acceptance. In terms of behavioural intention to use, 76.7% of participants expressed a positive inclination towards using smart charging as often as possible, and 73.8% showed a preference for it over unmanaged charging. However, perceived ease of use received the least agreement, with 70.9% expressing their confidence in its ease of use, and only 63.1% considering it a straightforward technology. In conclusion, smart charging was predominantly accepted by participants due to its perceived usefulness, while its acceptance based on behavioural intention to use, and perceived ease of use was moderate.

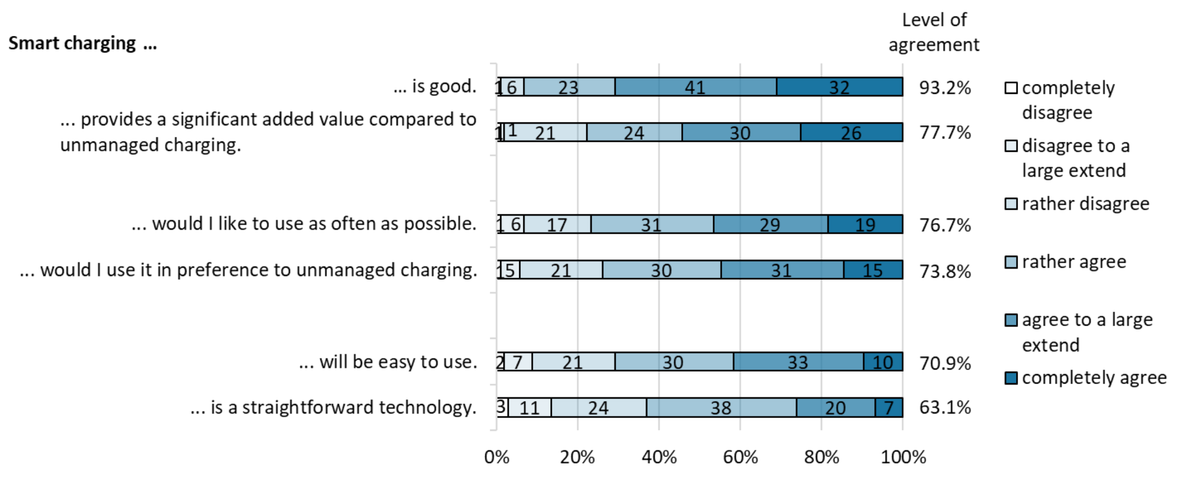

Figure 8. Participants' level of agreement regarding acceptance of smart charging.

Note. N = 103. The level of agreement correspondents to the sum percentage of *rather agree*, *agree to a large extent* and *completely agree*.

In the next step, the relationship between participants' experience with electric vehicles and their acceptance of smart charging was investigated. The results were plotted in a grouped bar chart for

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each experience group to a 6-point Likert scale, ranging from 1 *completely disagree* to 6 *completely agree*, for the three subscales: *perceived usefulness* (PU – items 1 & 2), *behavioural intention to use* (BIU – items 3 & 4), and *perceived ease of use* (PEOU – items 5 & 6). The findings (see Figure 9) showed a significant influence of participants' level of experience on PU and BIU, but not for PEOU ($F_{PU}(2, 100) = 6.54$, $p = .002$, $\eta^2_p = .116$; $F_{BIU}(2,100) = 4.07$, $p = .02$, $\eta^2_p = .075$; $F_{PEOU}(2, 100) = .44$, $p = .643$, $\eta^2_p = .009$). Results revealed that participants with higher experience in using BEVs showed a significantly higher level of agreement with the perceived usefulness of smart charging compared to those with less experience ($p = .001$). Additionally, participants with greater BEV experience demonstrated a stronger behavioural intention to use smart charging compared to those with less experience ($p = .034$). However, no significant differences were observed in the perceived ease of use among participants with varying levels of BEV experience ($p = 1.000$).

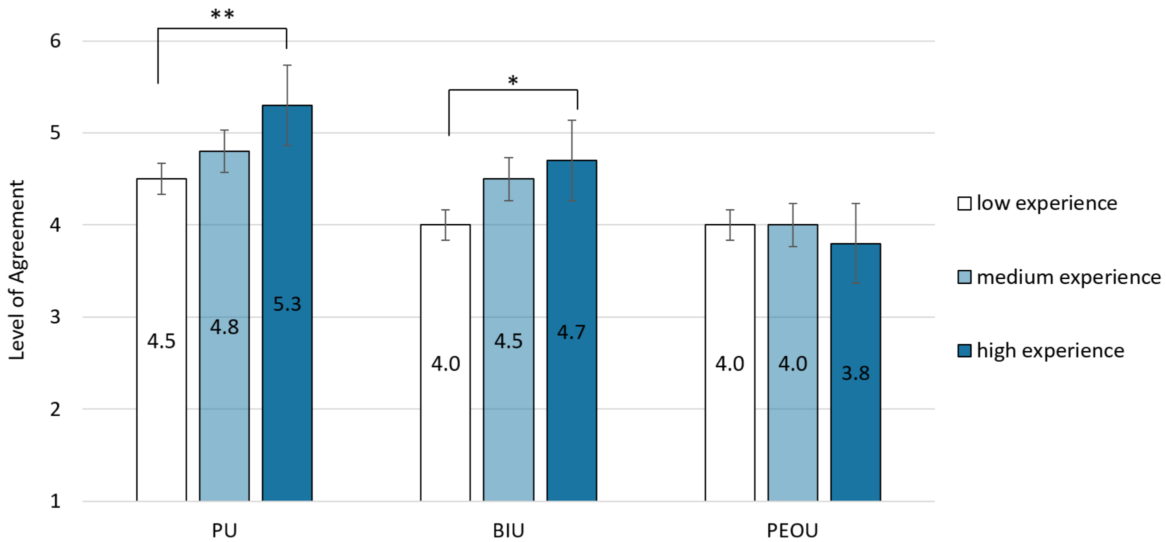

Figure 9. Influence of participants' BEV experience on their smart charging acceptance.
Note. $N = 103$, $n_{low\ experience} = 54$, $n_{medium\ experience} = 22$, $n_{high\ experience} = 27$. PU = perceived usefulness, BIU = behavioural intention to use, PEOU = perceived ease of use. $^*p < .05$, $^{**}p < .01$. The scale ranged from 1 *completely disagree* to 6 *completely agree*. Error bars represent standard errors.

Overall, the results suggest that as individuals gain more experience with BEVs, their perception of the usefulness and intention to use managed charging increases, but the perceived ease of use remains relatively consistent across different experience levels.

4.3.2 Preferences of charging concepts

There was a clear preference among participants for the concept of managed public charging (81.6%) as opposed to unmanaged public charging (18.4%). Similarly, in the context of private charging scenarios, the majority of participants favoured the concept of managed private charging (80.6%), with a relatively smaller proportion opting for unmanaged private charging (19.4%).

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The preference for managed charging was driven by its alignment with renewable energy usage, cost savings, battery health preservation, grid stabilization support, and utilization of cutting-edge charging technologies, making it an attractive and preferred choice for BEV owners.

Participants' preferences for unmanaged charging were driven by the desire for continuous high charge levels, battery control, charging simplicity, freedom of choice in contractual partners, privacy control over data sharing, and the preference for a single contractual partner.

4.3.3 Criticality of data disclosure

The participants evaluated the criticality of data disclosure using a 7-point Likert scale, ranging from 1 *not critical at all* to 7 *totally critical*, for four charging concepts: managed public charging, unmanaged public charging, managed private charging, and unmanaged private charging (see Figure 10).

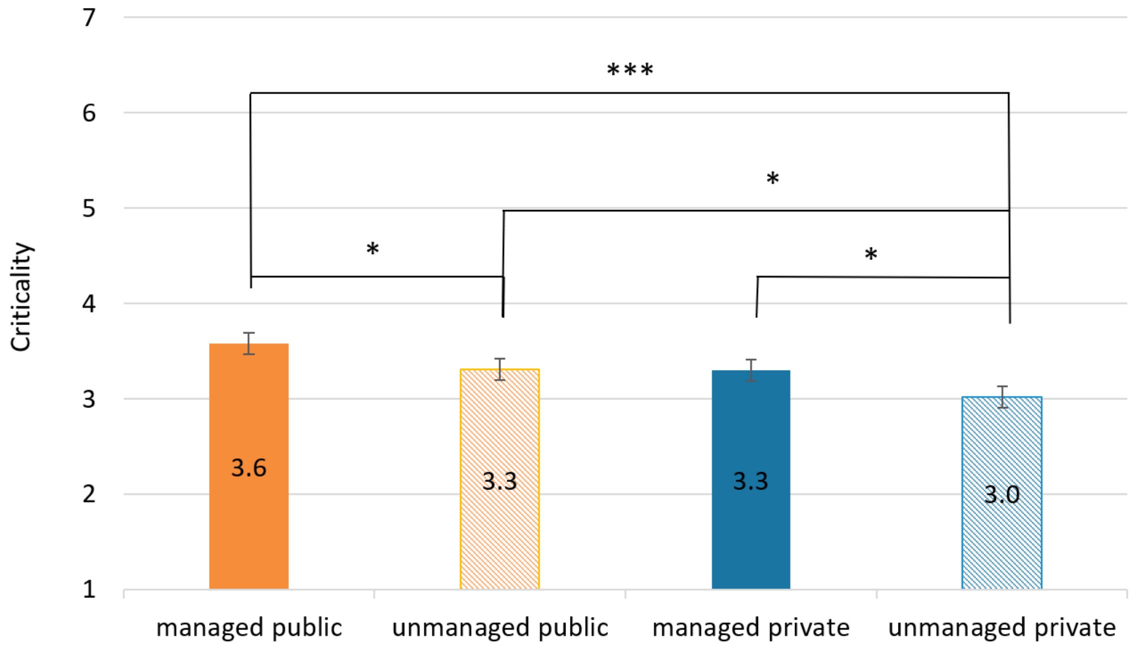

Figure 10. Participants' perceived criticality of data disclosure between smart (managed) and unmanaged as well as public and private charging.

Note. N = 103, $n_{managed\ public}$ = 25, $n_{unmanaged\ public}$ = 21, $n_{managed\ private}$ = 17, $n_{unmanaged\ private}$ = 12. * $p < .05$, $p < .01$, *** $p < .001$. The scale ranged from 1 *not critical at all* to 7 *totally critical.* Error bars represent standard errors.

Significant differences in the mean scores were observed among these charging concepts (F(2.5, 257.37) = 8.68, $p < .001$, $\eta^2_p = .078$). Pairwise comparisons revealed significant differences between managed public charging and unmanaged public charging (p = .033) as well as unmanaged private charging ($p < .001$). There were marginally significant differences between managed public and private charging (p = .053).

In general, managed public charging was perceived as the most critical in terms of data disclosure. In contrast, unmanaged private charging was considered the least critical. Unmanaged public

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charging and managed private charging were rated at 3.3, indicating an intermediate level of criticality concerning data disclosure.

4.3.4 Perceived risks

The online questionnaire study examined the perceived risks of data disclosure, considering participants' experience levels, using a 5-point Likert scale, ranging from 1 *no risk at all* to 5 *very high risk,* to assess five key items. These items encompassed concerns regarding the possibility of profiling, unauthorized access to personal data, the identity of data recipients, data storage location, and the risk of data loss. Regarding the possibility of profiling and data storage location significant differences in risk perceptions were observed between the experience groups ($F_{profiling}(2, 18) = 7.29$, $p = .005$, $\eta^2_p = .448$; $F_{data\ storage}(2, 18) = 5.95$, $p = .010$, $\eta^2_p = .398$). No significant differences could be observed for unauthorized access to personal data, the identity of data recipients, and the risk of data loss ($F_{unauthorized\_access}(2, 18) = 1.79$, $p = .195$, $\eta^2_p = .166$; $F_{data\_recipients}(2, 18) = .65$, $p = .532$, $\eta^2_p = .068$; $F_{data\_loss}(2, 18) = 1.21$, $p = .323$, $\eta^2_p = .118$). For details, see Figure 11.

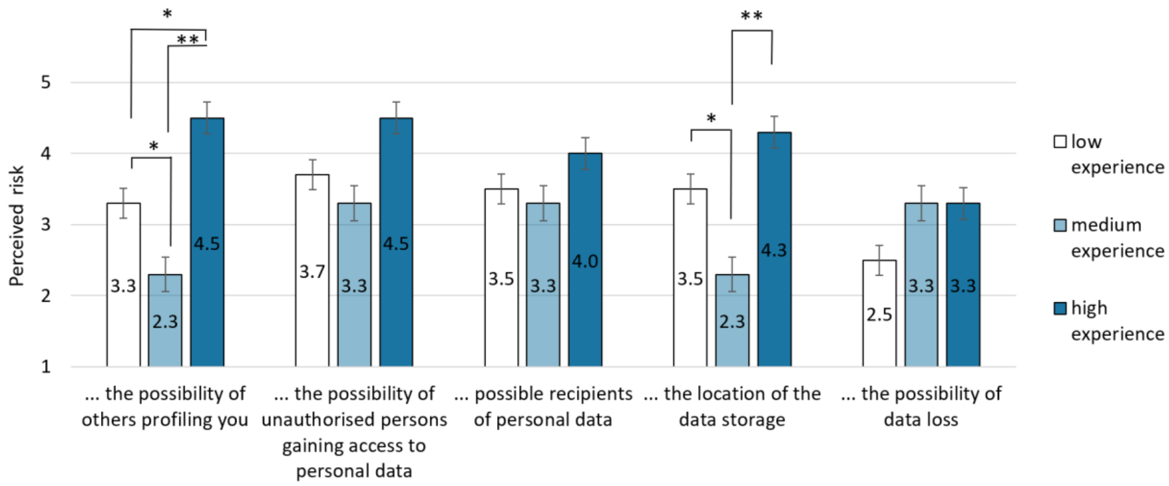

Figure 11. Participants' perceived risks in the context of smart charging.
Note. $N = 103$, $n_{low\ experience} = 54$, $n_{medium\ experience} = 22$, $n_{high\ experience} = 27$. * $p < .05$, ** $p < .01$, *** $p < .001$. The scale ranged from 1 *no risk at all* to 5 *very high risk.* Error bars represent standard errors.

Specifically, individuals with high BEV experience rated the perceived risks of profiling and data storage location as significantly higher compared to medium experienced drivers ($p_{profiling} = .004$; $p_{data\_storage} = .010$) (mean scores of 4.5 and 4.3, respectively). In contrast, the low-experience group perceived these risks at a more moderate level (mean scores of 3.3 and 3.5, respectively), and the medium-experience group considered them to be low (mean scores of 2.3 for both items). While there were varying mean scores for the other items among the experience groups, these differences were not statistically significant (all *p-values* >= .067).

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Notably, participants with high BEV experience perceived the highest risks in the possibility of profiling and the unauthorized access to personal data. Both the medium and low-experience groups also expressed high levels of concern for these two items regarding data disclosure.

4.3.5 Willingness to share data while charging

The willingness to share data while charging was assessed using a 4-point Likert scale, ranging from 1 *never* to 4 *always* (see Figure 12).

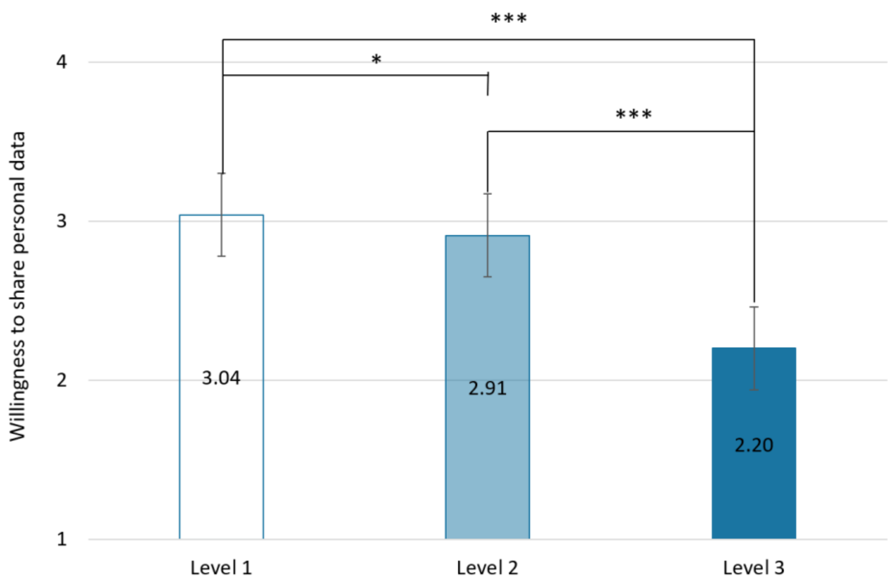

Figure 12. Participants' willingness to share personal data while charging.
Note. N = 103, * $p < .05$, *** $p < .001$. Scale ranged from 1 *never* to 4 *always.* Error bars represent standard errors.

In this context, *Level 1* represents the willingness to share raw data (e.g., "location of the charging station/wallbox where I charged"), while *Level 2* denotes the sharing of long-term data (e.g., "times when I arrive home") and *Level 3* represents deduced information based on Level 1 and Level 2 data (e.g., "my movement profiles"). Significant differences in mean scores were observed in the willingness to share data while charging across the three levels ($F(2, 204) = 134.09$, $p < .001$, $\eta^2_p = .568$). Participants exhibited a higher willingness to share *Level 1* data during charging (mean score of 3.04), closely followed by *Level 2* data (mean score of 2.91). In contrast, participants were less inclined to share *Level 3* data compared to *level 1* and *Level 2* data ($p < .001$) during charging (mean score of 2.2).

In other words, participants were most unwilling to provide level 3-information compared to level 2- and level 1-information and did not want to share the deduced information.

4.3.6 Trust in Stakeholders

The *E-mobility service provider* emerged as the preferred stakeholder among participants in both smart (managed; 42.1%) and unmanaged (52.6%) public charging scenarios. However, the participants

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showed a preference for the *energy provider* in the smart (52.6%) and unmanaged (76.3%) private charging context. Notably, the *aggregator* was not favoured in either charging situation.

The level of trust in stakeholders was evaluated using four items. Figure 13 illustrates a stacked chart displaying the degree of agreement among participants.

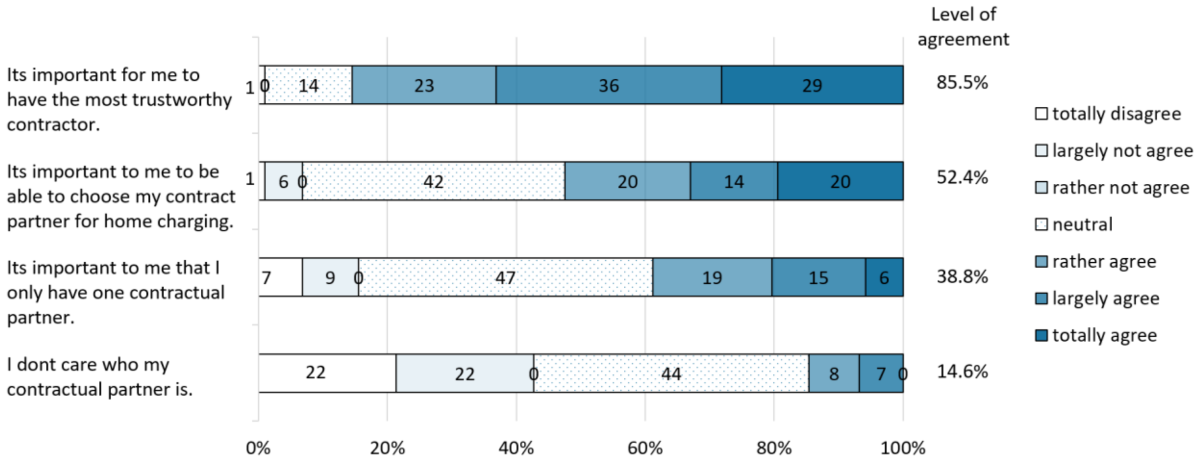

Figure 13. Participants' level of agreement regarding trust statements.
Note. *N* = 103. The level of agreement correspondents to the sum percentage of *rather agree*, *agree to a large extent* and *completely agree*.

The level of agreement was computed based on the gradations *rather agree*, *largely agree*, and *totally agree*. The results show that most of the participants (85.5%) considered having the most trustworthy contractor as important. Around half of the participants (52.4%) emphasized the importance of being able to select separate contract partners for home and public charging. A smaller but notable percentage (38.8%) preferred having only one contractual partner, while a minority (14.6%) expressed indifference towards the identity of the contracting partner.

Overall, the majority of participants considered having the most trustworthy contractor as important. This suggests that users place a high value on reliability and trustworthiness when it comes to the service providers involved in managing the charging process.

Participants from the *low experience*, *medium experience*, and *high experience* groups showed similar levels of agreement (mean score of 5.8 on a 7-point Likert scale ranging from 1 *totally disagree* to 7 *totally agree*) regarding the importance of having the most trustworthy contractor ($F(2, 100) = .50$, $p = .607$, $\eta^2_p = .01$). Likewise, there were no significant differences in their responses to other items related to being *able to select separate contract partners for home and public charging* (4.8-5.1; $F(2, 100) = .437$, $p = .647$, $\eta^2_p = .009$), *having only one contractual partner* (4.1-4.6; $F(2, 100) = 1.41$, $p = .248$, $\eta^2_p = .027$), and *indifference towards the identity of the contracting partner* (3.1-3.2; $F(2, 100) = .077$, $p = .926$, $\eta^2_p = .002$) based on their experience levels. For details, see Figure 14.

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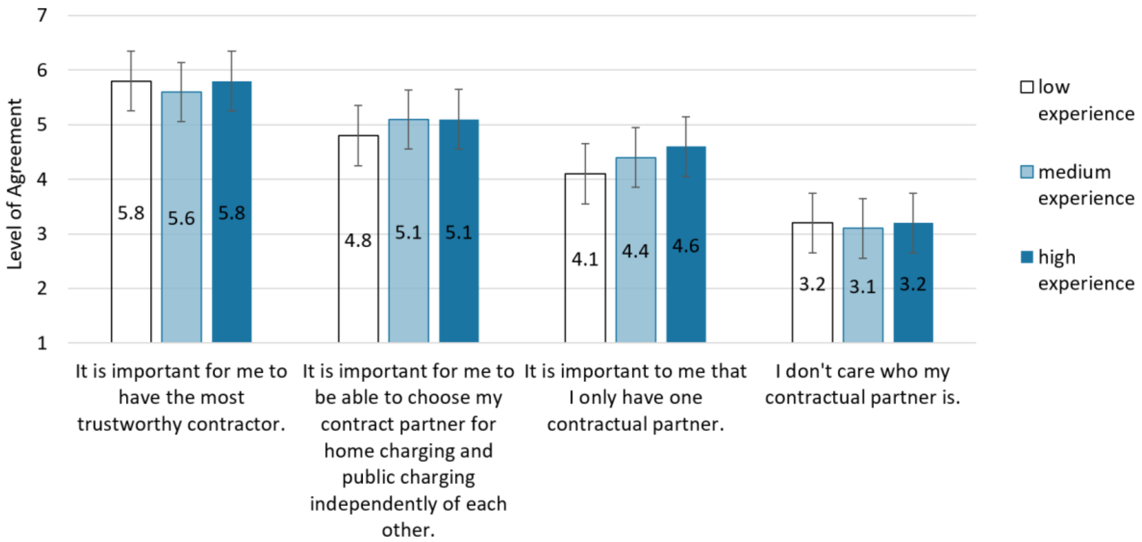

Figure 14. Influence of participants' BEV experience on their level of agreement regarding perceived trust statements.

Note. $N = 103$, $n_{low\ experience} = 54$, $n_{medium\ experience} = 22$, $n_{high\ experience} = 27$. * $p < .05$, ** $p < .01$, *** $p < .001$. The scale ranged from 1 *totally disagree* to 7 *totally agree.* Error bars represent standard errors.

In essence, the trust in stakeholders did not vary significantly among individuals with different levels of experience, as they all valued the presence of a trustworthy contractor similarly.

Participants rated their level of trust in three stakeholders, aggregator, energy provider, and E-mobility service provider, on a 7-point Likert scale, ranging from 1 *totally disagree* to 7 *totally agree*. Figure 15 represent their responses based on their experience levels.

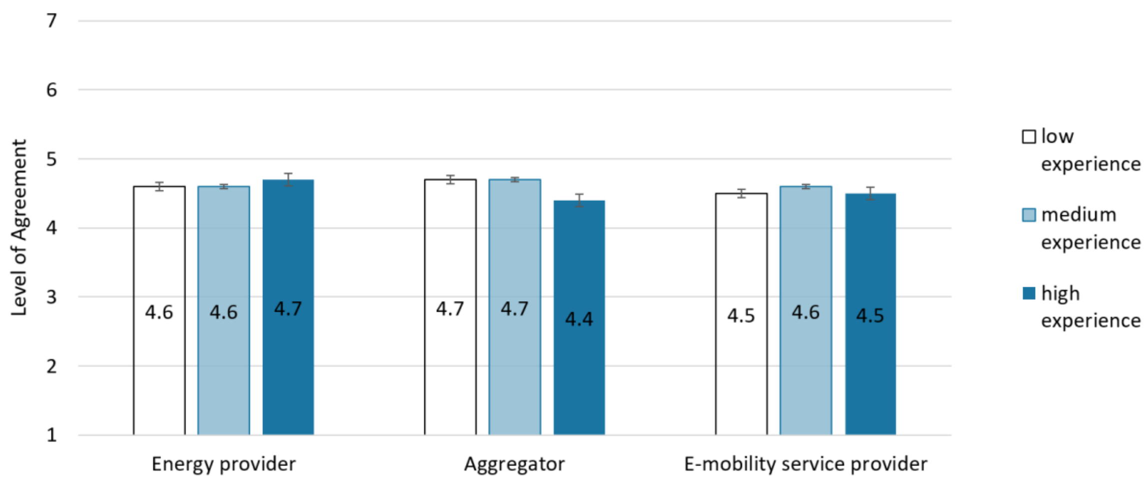

Figure 15. Participants' perceived trust between the stakeholders.

Note. $N = 103$, $n_{low\ experience} = 54$, $n_{medium\ experience} = 22$, $n_{high\ experience} = 27$. The scale ranged from 1 *totally disagree* to 7 *totally agree.* Error bars represent standard errors.

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The results showed that participants expressed for all stakeholders high levels of trust. No significant differences in trust levels were found among participants with varying levels of experience ($F_{energy\_provider}(2, 100) = .11$, $p = .896$, $\eta^2_p = .002$; $F_{aggregator}(2, 100) = .90$, $p = .411$, $\eta^2_p = .018$; $F_{E\_mobility\_service\_provider}(2, 100) = .105$, $p = .901$, $\eta^2_p = .002$).

Regardless of whether they had low, medium, or high experience, participants displayed similar levels of trust in the Energy Provider, the Aggregator, and the E-mobility Service Provider.

However, the participants' perceived trust in stakeholders can significantly predict their willingness to share personal information ($R_{adj}^2{}_{level1} = .163$, $F(3, 99) = 7.6$, $p < .001$; $R_{adj}^2{}_{level2} = .127$, $F(3, 99) = 5.95$, $p < .001$; $R_{adj}^2{}_{level3} = .179$, $F(3, 99) = 8.4$, $p < .001$). The most important data recipients are the aggregator for sharing level 1 data and the grid operator for sharing level 3 data. High levels of trust in the aggregator significantly increase the willingness to share raw data ($b = .21$, $p = .021$). Similarly, high levels of trust in the grid operator positively influence the willingness to share Level 2 data ($b = .26$, $p = .016$) as well as long-term data and deduced information ($b = .31$, $p = .003$).

In summary, trust plays a crucial role in data sharing behaviour, with higher levels of trust in specific stakeholders influencing the willingness of individuals to share different types of data.

4.4 User-friendly principles in the handling of user data and acceptable regulatory strategies

The user-friendly principles regarding the handling of user data and acceptable regulatory strategies were captured through two focus groups with V2G experienced users. For each of the six interview questions, a unique coding scheme was devised, comprising a main category and respective subcategories. These main and subcategories were developed exploratively from the responses of all seven participants across both focus groups. The aim was to establish a logical structure within the coding scheme based on the participants' responses. To prevent overestimation of statements, only one statement per participant was coded per subcategory. For instance, when a participant expressed opinions across multiple subcategories within a main category, the statements were coded for each relevant subcategory. Additionally, a statement could be assigned to two subcategories if applicable.

Addressing research RQ1 "What are the risks in sharing your data?" Table 20 summarises the main and subcategories along with their respective percentage values, relativized to the overall population of assigned codes. Additionally, for each main and subcategory, a core statement is illustrated.

The results are in line with the previous finding of our online questionnaire study, showing that for the participants, the primary concern was the risk of creating a movement profile (86%), emphasizing high transparency and visibility of their location (71%) as well as departure times (14%). The second most prevalent aspect was the risk of property absence and burglary (43%), along with the risk of data abuse and sale (43%). Specifically, the risk of abuse by artificial intelligence was mentioned (29%). Risks regarding unauthorized access to user data/hacking, the legal disclosure to third parties; for purchase & service offers and the uncontrolled data disclosure were named by 29% each. Linking several types of data with each other was the smallest perceived risk (14%).

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Table 20. Perceived risks in data sharing.

	frequency	%	example of participant statement (user number)
Creating movement profiles*	**6**	**86%**	
Location transparency	5	71%	"Transparency about where you are and where you spend time." (FG1_2)
Departure times	1	14%	"(...) the arrival times, in other words the start and end of charging, are also recorded." (FG1_5)
Property absence/ burglary	**3**	**43%**	"So, if someone wants to break in, they can track when I'm at home and when I'm not." (FG1_1)
User data sale/abuse*	**3**	**43%**	
By artificial intelligence	2	29%	"What is still a risk: AI, for example. So, what can be done by AI with this data? Well, we don't know that yet." (FG1_1)
Through marketing and advertising purposes	1	14%	"But anyone who has nothing to do with the topic or wants to use my data for marketing, advertising or burglary purposes, that would be a no-go for me." (FG2_2)
Unauthorized access to user data/hacking	**2**	**29%**	"Banks are being hacked (...). And I mean, it's probably a bit annoying when someone hacks into charging stations or something like that. But it's sensitive data after all." (FG1_3)
Legal disclosure to third parties; for purchase & service offers	**2**	**29%**	"Then simply the legal transfer to third parties. (...). So the trade with this kind of data was even used during the election campaign, for example." (FG1_3)
Uncontrolled data disclosure	**2**	**29%**	"(...) because even as a user you don't always know directly what information is being passed on." (FG1_3)
Data linking	**1**	**14%**	"Sometimes I wonder about that too. Did I share this information? No, it's only because of the IP address." (FG1_2)

Note. *N* = 7. Total ratings = 19. Main categories are marked in bold.*multiple answers possible

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4.4.1 Strategies to mitigate user' perceived risks in data sharing

RQ2 “How can the perceived risks be mitigated” was answered by five participants. Table 21 provides a summary of the primary categories along with a representative statement.

Table 21. Mitigation of risks in data sharing.

	frequency	%	example of participant statement (user number)
Data restriction	4	80%	"Limit data collection. You don't need that much data. I say: less is more. " (FG1_1)
Encrypt data (IP address)	3	60%	"Perhaps if you encrypt it, so that you don't say XY, but that everyone gets a number (...)." (FG1_3)
No long-term storage	2	40%	"In my opinion, it should be enshrined in law that, I'll say a hypothetical value now, that it is deleted after 4 weeks." (FG1_2)
Immediate and traceable billing like refuelling	2	40%	"I pay with my EC card; it's debited as if I'd made a normal purchase and the next day, I can see that I filled up yesterday. That's right, it fits. " (FG1_2)
Standardised and simplified charging system	2	40%	"You have to streamline it somehow so that it's in one system." (FG1_2)
Limited access	1	20%	"These are very limited accesses that may not be granted here at all. This is also stated in the General Data Protection Regulation." (FG1_5)
Additional security levels	1	20%	"Nowadays we have several security levels (...) asking “is that really you?” then please enter a PIN as well. If is not you, you can still stop the transfer and the contract doesn't materialize." (FG1_2)
Specialists take care of data management & protection	1	20%	"(...) many companies do that, they say there are specialists who take better care of things than I do, for example." (FG1_2)
Annual data protection checks	1	20%	"(...) that I am actively informed once a year that the auditors have carried out these data protection audits and certify that my company is exemplary in terms of data protection" (FG1_2)

Note. *N* = 5. Total ratings = 17. Main categories are marked in bold. Multiple answers possible

According to the participants, when considering general approaches to mitigate risks in data sharing, a significant emphasis was placed on the aspect of data restriction (80%), followed closely by the practice of encrypting data via an IP address (60%). Additionally, immediate and traceable billing, like refuelling, was considered important by 40% of the participants. Further strategies (20% each) were related to limited data access, additional security levels, and specialists taking care of data management & protection as well as annual data protection checks for companies.

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4.4.2 Strategies for a user-friendly contract design

RQ3 “How should the contract and the contract conclusion be designed so that you feel well informed about what data is collected and where it is shared?” was only part of the online focus group and was answered by two participants. Table 22 provides a concise summary of the primary categories, accompanied by a representative statement.

Table 22. Design of contract conclusion.

	frequency	%	example of participant statement (user number)
Transparency*	**3**	**150%**	
Addresses/contact information for all involved parties	1	50%	"Well, I mean, my requirement would be that I see the companies with their addresses in there.”(FG2_2)
Reasons for the use of all customer data	1	50%	"(...) so to speak, the vehicle manufacturer takes this data for this reason, the electricity grid operator has the following data for this reason (...)." (FG2_2)
Information on what data is collected	1	50%	"(...) but in a customer-friendly way I am told okay, the vehicle manufacturer (...) takes the following data for the following reason, but (...) it is formulated in a consumer-oriented way (...)." (FG2_2)
Storable contract forms	**2**	**100%**	"It's important that I can save it or print it out and then have access. So that I have the option of simply saving the things that are important to me somewhere so that I can access them again." (FG2_1)
User-relevant information summarized in a way that is easy to understand	**1**	**50%**	"So not every detail […], but in a customer-friendly way, that tells me, the vehicle manufacturer X assesses the following data Y for the following reason Z - but formulated in a consumer-oriented way […] so that I as an end customer be able to understand everything." (FG2_2)

Note. *N* = 2. Total ratings = 6. Main categories are marked in bold. *multiple answers possible

Transparency emerged as the most crucial aspect in contract design; with equal importance placed on visually displaying addresses and contact information for all involved parties, providing reasons for the use of all customer data, and furnishing information on the collected data. The second most significant aspect for participants was the inclusion of storable contract forms, garnering agreement from both participants followed by presenting user-relevant information in a way that is easy to understand by one participant.

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Considering RQ 4 “How can data use and data protection provisions be designed in a way that customers can understand?”, again two participants provided responses to this inquiry. Table 23 summarizes key categories and features representative statements.

Table 23. Understandable design of data protection.

	frequency	%	example of participant statement (user number)
User-relevant information summarized in a way that is easy to understand	**1**	**50%**	"Well, I think there are always so many possibilities that the average consumer doesn't actually know, because it's also far too complicated." (FG1_3)
Simple language	**1**	**50%**	"But in such a way that I and even my parents, at the age of 70, still understand what the logical reason is (...)." (FG2_2)
Compressed	**1**	**50%**	"(...) or the vehicle manufacturer translates it in such a way that I can understand it in my own everyday life and get a grip on my fears (...)." (FG2_2)

Note. *N* = 2. Total ratings = 3. Main categories are marked in bold.

According to the focus group participants, understandable means focus on user-relevant information, using a simple language, and presenting information in a compressed format, such as providing a summary of the key facts, are needed.

4.4.3 Strategies to strengthen consumer trust

Addressing RQ5 “How can data protection (implementation of the GDPR) be integrated into the service?” seven participants provided insights, and Table 24 presents a summary of the primary categories, accompanied by representative statements.

Within the context of integrating data protection and service, the primary focus was on incorporating behavioural suggestions derived from customer data (29%), closely followed by the provision of information concerning data access and usage (29%). Regarding the query about the interrelation of data protection and service, one participant underscored the role of data protection as a prerequisite, while the other asserted that data protection and service are mutually exclusive.

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Table 24. Integration of data protection & service.

	frequency	%	example of participant statement (user number)
Behavioural suggestions through data to customers[1]	**2**	**29%**	"(...) this use of data, for example on these typical dates, departure times, etc., naturally also harbours an opportunity to make the customers' life a little easier, to give them tips on how they could do things better." (FG1_5)
Information on data access and use[1]	**2**	**29%**	"It would be important to me that I am informed about who has access to my data and that my data is really only used for this purpose and not for any other purpose." (FG2_1)
Data protection vs. Service[2]	**2**	**100%**	
Data protection as a prerequisite	1	50%	"And so, for me, it's a non-negotiable thing, so to speak, that what we agree and sign contractually must be honoured, no matter what the service is like. That is my basic requirement for trust." (FG2_2)
Data protection excludes service	1	50%	"I say, if good data protection excludes good service. Of course, that's not so beneficial." (FG2_1)

Note. [1] *N* = 7, [2] *N* = 2. Main categories are marked in bold.

Addressing RQ6 “What would you advise an energy company to do to strengthen customer trust?” seven participants gave insight. Table 25 provides a summary of the primary categories along with a representative statement.

When considering general strategies to enhance customer trust, respondents ranked helpful and accessible customer service as the most important (100%), followed by transparency of processes (86%). In addition, participants highlighted that a constant personal contact person as well as system stability and performance were equally important (each 43%). Simplicity in operation, a timely settlement of invoices, and information about sustainability were named by one participant each (14%).

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Table 25. Strengthening customer trust.

	frequency	%	example of participant statement (user number)
Helpful, accessible customer service	**7**	**100%**	“The service provider’s service simply has to improve.” (FG1_2)
Transparency in processes	**6**	**86%**	"Yes, well, I think the components for trust are transparency, as little data as possible, um, only the data that is necessary (...)." (FG2_2)
Constant personal contact person	**3**	**43%**	"We always had a contact person in the project. So, whenever I had a problem, I called him and it always had an impact." (FG1_1)
System stability and performance	**3**	**43%**	"Well, but I think that with a certain, i.e., with certain intelligent algorithms, information could appear on the smartphone again in the evening if necessary. Vehicle is plugged in, controlled charging is active, set minimum range for tomorrow morning at 8:00, departure is 80 kilometres and it appears again as summarised information on the smartphone at 9:00 in the evening, for example." (FG2_2)
Simplicity in operation	**1**	**14%**	"Trust through simplicity also seems to be an instrument. It works. (...) It's easy for people, they accept it and then they also have trust." (FG1_2)
Timely settlement of invoices	**1**	**14%**	"Confidence is strengthened when, for example, settlements (…) simply happen in a timely manner. Not quite delayed or something." (FG2_1)
Information about sustainability	**1**	**14%**	"Above all, the storage facilities and the bitcoin mines, they're getting bigger and bigger, it's all energy." (FG1_4)

Note. *N* = 7. Total ratings = 22. Main categories are marked in bold.

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5. Summary of Results

The stated choice experiments have provided information on consumers' preferences for vehicle-to-grid concepts when it comes to the vehicle purchase situation and when it comes to short-term daily charging. The experiment on car purchase provided detailed information about preference for cost characteristics of car types, car and charging features, and we did not find that respondents were willing to pay extra for a BEV that has V2G capabilities. The experiment on daily charging analysed preferences for different aspects of a V2G contract that were described by different levels of flexibility and how much compensation a BEV driver would obtain to live up to the contract. On average, respondents with higher incomes require a higher compensation to enter a V2G contract with an electricity provider. Respondents prefer to have the V2G charging period during the night, but it is less important for young drivers as well as drivers in Germany, Italy, and Ireland. Drivers require an additional compensation of 7.6 Euros for each extra day in a 10-day period the car needs to be plugged in and 10 Euros for each extra hour the car needs to be plugged in for each day it is required to be plugged in. This duration is more important for young drivers than the rest of the sample. It is more important for drivers to have a guaranteed level of driving range when the charging period ends than to have a guaranteed level of driving range during the charging period. For these factors, a lower compensation of respectively 0.31 Euro and 0.28 Euro per km of guaranteed driving range is needed, with several significant differences across the countries and respondent characteristics. Men and respondents with the lowest level of education focus more on the level of guaranteed range during the charging period, whereas women are not affected at all by this factor.

In the online questionnaire study, participants from all backgrounds demonstrated high acceptance and a clear preference for smart charging solutions. Notably, individuals with prior experience as BEV drivers exhibited higher levels of perceived usefulness and behavioural intention towards smart charging, in comparison to those with low experience. Nevertheless, the participants' concerns regarding privacy emerged as a potential obstacle to their willingness to engage in smart charging practices. Specifically, the perceived criticality of data disclosure was significantly higher in the context of smart charging as opposed to unmanaged charging scenarios. An important concern among participants was the possibility of unauthorized individuals gaining access to their personal data. Moreover, the trustworthiness of the contractor played a crucial role in participants' decision-making. Having the most reliable and dependable stakeholders involved in the smart charging ecosystem was of paramount importance to respondents. Notably, the level of trust participants placed in various stakeholders significantly influenced their willingness to share personal information.

Within the focus groups we were able to investigate, that even for the V2X experienced drivers privacy concerns have to be addressed. The experts reported several acceptable regulatory strategies and approaches to mitigate the risks in data sharing. We were able to deduce guidelines for a user-friendly contract design and an improved user oriented service. Further, we identified strategies to enhance customer trust to increase participants' willingness to share user data and take part in smart charging.

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Key facts

Within our user research, we were able to investigate the following factors:

A) **increasing** users' acceptance of smart charging and V2X concepts:

- BEV driving and charging experience
- Perceived trust in involved actors

and

B) **reducing** users' acceptance of smart charging and V2X concepts:

- Privacy concerns
- Perceived criticality of data disclosure

Thus, we recommend the following **acceptable regulatory strategies**:

- Mitigate users' perceived risks in data sharing; for instance, by restricting data, encrypting data, data transparency and deletion of data upon customer request
- Design contracts user-friendly; for instance, by displaying addresses and contact information for all involved parties, providing reasons for the use of all customer data, furnishing information on the collected data, and providing storable contract forms
- Use an understandable contract design; for instance, by focusing on user-relevant information, using simple language, presenting information in a compressed format, and providing a summary of the key facts
- Strengthen consumer trust; for instance, by helpful, accessible customer service, a constant personal contact person, system stability and performance, transparency in processes, simplicity in operation, timely settlement of invoices, and information about sustainability

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6. References

Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behaviour. In D. Albarracín, B. T. Johnson, & M. P. Zanna (Ed.), *The influence of attitudes on behaviour*. The handbook of attitudes (pp. 173-221). Mahwah, NJ: Erlbaum.

Bailey, J., & Axsen, J. (2015). Anticipating PEV buyers' acceptance of utility controlled charging. *Transportation Research Part A: Policy and Practice*, *82*, 29-46. https://doi.org/10.1016/j.tra.2015.09.004Get rights and content

Ben-Akiva, M. E., & Lerman, S. R. (1985). *Discrete choice analysis: theory and application to travel demand* (Vol. 9). MIT press.

Bierlaire, M. (2023). A short introduction to Biogeme. *Transport and Mobility Laboratory, ENAC, EPFL*.

Cavoukian, A., Polonetsky, J., & Wolf, C. (2010). Smart Privacy for the Smart Grid: embedding privacy into the design of electricity conservation. *Identity in the Information Society, 3*, 275-294. doi:10.1007/s12394-010-0046-y

ChoiceMetrics. (2011). *Ngene 1.1 User Manual and Reference Guide - The Cutting Edge in Experimental Design http://choice-metrics.com/documentation.html*. ChoiceMetrics.

Crites, S. L., Fabrigar, L. R., & Petty, R. E. (1994). Measuring the Affective and Cognitive Properties of Attitudes: Conceptual and Methodological Issues. *Personality and Social Psychology Bulletin*, *20*(6), 619-634. https:// doi.org/10.1177/0146167294206001

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319-340. https://doi.org/10.2307/249008

Daziano, R. A. (2022). Willingness to delay charging of electric vehicles. *Research in Transportation Economics*, 94, 101177.

Delmonte, E., Kinnear, N., Jenkins, B. & Skippon, S. (2020). What do consumers think of smart charging? Perceptions among actual and potential plug-in electric vehicle adopters in the United Kingdom. *Energy Research & Social Science*, 60, 101318.

Demuth, J. L., Buberger, J., Huber, A., Behrens, E., Kuder, M., & Weyh, T. (2024). Unveiling the Power of Data in Bidirectional Charging: A Qualitative Stakeholder Approach Exploring the Potential and Challenges of V2G. *Green Energy and Intelligent Transportation*, 100225.

Dillon, A. (2001). User Acceptance of Information Technology. In W. Karwowski (Ed.), *Encyclopedia of Human Factors and Ergonomics*. Taylor and Francis.

Dillon, A., & Morris, M. (1996). User acceptance of new information technology-theories and models. *Annual Review of Information Science and Technology*, *31*, 3-32.

Funded by the European Union

Döbelt, S., & Günther, M. (2021). Two Values Work Alike: Linking Proenvironmental and Privacy Preserving Behavior. In A. Huckauf, M. Baumann, M. Ernst, C. Herbert, M. Kiefer, & M. Sauter (Eds.), *TeaP 2021 - Abstracts of the 63th Conference of Experimental Psychologists*. Lengerich: Pabst Science Publishers.

Döbelt, S., Günther, M., Kämpfe, B., & Krems, J.F. (2023). Examining BEV Drivers' Willingness to Share Personal Information in the Context of Smart Charging: Results of a Five-Month BEV Field Trail. *8th International Electric Vehicle Conference (EVC 2023)*, 21-23 June 2023, Edinburgh, UK.

Döbelt, S., Kämpfe, B. & Krems, J.F. (2014). Smart Grid, Smart Charging, Smart Privacy? An Empirical Investigation of Consumers' Willingness to Provide Smart Charging Information, *Tagungsband ComForEn 2014*, 29-37.

Dreisbusch, M., Mang, S., Ried, S., Kellerer, F., & Pfab, X. (2020). Regulierung des netzdienlichen Ladens aus der Nutzerperspektive. *ATZ-Automobiltechnische Zeitschrift*, *122*(12), 68-73.

Dunckley, J., & Tal, G. (2016). Plug-in electric vehicle multi-state market and charging survey. *EVS29*, 1–12.

Fett, D., Dehler-Holland, J., & Schmutz, M. (2021). A survey on the user acceptance of PV battery storage systems. *Sustainability Management Forum*, *29*, 161–171. https://doi.org/10.1007/s00550-021-00513-9

Gardien, L., Refa, N., & Tamis, M. (2020). Exploring electric vehicles owner's preferences and experiences with controlled charging: a mixed-method case study in the Netherlands. *In Electric Vehicle Symposium 33.* The Electric Drive Transportation Association.

Gschwendtner, C., Sinsel, S. R., & Stephan, A. (2021). Vehicle-to-X (V2X) implementation: An overview of predominate trial configurations and technical, social and regulatory challenges. *Renewable and Sustainable Energy Reviews*, *145*, 110977.

Haider, H. T., See, O. H., & Elmenreich, W. (2016). A review of residential demand response of smart grid. *Renewable and Sustainable Energy Reviews, 59*, 166-178. doi:10.1016/j.rser.2016.01.016

Hardman, S., Jenn, A., Tal, G., Axsen, J., Beard, G., Daina, N., Figenbaum, E., Jakobsson, N., Jochem, P., Kinnear, N., Turrentine, T., & Witkamp, B. (2018). A review of consumer preferences of and interactions with electric vehicle charging infrastructure. *Transportation Research Part D: Transport and Environment*, *62*, 508–523. https://doi.org/10.1016/j.trd.2018.04.002

Heuer, A. (2013). Forschung und Entwicklung zu Assistenzsystemen und Big Data – Vorsprung durch Datensparsamkeit. Tagungsband Fachkongress „Social Business“ Mittelstand Digital, 41-55.

Huber, J., Schaule, E., Jung, D., & Weinhardt, C. (2019). Quo vadis smart charging? A literature review and expert survey on technical potentials and user acceptance of smart charging systems. *World Electric Vehicle Journal, 10*(4), 85. doi:10.3390/wevj10040085

Jensen, A. F., Thorhauge, M., Mabit, S. E., & Rich, J. (2021). Demand for plug-in electric vehicles across segments in the future vehicle market. *Transportation Research Part D: Transport and Environment*, *98*, 102976. https://doi.org/10.1016/J.TRD.2021.102976

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Kämpfe, B., Zimmermann, J., Dreisbusch, M., Grimm, A. L., Schumann, J. H., Naujoks, F., Keinath, A., & Krems, J.F. (2022). Preferences and perceptions of bidirectional charging from a customer's perspective–a literature review and qualitative approach. *Electrified Mobility 2019: Including Grid Integration of Electric Mobility*, 177-191.

Kubli, M., Loock, M. & Wüstenhagen, R. (2018). The flexible prosumer: Measuring the willingness to co-create distributed flexibility. *Energy Policy*, 114, 540–548.

Liu, Y., Francis, A., Hollauer, C., Lawson, M. C., Shaikh, O., Cotsman, A., Bhardwaj, K., Banboukian, A., Li, M., Webb, A., Webb, A., & Asensio, O. I. (2023). Reliability of electric vehicle charging infrastructure: A cross-lingual deep learning approach. *Communications in Transportation Research*, *3*. https://doi.org/10.1016/j.commtr.2023.100095

Louviere, J. J., Hensher, D. A., & Swait, J. D. (2000). *Stated choice methods: analysis and applications*. Cambridge University Press.

Marxen, H., Chemudupaty, R., Graf-Drasch, V., Schoepf, M., & Fridgen, G. (2022). Towards an evaluation of incentives and nudges for smart charging. *In Proceedings of the 30th European Conference on Information Systems* (ECIS 2022).

Mayring, P. (2000) Qualitative content analysis, *Qualitative Methods in Various Disciplines I: Psychology, 1*(2). http://www.nbn-resolving.de/urn:nbn:de:0114-fqs0002204

Ortúzar, J. de D., & Willumsen, L. G. (2011). *Modelling transport* (Vol. 4). Wiley.

Raabe, O., Lorenz, M., Pallas, F., Weis, E., & Jahr, I. (2011). *Datenschutz im Smart Grid und in der Elektromobilität*, Karlsruher Institut für Technologie.

Rose, J. M., & Bliemer, M. C. J. (2009). Designing Stated Choice Experiments: State of the art. In R. Kitamura, T. Yoshii, & T. Yamamoto (Eds.), *The expanding sphere of travel behaviour research* (Issue 32, pp. 499–537). Emerald Group Publishing Limited.

Schäfer, M., & Keppler, D. (2013). Modelle der technikorientierten Akzeptanzforschung—Überblick und Reflexion am Beispiel eines Forschungsprojekts zur Implementierung innovativer technischer Energieeffizienz-Maßnahmen. *ZTG Discussion Paper*. https://doi.org/10.14279/depositonce-4461

Schmalfuß, F., Kreußlein, M., Mair, C., Döbelt, S., Heller, C., Wüstemann, R., ... & Krems, J.F. (2017). Smart charging in daily routine–expectations, experiences, and preferences of potential users. *In Grid Integration of Electric Mobility: 1st International ATZ Conference 2016* (pp. 33-47). Springer Fachmedien Wiesbaden.

Schmalfuß, F., Mair, C., Döbelt, S., Kämpfe, B., Wüstemann, R., Krems, J. F., & Keinath, A. (2015). User responses to a smart charging system in Germany: Battery electric vehicle driver motivation, attitudes and acceptance. *Energy Research & Social Science, 9*, 60-71.

Signer, T., Baumgartner, N., Ruppert, M., Sandmeier, T., & Fichtner, W. (2024). Modeling V2G spot market trading: The impact of charging tariffs on economic viability. *Energy Policy*, *189*, 114109.

Funded by the European Union

Skippon, S., & Garwood, M. (2011). Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. *Transportation Research Part D: Transport and Environment*, *16*(7), 525–531. https://doi.org/10.1016/j.trd.2011.05.005

Visaria, A. A., Jensen, A. F., Thorhauge, M., & Mabit, S. E. (2022). User preferences for EV charging, pricing schemes, and charging infrastructure. *Transportation Research Part A: Policy and Practice*, *165*, 120–143. https://doi.org/10.1016/J.TRA.2022.08.013

Wicki, M., Brückmann, G., Quoss, F., & Bernauer, T. (2023). What do we really know about the acceptance of battery electric vehicles?–Turns out, not much. *Transport Reviews*, *43*(1), 62–87. https://doi.org/10.1080/01441647.2021.2023693

Will, C., & Schuller, A. (2016). Understanding user acceptance factors of electric vehicle smart charging. *Transportation Research Part C: Emerging Technologies*, *71*, 198-214.

Wong, S. D., Shaheen, S. A., Martin, E., & Uyeki, R. (2023). Do incentives make a difference? Understanding smart charging program adoption for electric vehicles. *Transportation Research Part C: Emerging Technologies*, *151*, 104123.

Yang, H., Lee, H., & Zo, H. (2017). User acceptance of smart home services: an extension of the theory of planned behavior. *Industrial Management & Data Systems 117(1)*, 68-89.

Yilmaz, S., Cuony, P., & Chanez, C. (2021). Prioritize your heat pump or electric vehicle? Analysing design preferences for Direct Load Control programmes in Swiss households. *Energy Research & Social Science*, *82*, 102319.

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7. Appendix A: Full output from model estimation

Description	Value	Rob. t-test	WTP	Unit
ASC BEV, Czech	-2.10164	-8.47074	-78561.7	Dum
ASC BEV, Germany	-2.30813	-7.06062	-86280.7	Dum
ASC BEV, Italy	0.779269	3.553171	29130	Dum
ASC BEV, REF	-0.97671	-4.89059	-36510.6	Dum
Std. for ASC_BEV	3.92333	43.33381	146658.8	-
ASC BEV, age_1	0.259562	2.509904	9702.723	Dum
ASC Large	-0.24223	-6.19062	-9054.99	Dum
ASC Mini	-0.56847	-10.4222	-21250.2	Dum
ASC PHEV, Czech	-1.53563	-7.46608	-57403.8	Dum
ASC PHEV, Germany	-1.49648	-6.00693	-55940.1	Dum
ASC PHEV, Italy	1.196388	7.297964	44722.43	Dum
ASC PHEV, REF	-0.01506	-0.07284	-563.04	Dum
Std. for ASC_PHEV	2.170522	42.38707	81136.72	-
ASC PHEV, Spain	0.747409	3.885348	27939.06	Dum
ASC Premium	0.593149	7.595085	22172.64	Dum
ASC Small	-0.47594	-12.2386	-17791.1	Dum
Time to 100km/h	-0.00974	-3.38244	-364.198	sec
Size of the boot	0.00984	0.841968	3.678324	Liter
Carbon emissions, Kvinde	-0.13101	-2.13682	-48.9722	g/km
Carbon emissions, REF	-0.10169	-1.81564	-38.0113	g/km
Carbon emissions, age_3	-0.11182	-1.47763	-41.7981	g/km
Carbon emissions, age_4	-0.20565	-2.77776	-76.8745	g/km
Range from 10 min charging BEV, Czech	-0.28043	-2.75972	-104.829	km/10min
Range from 10 min charging BEV, Germany	-0.16984	-1.75956	-63.4891	km/10min
Range from 10 min charging BEV, Ireland	-0.20852	-2.32701	-77.9459	km/10min
Range from 10 min charging BEV, Italy	-0.31248	-3.43898	-116.809	km/10min
Range from 10 min charging BEV, REF	0.513667	8.216374	192.015	km/10min
Range from 10 min charging BEV, Spain	-0.17025	-2.01532	-63.6424	km/10min
Range from 10 min charging BEV, age_4	-0.2589	-4.24253	-96.7812	km/10min
Home ch av BEV/PHEV at least 3/4	0.09529	1.370713	3562.045	Dum
Dist. to nearest charger from home BEV, Czech	-0.06362	-1.58701	-23.783	meters
Dist. to nearest charger from home BEV, REF	-0.03218	-1.66115	-12.0287	meters
Private Charging possible BEV, Germany	1.813649	4.860618	67796.39	Dum
Private Charging possible BEV, REF	1.849005	11.1456	69118.06	Dum
Private Charging possible PHEV, Czech	0.558264	2.405144	20868.59	Dum
Private Charging possible PHEV, Germany	1.453336	4.781923	54327.47	Dum
Private Charging possible PHEV, REF	1.230507	8.134589	45997.83	Dum

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Private Charging possible PHEV, Spain	0.457026	2.216025	17084.17	Dum
Operation costs	-3.35791	-6.24285	-125523	EUR/km
Purchase price	-2.67514	-21.7147	-1	EUR
Annual costs	-0.79188	-11.9657	-29.6014	EUR/year
Driving range on battery BEV, Czech	-0.21227	-5.06478	-79.3491	km
Driving range on battery BEV, Germany	-0.11409	-2.8888	-42.6501	km
Driving range on battery BEV, Ireland	-0.15222	-4.72423	-56.9031	km
Driving range on battery BEV, Italy	-0.21983	-5.62671	-82.1746	km
Driving range on battery BEV, Female	-0.10737	-5.53452	-40.1379	km
Driving range on battery BEV, REF	0.330493	11.56198	123.5421	km
Driving range on battery BEV, Spain	-0.16495	-5.10848	-61.6601	km
Driving range on battery BEV age 3 and 4	-0.06407	-3.21658	-23.9516	km
Driving range on battery PHEV, Ireland	0.740296	3.317163	276.7314	km
Driving range on battery PHEV, Female	-0.48932	-3.21776	-182.914	km
Driving range on battery PHEV, REF	0.287718	2.19757	107.5525	km
Driving range on gasoline ICV	0.049298	3.812856	18.42805	km
Driving range on gasoline PHEV	-0.00133	-0.1085	-0.4986	km
Vehicle to grid option possible, Germany	0.285092	1.815239	10657.08	Dum
Vehicle to grid option possible, REF	0.038699	0.604842	1446.617	Dum
Correlation	2.461122	27.57957	91999.7	-

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