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A Discrete Choice Experiment

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Abstract

This data collection instrument provides guideline and some example survey questions aimed at understanding consumer preferences and willingness to pay for battery health information in the used battery electric vehicle (BEV) market. The potential survey design includes questions about current vehicle information, future vehicle preferences, a discrete choice experiment (DCE), EV knowledge, and demographics. The DCE systematically varies both standard vehicle attributes (e.g., price, mileage) and battery-specific features (e.g., state-of-health, refurbishment history) to quantify the economic value consumers place on battery-related information. Findings from this research project will improve the understanding of second-life battery markets, and guide future research in the evolving used EV landscape.

Keywords

Battery electric vehicle; battery information; discrete choice experiment; willingness-to-pay; consumer preferences; survey design

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1. Introduction

Electric vehicles (EVs) sales are increasing in the US automotive market. While much of the focus of industry professionals and academics has been on understanding drivers of new EV adoption, the used EV market has received comparatively little attention. Meanwhile, the used vehicle market in the U.S. has reached record highs in recent years and is projected to grow steadily over the coming decade (Market Research Future, 2025). As more EVs reach the end of their initial ownership, they are increasingly entering the used market. According to February 2025 sales data (Cox Automotive Inc., 2025), used EV sales rose by 34.2 % year-over-year, while the average days' supply fell by 21.5 %, signaling strong and accelerating demand in the US.

Understanding how the used EV market differs from the new EV market is necessary to estimate the flow of critical minerals through the US economy. It contributes to a circular economy by extending the useful life of vehicles and batteries, thereby reducing resource utilization (Guzek et al., 2024). Used EVs also lower the financial barriers for households to enter the EV market (Hagman et al., 2016), although the most affordable models remain relatively limited in availability (Sheykhfard et al., 2025).

Despite rising supply, consumers still perceive used EVs as scarce in the marketplace (Krishna, 2021). Survey data (Fernandes, 2023) also reflect lingering consumer hesitation: 52 % of U.S. adults reported being unlikely to consider buying a used EV, compared to only 28 % who were open to the idea. In addition to challenges common to both new and used EV, such as range anxiety, limited charging infrastructure, and high purchase costs (Sheykhfard et al., 2025), used EVs come with added concerns. Key issues include uncertainty about the vehicle history and condition (cited by 41 % of respondents in Fernandes' study), as well as perceptions of lower reliability compared to new EVs (23 %). Based on Sheykhfard et al., (2025), more than half (55.1 %) of current used EV owners reported having pre-purchase concerns about battery longevity, primarily due to the perceived risk of frequent and costly battery replacements. However, while nearly two thirds (65.5 %) of respondents reported some degree of battery decline over time, only 5.1 % experienced a substantial loss in battery performance. Moreover, 39.2 % of individuals indicated they were likely to buy a used BEV in the future while an additional 26.3 % indicated they very likely to buy a used BEV in the future (Sheykhfard et al., 2025). These findings suggest that most used EV owners had a positive ownership experience.

These studies highlight that the used EV market faces a significant information asymmetry problem centered on the battery — the most critical and expensive component affecting a used EV's value — in terms of its unobserved maintenance history, current "State of Health" (SOH), and remaining useful life (RUL). Unlike conventional vehicles, where age and mileage serve as reasonable proxies for engine condition and overall wear (Prieto et al., 2015), the battery degradation path and RUL of the battery can vary substantially even among EVs of the same model year and mileage, making the vehicle's true condition far more difficult to assess and increasing the level of risk in the purchase for consumers (Prieto et al., 2015). This information gap could create economic inefficiencies. Buyers may undervalue well-maintained EVs or unknowingly overpay for poorly maintained ones. Sellers with well-maintained batteries may struggle to recoup the true value of their vehicles at resale.

Understanding the key determinants of used EV purchase decisions — particularly for battery electric vehicles (BEVs) — and how consumers evaluate battery health information is helpful for US industry stakeholders, consumers, and researchers. This data collection instrument (DCI) aims to provide a guideline of the survey design that could be conducted to measure willingness to pay (WTP) for battery related information. The study would be the first attempt to quantify the economic value consumers place on battery health information in the used BEV market. At the core of the study is a discrete choice experiment (DCE), which presents respondents with repeated choices between hypothetical used BEVs. Drawing on insights from the existing literature, the research team identifies key factors influencing used BEV adoption. The DCE systematically varies both conventional vehicle attributes (e.g., mileage, purchase price) and battery-specific attributes (e.g., range, refurbishment history, SOH) to determine which characteristics most influence consumer preferences and to estimate their willingness to pay for specific aspects of battery performance. Ultimately, this study supports future advancements in BEV technology, the effective communication of critical battery information at the point of sale, and a better understanding of consumer priorities, demographic differences, and decision-making factors in the used BEV market.

2. Background

This section provides a concise overview of the key literature informing the design of this data collection instrument. The first subsection examines the main drivers and barriers to the adoption of used BEVs, while the second subsection focuses on EV battery technology and how it shapes consumer perceptions and decision-making.

2.1. Used Electric Vehicle Adoption

Gore et al. (2024) provided a comprehensive review on consumer perspectives on EVs and the factors influencing EV adoption, identifying a broad range of determinants including attitudinal, demographic, societal, environmental, technological, and economic variables (Logansen et al., 2023; Naseri et al., 2024). However, most existing studies focused on new EV markets, with comparatively limited attention given to the used EV markets, which is rapidly expanding.

Though some preferences may carry over between new and used vehicle buyers—for instance, longer driving range is consistently correlated with stronger EV adoption likelihood—emerging evidence suggests that these two consumer groups differ in meaningful ways. For example, used EV buyers are more sensitive to the availability of public charging infrastructure than new EV buyers, likely due to lower rates of home charging access (Zou et al., 2020). Moreover, purchasing behavior for used vehicles is often more risk-averse and budget-conscious, reflecting different decision-making processes than those found in the new car market. This indicates that used EV adoption is not simply a scaled-down version of new EV adoption and warrants independent investigation.

Several studies have begun to profile the typical used EV buyer. Canepa et al. (2019) found that used car buyers are commonly cost-conscious. Compared to the general population, used EV buyers are more likely to be younger, male, White, and better educated. However, compared to new-EV buyers, used EV buyers tend to have lower household incomes and be renters, with lower access to private garages with EV chargers (Khaloei et al., 2020; Sheykhfard et al., 2025). These characteristics differ from the traditional early adopter profile seen in the new EV market (typically wealthier, homeowners with garages), suggesting that used EVs may serve as a more accessible entry point into EV ownership for broader population segments. Although range is a common concern for EV users, Sheykhfard et al. (2025) found that the majority of used EV owners drive well within the range capabilities of most existing EV models: 59.4 % reported driving fewer than 100 miles per day and 29.4 % drove less than 50 miles per day.

2.2. Electric Vehicle Battery Technology and Consumer Perception

The electric vehicle batteries (EVBs) present new risks and opportunities for consumers and the automotive industry. Despite progress in battery technology, consumer concerns about battery health, replacement cost, and resale value persist, especially in the used EV market. A major concern is battery cost—it can represent up to 30 % of an EV's total price (Boudway, 2020). Because of this, battery longevity and reliability play a crucial role in determining the economic viability of EV ownership.

2.2.1. Battery Degradation and State-of-Health

In the adoption literature, battery-related considerations for BEVs have largely centered on driving range (Yuan et al., 2018). Similarly, the common hesitation among prospective used EV buyers stems from battery degradation, SOH uncertainty, and the unreliability of older technology (Pedrosa & Nobre, 2018).

Battery degradation is typically manifested by a decrease in energy capacity, driving range, and increased charging time over time (Attia et al., 2022). The rate of degradation depends on multiple factors, including charging patterns (e.g., fast vs. slow charging, charging frequency), driving patterns, depth of discharge cycles, and operation conditions (e.g., humidity and temperature exposure) (Bashash et al., 2011; Neubauer et al., 2012). The BEV batteries can last five years to thirteen years depending on the operational conditions (Yang et al., 2018). Studies suggest that battery aging trajectories are often linear or sublinear, meaning that the degradation either occurs at a constant rate or a reduced rate over time, likely due to the stabilization of battery chemistry after initial use (Attia et al., 2020, 2022). Batteries are generally considered to reach their End-of-Life (EoL) for vehicle use when their SOH drops to approximately 70 % to 80 % of the original capacity (Canals Casals et al., 2019, 2022). Battery degradation has been shown to reduce consumers' perceived future value of the vehicle and heighten resale anxiety.

2.2.2. Battery Replacement, Cost, and Warranty Considerations

While the existing literature has considered the longevity of the batteries when calculating the overall cost of EVs (Hagman et al., 2016; Letmathe & Soares, 2017), there is a lack of studies that directly examined the cost of EVBs.

Most modern EVBs are designed to last the lifetime of the vehicle under normal use. Dnistran (2024) studied almost 5000 EVs and revealed that the average annual degradation rate to be 1.8 %, making the battery lifespan expected to outlast the vehicle's useful life. However, Sheykhfard et al. (2025) report that although battery performance degradation, to the point of needing replacement is rare, it can be expensive. Drawing from real-world experience compiled from a few online sources, the replacement costs can range between \$5000 and \$20 000 or more depending on the vehicle model and labor (Kothari, 2024; Witt, 2024).

To improve consumer's confidence, most EV manufacturers offer warranties covering 8 years or 100 000 miles – whichever comes first (Clarke, 2024). This suggests that consumer purchase intentions can be closely linked to how long they expect to keep the vehicle and whether the battery's SOH will fall below the threshold (70 %~75 %) within the ownership window. Hitting this threshold can trigger a free battery replacement, which adds economic value and reassurance. This is supported by prior literature suggesting that the cost of BEVs varies widely by how long someone is expected to own the vehicle (Hagman et al., 2016). Letmathe and Soares also specifically consider reselling the battery separately from the resale cost of the vehicle when calculating the total cost of ownership (Letmathe & Soares, 2017).

2.2.3. Second-Life and Refurbished Batteries

As the number of used EVBs increases, opportunities for reuse and recycling are more available (Skeete et al., 2020; Tankou et al., 2023). Many circular business models emphasize two main second-life pathways for EVBs: one is to exploit deteriorated batteries for less demanding applications, such as stationary energy storage for homes or grids (Christensen et al., 2021), and the other one is to refurbish those batteries and reintegrate into the EV market. This review focuses on the latter – refurbishing batteries for continued use in EVs.

Refurbishing batteries at the cell or module level can offer cost savings and support the economic viability of BEVs. For example, Jiao & Evans suggest that repurposing EoL EVBs could reduce the cost differential between BEVs and conventional vehicles (Jiao & Evans, 2016). Similarly, Shaikh et al. (2023) conducted a simulation showing that refurbished EVBs are more affordable than new ones. Moreover, the refurbishment costs are lowest when batteries are sold locally, compared to regional and national markets. These findings indicate clear advantages for both automotive manufactures and customers. However, existing studies on second-life EVBs have largely focused on technical and economic feasibility, often outside of the U.S. contexts where EV penetration is higher and EoL battery volumes are projected to increase significantly. In contrast, relatively little attention has been paid to consumer preferences and willingness to pay for refurbished EVBs, which are essential to the viability of refurbishment-based business models.

One of the few relevant studies, conducted by Pedrosa & Nobre (2018) in Portugal found that all interviewees expressed positive attitudes toward refurbished EVs—particularly those fitted with replacement batteries backed by dealership warranties. Participants viewed these vehicles as more reliable, with the potential for extended driving range and greater peace of mind, and even indicated a higher willingness to pay compared to used EVs retaining their original batteries. The main limitation of this study is that it is a qualitative interview based on a very small sample and may not be generalizable to the U.S. market. Moreover, while the study suggests a consumer preference for BEVs with brand-new batteries over original ones, to the best of the authors' knowledge, no studies have directly examined consumer attitudes towards more nuanced refurbishment options, such as partial battery replacements or full pack replacements. Understanding consumer acceptance of these varying levels of refurbishment is understanding and predicting EV adoption, and the infrastructure needs that come along with EV usage.

3. Survey Instrument

3.1. Survey Introduction and Participation Consent

If implemented, the survey should begin with an introduction to the research team, an overview of the survey's main topics, and an estimated completion time. This is typically followed by an informed consent section, which outlines the study's purpose, funding sources, voluntary nature of participation, confidentiality assurances, eligibility criteria (participants must be at least 18 years old), and potential benefits and risks of participation. Only individuals who agree to the consent may proceed with the survey. The consent language should be reviewed and approved by the Institutional Review Board (IRB).

3.2. Survey Sections

The survey instrument is organized into six main sections:

- 1) **Screening Questions** – Assess respondents' intentions to purchase a used vehicle within the next two years.
- 2) **Current Vehicle Ownership** – Gather information on the household's current vehicle fleet and detailed vehicle attributes.
- 3) **Future Vehicle Ownership** – Explore anticipated changes in the household's vehicle ownership.
- 4) **BEV Discrete Choice Experiments** – Present six choice scenarios to examine preferences related to BEV adoption.
- 5) **BEV Knowledge and Attitudes** – Measure respondents' familiarity with and attitudes toward BEVs and related topics.
- 6) **Demographics** – Collect basic sociodemographic information to support segmentation and analysis.

3.2.1. Screening Questions

The first section of the survey includes four screening questions to identify eligible respondents. These questions assess the expected timeline for purchasing a vehicle, interest in the new or used vehicle market, and preferred vehicle body styles. Respondents who indicate they are likely to purchase a vehicle within the next two years, are considering a used vehicle (alone or alongside new vehicles), and are interested in a car/sedan/hatchback or SUV/crossover are eligible to proceed. An additional question on Toyota ownership history is included solely for bot detection and is not shown to typical respondents.

To your best estimate, when will you likely need to purchase your next vehicle?

- *Within the next 3 months*
- *In 3-6 months*
- *In 6-12 months*
- *In 1-2 years*
- *After 2 years*
- *I'm not sure*

Are you interested in buying a new or used vehicle?

- New vehicle only
- Used vehicle only
- I'm looking at both markets

Which vehicle body style would you consider for your next vehicle?

- Car / sedan / hatchback
- SUV / crossover
- Minivan / Van
- Truck
- Other

Have you ever owned a Toyota vehicle?

- Yes, currently
- Yes, in the past
- No

3.2.2. Current Vehicle Ownership Questions

This section collects information about the respondent's current household vehicle fleet. Respondents are instructed to include all passenger vehicles (cars, SUVs, vans, and trucks) but exclude motorcycles. A household is defined as all individuals living in the same residence. Table 1 is also provided below to help familiarize respondents with each type of passenger vehicle included in the survey options.

Table 1. Descriptions of different vehicle types

Types of Powertrain	Powertrain Definition	Example
Conventional 	Gasoline or other liquid-fuel engine, such as diesel or flex-fuel.	Honda Civic, Ford Explorer
Gas hybrid electric vehicles (HEV) 	Smaller gasoline engine + electric motor + small battery. Gasoline engine recharges the battery to improve fuel efficiency.	Toyota Prius, Ford Escape Hybrid
Plug-in hybrid electric vehicle (PHEV)  	Hybrid that can also be plugged into an electrical outlet to charge the battery. Runs on electricity for a short range (10 – 40 miles), then switches to gasoline.	Kia Niro, Toyota RAV4 Prime
Battery electric vehicle (BEV) 	Electric motor only. Must be plugged into an electrical outlet to be refueled.	Nissan Leaf, Tesla Model Y

Four survey questions ask: (1) how many passenger vehicles the household currently owns or leases; (2) the types of vehicles owned or leased (e.g., conventional, gas hybrid, plug-in hybrid,

battery electric, other); (3) whether the respondent has access to an electrical outlet where their vehicle is typically parked (at home or work); and (4) whether any neighbors own or lease a plug-in hybrid or battery electric vehicle.

How many passenger vehicles are currently owned or leased by your household?

- 0
- 1
- 2
- 3
- 4
- 5
- 6 or more

Which of the following types of vehicles are currently owned or leased by your household? Select all that apply.

- Conventional
- Gas hybrid
- Plug-in hybrid
- Battery electric
- Other

Do you have access to an electrical outlet where your vehicle is typically parked at your primary residence or workplace?

- Yes
- No
- I'm not sure

Do any of your neighbors own or lease a plug-in hybrid or a battery electric vehicle?

- Yes
- No
- I'm not sure

For respondents who report owning or leasing at least one household vehicle, follow-up questions are asked about the vehicle they drive most frequently. If the household has more than one vehicle, respondents are asked to specify the fuel type of their primary vehicle; otherwise, this information is already captured in an earlier question. Additional questions gather details on whether the vehicle was obtained new or used, and the method of acquisition. For respondents who reported buying or leasing the vehicle, they are also asked to estimate the total purchase or lease cost—including all related expenses—as well as their current monthly payment. Additional questions assess the average fuel efficiency (in miles per gallon) for non-BEVs, frequency of refueling or recharging, and estimated driving range on a full tank or full charge. This information helps to characterize the cost, usage patterns, and energy efficiency of respondents' primary household vehicles.

What is the fuel type of this vehicle?

- Conventional
- Gas hybrid
- Plug-in hybrid

- *Battery electric*
- *Other*

Was this vehicle obtained as a new or used vehicle?

- *New*
- *Used*

How was this vehicle obtained?

- *Bought from a dealership*
- *Leased from a dealership*
- *Bought from an online retailer (e.g., Carvana)*
- *Bought from a private seller*
- *Received as a gift*
- *Do not remember / do not know*
- *Other*

To your best estimate, what was the total purchase or lease price for this vehicle? Please include all related expenses (such as down payment, monthly payments, taxes, fees, etc.), but **do not include any trade-in value or credits from selling another vehicle.**

- *\$9,999 or less*
- *\$10,000 - \$19,999*
- *\$20,000 - \$29,999*
- *\$30,000 - \$39,999*
- *\$40,000 - \$49,999*
- *\$50,000 - \$59,999*
- *\$60,000 - \$69,999*
- *\$70,000 - \$79,999*
- *\$80,000 - \$89,999*
- *\$90,000 - \$99,999*
- *\$100,000 or more*
- *Do not remember / do not know*

What is your current monthly payment for this vehicle?

- *Paid in full/ No loan*
- *\$99 or less*
- *\$100 - \$199*
- *\$200 - \$299*
- *\$300 - \$399*
- *\$400 - \$499*
- *\$500 - \$599*
- *\$600 - \$699*
- *\$700 - \$799*
- *\$800 - \$899*
- *\$900 - \$999*
- *\$1,000 or more*
- *Do not remember / do not know*

What is the average gas mileage (in miles per gallon, MPG) of this vehicle? Please provide your best estimate.

- 9.99 MPG or less
- 10 - 19.99 MPG
- 20 - 29.99 MPG
- 30 - 39.99 MPG
- 40 - 49.99 MPG
- 50 - 59.99 MPG
- 60 MPG or more
- I'm not sure

How often do you refuel or recharge this vehicle?

- Once a month
- Once every two weeks
- Once a week
- Twice a week
- Three times a week
- Four times a week
- Five or more times a week

How many miles can this vehicle travel on a full tank or full charge?

- 49 miles or less
- 50 - 99 miles
- 100 - 149 miles
- 150 - 199 miles
- 200 - 249 miles
- 250 - 299 miles
- 300 - 349 miles
- 350 miles or more

3.2.3. Future Vehicle Ownership

Section 3 focuses on respondents' future vehicle purchasing plans and preferences. It begins by asking about their anticipated budget for their next vehicle, offering a range of price brackets to capture affordability considerations. Respondents are then asked how they plan to pay for the vehicle—either by paying in full or through financing. Each respondent's anticipated budget will serve as a benchmark for setting vehicle purchase prices in the DCE, ensuring that price levels remain realistic and do not overshadow the effects of other vehicle attributes on their choices.

To better understand openness to alternative fuel vehicles, the survey assesses the likelihood of purchasing a new or used plug-in hybrid or BEV using a 5-point Likert scale, ranging from "very unlikely" to "very likely". For those who express a low likelihood of choosing both a new and a used BEV (i.e., selecting "very unlikely" or "somewhat unlikely"), a follow-up open-ended question asks them to identify their primary concern or reason. These questions help gauge financial expectations, payment strategies, and perceived barriers to adopting electrified vehicles. The open-ended question serves both as a source of rich qualitative data and a quality control mechanism for screening inattentive or unreliable participants.

What is your budget for the vehicle?

- \$4,999 or less
- \$5,000 - \$9,999
- \$10,000 - \$14,999
- \$15,000 - \$19,999
- \$20,000 - \$24,999
- \$25,000 - \$29,999
- \$30,000 - \$34,999
- \$35,000 - \$39,999
- \$40,000 - \$44,999
- \$45,000 - \$49,999
- \$50,000 or more

How do you intend to pay for the vehicle?

- Pay in full
- Finance

How likely are you to purchase the following types of vehicles as your next vehicle?

	<i>Very unlikely</i>	<i>Somewhat unlikely</i>	<i>Neither likely nor unlikely</i>	<i>Somewhat likely</i>	<i>Very likely</i>
<i>New plug-in hybrid vehicle</i>					
<i>Used plug-in hybrid vehicle</i>					
<i>New battery electric vehicle</i>					
<i>Used battery electric vehicle</i>					

You indicated that you are unlikely to purchase a battery electric vehicle as your next vehicle. What is your biggest concern or reason for this?

3.2.4. BEV Discrete Choice Experiments

Section 4 is the core component of the survey, where respondents are asked to consider a scenario in which they choose a used BEV from a set of options with varying attributes. Participants who are very unlikely to purchase a BEV were not asked this set of questions. Before presenting the choice tasks, we provide key background information about BEVs and their batteries to help respondents make informed decisions (see Table 2).

To examine the effects of goal priming—specifically, how the presentation of certain information may influence consumer preferences—participants are randomly divided into two groups. One group receives only information about **vehicle driving range and battery health**,

while the other group is shown additional details about **battery maintenance** and **warranty coverage**. This design allows us to assess whether specific types of information impact respondents' choices in the BEV selection tasks.

Table 2. Battery information treatment



Vehicle Driving Range and Battery Health

- EV batteries **gradually lose capacity over time (battery degradation)**, which reduces the vehicle's **driving range** and increases charging time.
- The condition of an EV battery is often described using **State of Health (SOH)**, expressed as a percentage.



Battery Maintenance

- **Battery replacements** are rare but can be expensive, costing **between \$5,000 and \$20,000** or more depending on the model and labor costs.
- However, most modern EV batteries are **designed to last the lifetime** of the vehicle under normal use.



Battery Warranty

- BEVs come with a **battery warranty** of at least **8 years or 100,000 miles**, whichever comes first.
- Many batteries continue to perform well **beyond the warranty period**, though some performance degradation is expected over time.
- Most manufacturers will replace the battery when the SOH falls **below 70-75%** while under warranty.

Next, we introduce the specific attributes of the BEVs that respondents will evaluate in the upcoming choice experiments (see Table 3). Based on prior studies, age and mileage are the main factors influencing the value of a used car (Prieto et al., 2015). For all choice questions, we ask respondents to assume the used vehicle was built in 2022 and is currently three years old. The attributes with varying values include **vehicle mileage**, **purchase price**, **battery refurbishment history**, **electric range**, and **battery state-of-health**. All the information ensures respondents clearly understand the meaning of each attribute before making their selections.

Table 3. Used BEV vehicle attributes presented in the choice experiments

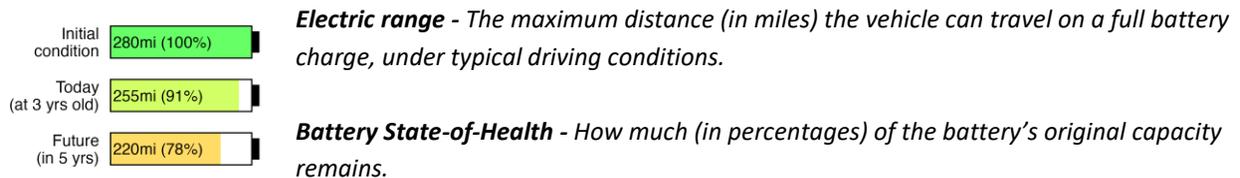


Mileage - The number of miles a vehicle has traveled.



Purchase price - The total price for the vehicle (in dollars), including down payment, monthly payments, taxes, fees, etc.

Battery refurbishment history - The repair or replacement work that has been done on the vehicle's main battery.



We generate a set of possible vehicle profiles (see Table 4). Each choice will be defined by a combination of these attributes and levels.

Table 4. Attributes and attribute levels

Attributes	Levels
Mileage	Ranges from 15,000 miles to 50,000 miles, increasing in increments of 500 miles.
Purchase price	Ranges from 80 % to 120 % of the respondents' self-reported maximum budget for their next vehicle, in 10 % increments.
Battery refurbishment history	<ul style="list-style-type: none"> Original – The battery remains in its factory-original condition with no repairs or replacements. Some battery cells replaced – A portion of the battery cells has been replaced to address performance issues or extend battery life, while the rest remains original. Entire battery pack replaced – The full battery pack has been replaced with a new, refurbished, or used pack, typically due to a decline in battery performance below a certain threshold.
Electric range; Battery State-of-Health	<ul style="list-style-type: none"> Initial Electric Range (Year 0): Ranges from 200 miles to 360 miles, in increments of 40 miles¹. Battery Degradation: Indicates the average annual loss in both electric range and battery state-of-health, varying from 1 % to 8 % in 1 % increments².

¹ To establish a representative range for BEVs, the EPA-estimated range data for 762 BEVs is used, including models released between 2013 and 2025 as compiled by CarSheet.io (2025). The median driving range across these vehicles is 256 miles, with over 80 % falling between 200 and 360 miles. Accordingly, 200 miles to 360 miles is considered as a reasonable estimate of typical BEV driving range, which will be used in the DCEs.

² Even though prior studies have suggested that the average annual degradation rate of EVBs is less than 2 % (Dnistran, 2024), we deliberately extend the range to 1 % - 8 % in the DCEs to capture scenarios where a BEV's battery reaches the critical SOH threshold of 70 %, potentially to

Before the actual choice tasks, respondents are shown an example scenario in which Option 3 is clearly the dominant alternative (see Figure 1). In this scenario, all three options share identical attribute categories, but Option 3 offers the highest electric range, the lowest battery degradation rate, and the lowest purchase price. According to rational choice theory, attentive and engaged respondents are expected to select Option 3. Those who choose Option 1 or 2 instead will be flagged as providing low-quality data. Respondents are then presented with six actual choice tasks. An example is illustrated in Figure 2.

triggering the warranty coverage for battery replacement. This allows us to evaluate whether respondents are actually willing to pay for vehicles with higher battery degradation rate if they anticipate a future replacement covered under warranty. Based on Attia et al.'s studies (2020, 2022), we also assume a constant annual degradation rate.

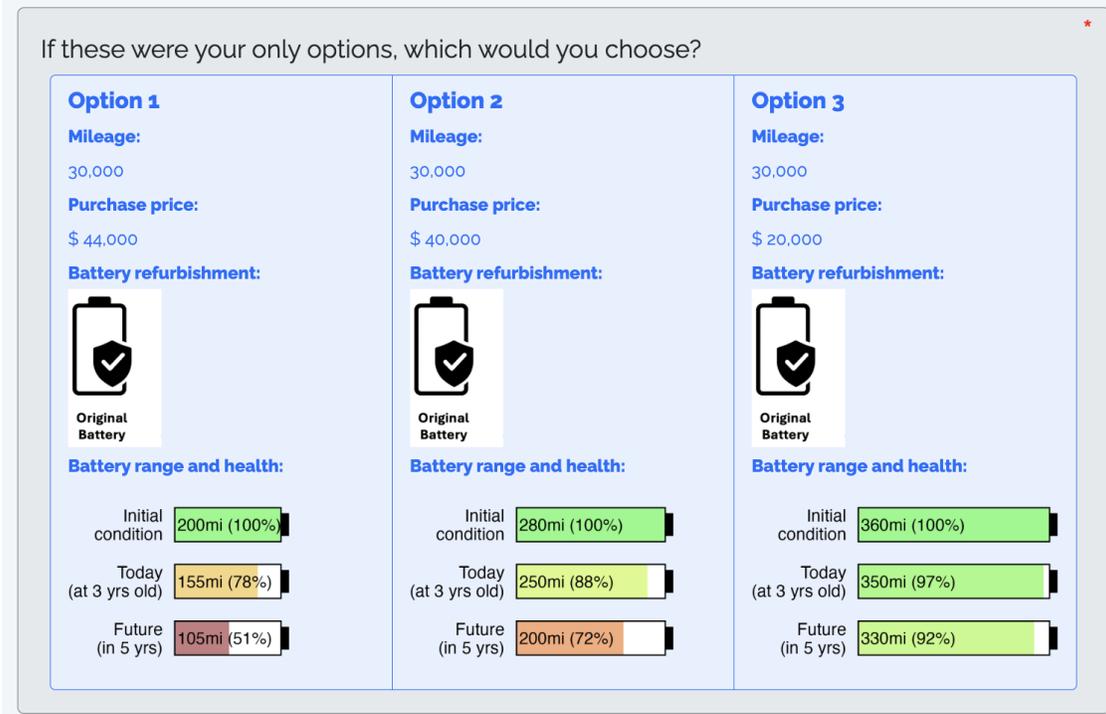


Figure 1. An example scenario before the choice experiment

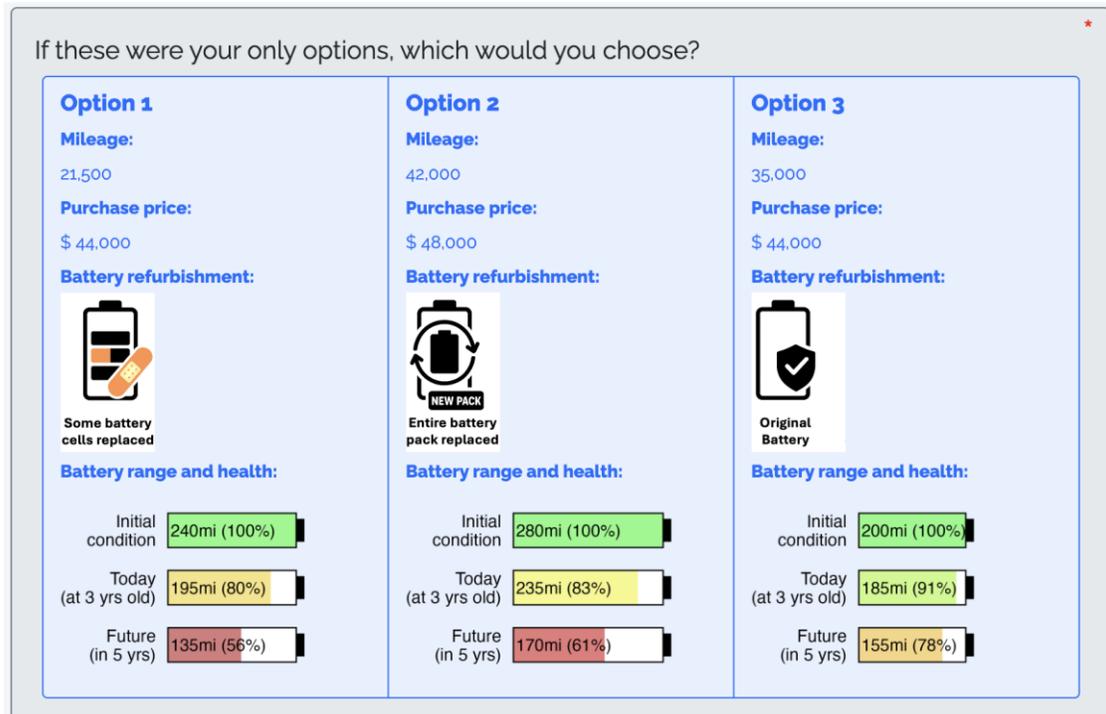


Figure 2. An example of the choice experiment

Following the choice experiments, the survey includes a self-assessment question asking respondents to rate the importance of each attribute using a Likert scale, ranging from “Not at all important” to “Extremely important.” This question serves multiple purposes: (1) Validating choice behavior – It provides a way to cross-check whether the attributes respondents claim to value (i.e., stated importance) align with the trade-offs revealed in their actual choices (i.e., derived importance) (Chu, 2002; Huster et al., 2024). Inconsistencies may signal issues such as misunderstanding or inattention. (2) Understanding perceived salience – Because respondents may focus on different attributes during the experiment, self-reported ratings help identify which attributes were most influential in their decision-making process. (3) Segmenting respondents – These ratings can be used to group participants based on their stated priorities (e.g., price-sensitive vs. battery-conscious consumers), enabling more targeted analysis or class-specific modeling. (4) Survey diagnostics and data quality checks – Discrepancies between stated importance and revealed preferences may indicate low engagement, confusion, or misinterpretation of the attribute descriptions, helping researchers assess the overall quality of the data.

How important are the following attributes to you when selecting a battery electric vehicle?

	<i>Unimportant</i>	<i>Of little importance</i>	<i>Moderately important</i>	<i>Important</i>	<i>Very important</i>
<i>Vehicle mileage</i>					
<i>Vehicle price</i>					
<i>Battery Refurbishment history</i>					
<i>Battery range and health</i>					

3.2.5. BEV Knowledge and Attitudes

This section of the survey assesses respondents’ knowledge, attitudes, and perceptions related to EVs, battery technologies, and related topics. It begins with a series of factual questions that evaluate understanding of which vehicles can run on gasoline or be plugged in, whether respondents can name a BEV, and their knowledge of the current U.S. federal tax credit for new EV purchases. These items help establish respondents’ baseline knowledge, which may influence their preferences in earlier choice tasks. The section then presents a series of attitudinal statements covering topics such as social norms, environmental beliefs, cost perceptions, battery concerns, and personality traits like risk-taking and price sensitivity. Respondents rate their agreement using a 5-point Likert scale. Embedded within these statements is an attention check item instructing respondents to select “Disagree” as their

answer—used to identify inattentive or low-quality responses. This section provides key context for interpreting behavioral patterns and supports more nuanced analysis of factors influencing EV adoption.

Please select which vehicle(s) can run on gasoline. Select all that apply.

- Gas hybrid electric vehicle
- Plug-in hybrid electric vehicle
- Battery electric vehicle
- I'm not sure

Please select which vehicles can be plugged-in. Select all that apply.

- Gas hybrid electric vehicle
- Plug-in hybrid electric vehicle
- Battery electric vehicle
- I'm not sure

Can you name the make and model of at least one vehicle powered completely by electricity (a battery electric vehicle)?

- Yes
- No

Please name the make and model of the vehicle _____

To the best of your knowledge, what is the maximum federal tax credit currently available in the US for purchasing a new electric vehicle?

- \$1,000
- \$2,500
- \$5,000
- \$7,500
- \$10,000
- I'm not sure

Please indicate the extent to which you agree or disagree with the following statements.

	<i>Strongly disagree</i>	<i>Somewhat disagree</i>	<i>Neither agree nor disagree</i>	<i>Somewhat agree</i>	<i>Strongly agree</i>
<i>Driving an electric vehicle would eventually result in cost savings.</i>					
<i>If I owned a BEV, I would often worry about running out of charge.</i>					
<i>BEVs are less valuable than gasoline cars on the</i>					

<i>resale market, because the technology is always advancing.</i>					
<i>Please select "Disagree" as your response to this item.</i>					
<i>The price of an electric vehicle is too high.</i>					
<i>Remanufactured EV batteries do NOT perform and function as original EV batteries.</i>					
<i>Generally, I am willing to go to extra effort to find lower prices.</i>					
<i>I like to be among the first people to have the latest technology.</i>					
<i>I am a person who is fully prepared to take risks.</i>					

3.2.6. Demographics

The final section of the survey collects demographic and attitudinal information to support subgroup analyses and contextualize respondents’ choices. It includes standard demographic questions such as year of birth, gender, race/ethnicity, household size, income, education level, employment status, and housing type. These variables are crucial for understanding how socio-demographic factors influence preferences and attitudes toward EVs. Additional questions explore home ownership and average electricity bills, factors that may shape EV adoption decisions. The survey also asks for the respondent’s ZIP code to support geographic and spatial analyses. This section concludes with an open-ended question inviting them to describe, in their own words, what they believe the survey is about. These open-ended responses can help to validate the overall survey design and identify potential misinterpretations. This question can also serve to identify inattentive respondents who provide nonsensical or irrelevant answers.

What is your year of birth?

Choose an option... 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007

Including yourself, how many people live in your household?

- 1
- 2
- 3
- 4
- 5
- More than 5

Which of the following categories best describes your current employment status? Select all that apply.

- *I am a part-time or full-time student*
- *Employed, working fewer than 40 hours per week*
- *Employed, working 40 or more hours per week*

- *Not employed, looking for work*
- *Not employed, NOT looking for work*
- *Retired*
- *Disabled, not able to work*
- *Prefer not to answer*

What is your annual household income?

- *\$9,999 or less*
- *\$10,000 - \$19,999*
- *\$20,000 - \$29,999*
- *\$30,000 - \$39,999*
- *\$40,000 - \$49,999*
- *\$50,000 - \$59,999*
- *\$60,000 - \$69,999*
- *\$70,000 - \$79,999*
- *\$80,000 - \$89,999*
- *\$90,000 - \$99,999*
- *\$100,000 - \$109,999*
- *\$110,000 - \$119,999*
- *\$120,000 - \$129,999*
- *\$130,000 - \$139,999*
- *\$140,000 - \$149,999*
- *\$150,000 - \$159,999*
- *\$160,000 - \$169,999*
- *\$170,000 - \$179,999*
- *\$180,000 - \$189,999*
- *\$190,000 - \$199,999*
- *\$200,000 - \$209,999*
- *\$210,000 - \$219,999*
- *\$220,000 - \$229,999*
- *\$230,000 - \$239,999*
- *\$240,000 - \$249,999*
- *\$250,000 or more*
- *Prefer not to answer*

What is the last grade or level of school you have completed? If currently enrolled, please use the highest degree received.

- *Less than a high school diploma*
- *High school degree or equivalent (e.g. GED)*
- *Some college - but less than two years of college*
- *Some college - two years or more/A.A. degree*
- *Technical or trade school*
- *College graduate/bachelor's degree/B.A./B.S.*
- *Postgraduate courses*
- *Master's degree*
- *M.B.A. or law degree*
- *Ph.D. or M.D.*
- *Prefer not to answer*

In which type of housing do you currently live?

- *Single family house not attached to any other house*
- *Single family house attached to one or more houses (townhouse, rowhome, condo, duplex, triplex, etc.)*

- *Building with 2-4 apartments/condos/studios*
- *Building with 5-19 apartments/condos/studios*
- *Building with 20 or more apartments/condos/studios*
- *A mobile home or trailer*
- *Boat, RV, van, etc.*
- *Other*

Do you own or rent the current place you are living in?

- *Own*
- *Rent*
- *Neither*
- *Do not know / prefer not to answer*

What is your monthly electricity bill on average?

- *\$99 or less*
- *\$100 - \$199*
- *\$200 - \$299*
- *\$300 - \$399*
- *\$400 - \$499*
- *\$500 or more*

What is the ZIP code of your primary residence? Please provide a 5-digit number.

Please briefly describe what this survey is about:

4. Survey Approvals and Data Collection

The target population is U.S. residents aged 18 or older who are considering purchasing a used vehicle within the next two years. Prior to full deployment, the survey should undergo a pilot testing phase to provide feedback on question clarity, survey flow, and overall length. The target sample size should be approximately 2000 respondents, aiming to ensure a wide array of potential used vehicle buyers in the United States. Prior to deployment, the research survey should be submitted for review and approval by an Institutional Review Board, which oversees the ethical conduct of research involving human subjects, including survey-based studies.

5. Summary and Future Efforts

As more EVs reach the end of their first ownership cycle, understanding the dynamics of the used EV market—particularly the unique concerns surrounding battery condition—has become both timely and helpful for future infrastructure planning needs like electricity usage projections. Yet the lack of transparent, standardized battery health information at the point of sale continues to fuel uncertainty and undervaluation, which may impact consumer decisions of pre-owned EVs. This DCI provides guidelines to survey design and data collection effort that could address a major gap in the literature by focusing on how consumers evaluate used battery electric vehicles (BEVs), what factors influence their willingness to adopt them, and how information asymmetries, particularly around battery health, impact market confidence and transaction outcomes.

This survey-based study represents a novel and rigorous approach to addressing these challenges. By combining insights from prior literature with a discrete choice experiment (DCE), the survey design allows researchers to empirically estimate the value consumers place on different forms of battery information and vehicle characteristics. Looking ahead, this DCI and the results from this research project can inform future research and innovation in the second-life EV battery space. For example, further studies could explore consumer attitudes toward more complex refurbishment scenarios—such as partial vs. full battery replacements—and investigate how different warranty structures influence willingness to pay. Additionally, integrating insights from behavioral economics and data from telematics or vehicle diagnostics could enhance our understanding of how consumers interpret and act upon battery health information.

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