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# Analyse af indfasning af elbiler: SP metode og model

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# Analyse af indfasning af elbiler: SP metode og model

Projektet 'ELISA' af DTU Management for kommissionen for grøn omstilling af personbiler

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# Forord

Følgende rapport beskriver ELISA projektet udført af DTU for KEFM/ENS, TRM og FM. Projektet er udført i perioden Jan.–Sept. 2020.

Rapporten beskriver tekniske detaljer vedr. dataindsamlingen og egenskaber ved den endelige stikprøve. Dernæst beskriver rapporten resultater fra en diskret valgmodel, herunder parametre, elasticiteter og betalingsvillighed.

DTU takker for et godt samarbejde i arbejdsgruppen hvor mange gode diskussioner har bidraget positivt til projektet.

Kgs. Lyngby, August 2020

Jeppe Rich, Professor

# Abbreviations:

| | |
|---|---|
| DTU | Danmarks Tekniske Universitet *(EN: Technical University of Denmark)* |
| KEFM | Klima-, Energi-, og Forsyningsministeriet *(EN: Danish Ministry of Climate, Energy and Utilities)* |
| ENS | Energistyrelsen *(EN: Danish Energy Agency)* |
| TRM | Transport- og Boligministeriet (Ministry of Transport and Housing) |
| FM | Finansministeriet (Danish Ministry of Finance) |
| ICV | Internal Combustion engine Vehicle |
| BEV | Battery Electric Vehicle |
| PHEV | Plug-in Hybrid Electric Vehicle |
| SC | Stated Choice |
| MNL | Multinomial Logit |
| NL | Nested Logit |
| ML | Mixed Logit |
| WTP | Willingness-to-pay |

# Contents

# 1. Dansk resumé

Følgende rapport beskriver ELISA projektet udført af DTU for KEFM/ENS, TRM og FM. Projektet omhandler i alt fire overordnede aktiviteter, hvor nærværende rapport fokuserer på aktivitet A:

A) Design og opsamling af Stated Preference (SP) data, dvs. data baseret på hypotetiske valgsituationer og estimation af modeller på basis af de indsamlede data
B) Ekspertrådgivning i forhold til hvordan substitution kan håndteres for elbiler i forhold til fremskrivninger af bilparken og dens sammensætning
C) At bidrage med data der kan anvendes til at analysere indfasningen af elbiler under forskellige forudsætninger
D) Modellering af den generelle bilbestand og hvordan denne påvirkes af afgifter og indkomster fremadrettet

Formålet med *Aktivitet A* er at opdatere datagrundlaget for at kunne fremskrive valg af biltype ved at estimere de mest relevante adfærdsparametre, herunder parametre for specifikke attributter for elbiler og plug-in hybridbiler. Data er indsamlet vha. et såkaldt stated choice (SC) eksperiment hvor hver respondent blev bedt om at foretage en række hypotetiske valg imellem 3 biltyper: ren elbil (BEV), plug-in hybrid (PHEV) samt konventionel benzin eller diesel (ICV). stated choice eksperimentet tager udgangspunkt i et efficient design, hvilket var nødvendigt grundet kompleksiteten i valgeksperimentet.

Det er vigtigt at respondenten kan relatere til de hypotetiske scenarier for at kunne afgive præcise svar. De præsenterede scenarier er derfor opbygget omkring det mest sandsynlige næste bilkøb. En vigtig faktor her er hvilke bilsegmenter forbrugeren er mest interesseret i. Sammen med styregruppen blev det besluttet at SC eksperimentet skulle bygges op omkring følgende seks bilsegmenter: Mini, Lille, Medium, Stor, Premium og Luksus/Sport. I den eksisterende litteratur er der i de fleste tilfælde kun benyttet ét segment per respondent. Dette gør det ikke muligt at fange overflytning mellem bilsegmenter (fx fra *stor* til *lille*). Det er imidlertid muligt at afgiftsomlægninger, der rammer specifikke segmenter/biltyper, kan føre til en substitution mellem segmenter og/eller biltyper. I eksperimentet er det derfor besluttet at inkludere flere segmenter per respondent. For at undgå et meget stort antal alternativer (alle kombinationer af 3 biltyper og 6 segmenter) benyttedes en metode, hvor respondenten angiver sandsynligheden for at næste bilkøb tilhørte hvert af de seks segmenter, og kun de to mest relevante segmenter udvælges. Dette giver mulighed for at analysere substitution mellem alle segmenter og biltyper efterfølgende.

I hvert scenarie er hvert af de præsenterede alternativer beskrevet vha. en række variable (attributter), som er tilpasset den enkelte biltype/segment og som varierer systematisk igennem eksperimentet. Efter en litteraturgennemgang og yderligere overvejelser og diskussioner i styregruppen er følgende attributter blevet udvalgt jf. *Table 1:* .

| Main design | House | | Flat | |
| --- | --- | --- | --- | --- |
| **Sub-design** | **1** | **2** | **1** | **2** |
| *Car types* | | | | |
| ICV | • | • | • | • |
| BEV | • | • | • | • |
| PHEV | | | • | • |
| *Attributes* | | | | |
| Purchase price [*DKK*] | • | • | • | • |
| Yearly cost [*DKK/Year*] | • | • | • | • |
| Operation costs [*DKK/km*] | • | • | • | • |
| Range [*km*] | • | • | • | • |
| Acceleration [*s*] | • | • | • | • |
| Boot size | • | • | • | • |
| Carbon emissions [g/km] | • | • | • | • |
| Distance to home charging [*m*] (PHEV and BEV) | | | • | • |
| Home charging availability (PHEV and BEV) | | | • | • |
| Distance between fast chargers [*km*] (BEV) | • | • | • | • |
| Charging speed [*km per 10 minutes of charging*] (BEV) | • | • | • | • |

Table 1: Inkluderede attributter samt hvilket eksperiment/teknologi de er medtaget i.

Det har været nødvendigt at tilpasse opladningsattributter for BEV og PHEV, så de passer til respondentens muligheder for opladning ved hjemmet. Således er der opbygget forskellige designs til personer med mulighed for opladning på en privat parkeringsplads og dem, som f.eks. bor i lejlighed og parkerer på gaden når de er hjemme. Kun for dem, der ikke har mulighed for at lade på en privat/dedikeret parkeringsplads ved hjemmet, bliver der stillet spørgsmål omkring afstand til nærmeste ladestander fra hjemmet samt sandsynlighed for at disse ladestandere er ledige. Inden for hvert af disse designs, er opladningsattributter ligeledes kun brugt til at beskrive de teknologier, hvor disse er relevante. Således bliver PHEV kun beskrevet med opladningsattributter der beskriver opladning ved hjemmet, mens BEV både er beskrevet med opladningsattributter der beskriver opladning ved hjemmet og opladning på farten.

Som det fremgår, er de endelig designs beskrevet med mange attributter og vi stiller dermed respondenterne over for en kompleks opgave. Idet der er en forventning om at BEV biler på lang sigt bliver dominerende, og for at reducere kompleksiteten for respondenten, blev det besluttet at respondenten skulle stilles overfor 4 scenarier hvor kun ICV og BEV teknologier indgår. Dette efterfølges af 4 scenarier hvor ICV, BEV og PHEV indgår, dvs. respondenten stilles overfor 4 scenarier med 4 alternativer (2 biltyper og 2 segmenter) samt 4 scenarier med 6 alternativer (3 biltyper og 2 segmenter).

Eksperimentet er kodet og udsendt gennem Epinion. Respondenter blev tilfældigt udvalgt fra den danske population med samme metode som benyttes i transportvaneundersøgelsen hvor CPR numre er udvalgt tilfældigt og udsendt via e-boks. Spørgeskemaet blev udsendt som pilot test til 1495 respondenter i maj 2020, hvor der blev opnået en responsrate på 14,8%. Efter mindre justeringer blev de resterende 25.209 invitationer udsendt i mindre sæt. Seneste

udsending var 22/6 2020 og der blev samlet set for hovedundersøgelsen opnået en responsrate på 11,7%, hvilket passer med forventningerne.

Denne rapport inkluderer en modelestimation i form af en Mixed Logit Model baseret på de 23.674 observationer fra 2.961 respondenter, den udregnede betalingsvillighed (willingness to pay) for hver attribut samt elasticiteter på tværs af alle biltyper og segmenter for både købspris og rækkevidde. Alle estimerede parametre er signifikante (indenfor et 1% konfidensniveau) og med forventede fortegn. Modellen er overleveret til ENS og der udføres videre rådgivning omkring hvordan modellen implementeres i deres basisfremskrivninger samt evt. hvordan der tages højde for substitution som angivet i *Aktivitet B.*

# 2. Purpose

This report documents the work on activity A within the overall ELISA project. The overall goal for ELISA is to support the development of a model that can predict market shares for conventional as well as electric and plug-in hybrids in future scenarios. The purpose of activity A is to update the data foundation for a forecasting tool describing vehicle demand by fuel type across car segments which is developed by  KEFM/ENS and also relevant for TRM and FM. In addition, the activity includes the estimation of relevant parameters for this forecasting tool. The data update is based on a stated choice experiment that is sent out to a random sample of the Danish population. New car technologies, such as battery electric vehicles and plug-in hybrid vehicles, comes with different features compared to conventional vehicles and the experiment thus specifically targets behavior related to factors such as driving range, charging of batteries and the price of the vehicles. As changes in levels for specific segments or vehicle types can result in substitution effects across both vehicle types and segments, the experiment includes both vehicle types and segments. A discrete choice model that is estimated on the collected data.

# 3. Literature and experiences

In the following, we review the literature and previous experience. In particular, we identify relevant attributes with respect to the choice of car and consider;

    i)       how they can be measured,
    ii)     their relative effect,
    iii)    their importance.

## 3.1 Monetary cost attributes

Several cost components can be considered including the purchase cost, operating expenses (variable km costs) and annual costs (e.g., green tax and insurance).

One tempting approach from an application perspective is to include different cost components in a combined 'Total Cost of Ownership' variable, here referred to as TCO. However, it is not obvious that a stated preference experiment would provide realistic trade-offs from cost attributes described by TCO. TCO is not a commonly understood concept among private customers and it is expected that many respondents will have difficulties relating to this concept.

**Purchase/leasing price**

In a recent literature review of SP studies regarding BEV purchase, Liao, Molin, and van Wee (2017) state that all reviewed studies included *purchase price* and that many studies used a pivoted design with respect to the price. Hence, the values for the purchase price that are presented to consumers are pivoted around a reference price stated by each respondent. Indeed, (Glerum et al. 2013) include both purchase price and *leasing price* but do not include details on how these are calculated. In order to control for uncertainty with respect to value depreciation due to technological development, Bockarjova, Rietveld, and Knockaert (2013) included both purchase price and expected resale price in their choice experiment.

**Operation costs**

Another important cost attribute is the costs of using the vehicles. It is widely accepted to use approximate *operation costs* by energy costs per km or per 100 km (e.g. Potoglou and Kanaroglou, 2007; Jensen, Cherchi and Ortúzar, 2014). However, there are also examples of combined costs for energy and maintenance (Mabit and Fosgerau 2011) and annual operation costs (Giansoldati et al. 2018).

Where the energy costs for ICVs are easily measured as the cost of fuel, the energy costs for BEVs are more complicated. This is because BEVs can be charged at home and away from home. When charging at home, the costs is often equal to a fixed rate. However, BEV users can also have special agreements with separate charging operators and many different cost structures are possible, e.g. flat rate, variable rate and/or lump sum payment.

When BEVs are charged away from home, different roaming conditions can influence the price as well.

## 3.2 Technical attributes
Technical attributes describe technical features of the individual vehicles.

**Driving range**
The limited driving range of many BEVs is often found to be a great barrier for the BEV market share. Driving range has been included in different ways in stated preference surveys. In many studies, driving range only vary for BEVs, while in other studies, the driving range also varies for other vehicle alternatives. The attribute values also vary significantly, e.g. from 30-60 miles (48-97 km) (Hess et al. 2012) to 200-600 km (Giansoldati et al. 2018). Generally, older studies are characterized by limited range because these studies reflected the technology state at the time of the study. However, more recent studies include BEVs with longer driving range.

The functional form of driving range has been debated in the literature. As discussed (Dimitropoulos, Rietveld, and van Ommeren 2013) it is not reasonable to expect that the marginal increase is constant across different reference levels of driving range. In a Meta study they find evidence for a log transformation of driving range. Furthermore, they suggest that driving range can depend on charging activities, charging time and the extent of the charging infrastructure.

**Charging infrastructure**
Most BEV users are able to charge at home. Several studies suggest that about 70%-80% of all charging events occur at home (Figenbaum and Kolbenstvedt 2016; Franke and Krems 2013; Haustein and Jensen 2018). However, even though long-distance trips represent only a small share of the transport demand of the household, the need for charging while taking these trips is known to have influence on the car purchase decision (Nicholas, Tal, and Turrentine 2017). It has been found that owners of first generation Nissan Leaf BEVs (with a comfortable driving range of 110 km) stays within the one-way distance of their battery range, whereas Tesla owners (with a driving range above 300 km) often exceeds this limitation, i.e. they use fast charging on longer trips. As the battery size for BEVs increase, we can expect to see more long-distance trips. However, such development also dependent on the supply of fast chargers (Nicholas, Tal, and Turrentine 2017).

Currently there is a research gap with respect to the type of infrastructure that will support the transition to long distance BEV trips (Hardman et al. 2018). Several past studies included fuel availability in a single attribute and do not distinguish between BEVs and other vehicles (e.g. Horne, Jaccard and Tiedemann, 2005; Potoglou and Kanaroglou, 2007; Bolduc, Boucher and Alvarez-Daziano, 2008; Achtnicht, 2012). Bockarjova, Rietveld and Knockaert (2013), as one of the first studies, included the detour and waiting time to reach a charging point whereas (Hidrue et al. 2011) only included charging time. In another study (Ito, Takeuchi, and Managi 2013) included charging time and a combined refuel availability and refuel location in one attribute. In order to account for access to private parking space at home, (Jensen, Cherchi, and Mabit 2013) included the distance to the nearest charging option from home and charging at work. Hardman *et al.* (2018) found the work destination to be the second most frequently used charging location.

**Vehicle performance and characteristics**

Several studies also include an attribute describing the driving performance of the vehicles, e.g. acceleration, top speed and size. In the early studies, (e.g. Bunch et al. 1993; Ewing and Sarigöllü 1998), this was especially important as electric vehicles were known as being rather small and slow. Today, electric vehicles perform at least as well as conventional cars and several studies show that drivers appreciate the fast acceleration, the smoothness and the silence of BEVs (Franke et al. 2012; Gärling and Johansson 1998; Jensen, Cherchi, and Ortúzar 2014; Skippon et al. 2016). Furthermore, it is now possible to get an BEV in all size segments. However, as BEVs are still significantly more expensive compared with ICV vehicles, it is particularly relevant to consider size segments in order to investigate potential substitution effects between segments. As an example, a household might be willing to consider a smaller and cheaper BEV over a larger conventional car, if this vehicle is within budget constraints.

It is also likely that households will prefer BEVs due to environmental performance. Previously, such performance has mostly been included as an attribute describing carbon dioxide emissions (Achtnicht 2012; Ito, Takeuchi, and Managi 2013; Jensen, Cherchi, and Mabit 2013) but also simpler definitions for pollution effects have been used, such as the pollution represented as a percentage of a reference vehicle (Hackbarth and Madlener 2013; Hidrue et al. 2011; Potoglou and Kanaroglou 2007).

## 3.3 Policy attributes

In order to promote the market uptake of BEVs, different countries have suggested different types of incentives. According to a recent literature review (Liao, Molin, and van Wee 2017), several studies consider reductions in purchase price (Glerum et al. 2013; Mau et al. 2008; Potoglou and Kanaroglou 2007) or usage cost reductions (Hackbarth and Madlener 2013; Hoen and Koetse 2014). No studies have found free parking to be effective and only 2 out of 10 studies (Hackbarth and Madlener 2013; Horne, Jaccard, and Tiedemann 2005) has found that access to high occupancy vehicle or bus lanes were effective in promoting BEVs.

# 4. SP design

In this section we will describe the design process of the stated choice experiment. The experiment is designed to capture substitution between car types (e.g. different propulsion) and car segments (size of cars). We consider the following car types and car segments:

| Dimensions | Description |
|---|---|
| Types | 1: Conventional cars (ICVs), |
| | 2: Plug-in Hybrids (PHEVs), |
| | 3: Battery Electric cars (BEVs) |
| Segments | 1: Mini, 2: Small, 3: Medium, 4: Large, 5: Premium, 6: Luxury/Sport |

Table 2: Overview and definition of car types and car segments considered in the study.

The full set of alternatives will consist of all combinations of car types and segments, thus a total of 18 alternatives. For simplicity, each respondent is only presented with a subset of the most relevant alternatives.

## 4.1 Attributes

The final design included the following attributes:

***Cost attributes:***
- **Purchase price [*DKK*]**: The purchase market price of the vehicle from new.
- **Yearly cost [*DKK/Year*]**: A fixed yearly cost that reflects expenses for annual taxation and insurances.
- **Operation costs [*DKK/km*]:** The cost related to operation/propulsion of the vehicle.

***Car characteristics:***
- **Range [km]:** The driving range of the vehicle with full battery or tank. For PHEV, only the battery range varies and the gasoline/diesel driving range is fixed to 600 km.
- **Acceleration [*Seconds*]:** The acceleration time from 0-100 km/h.
- **Boot size:** The size of the vehicle boot defined by the categories, small, medium, large and very large. This solution was chosen over specific storage capacity as simplicity for respondents was considered more important than actual size.
- **Carbon emissions [*g/km*]**: The pollution related to $CO_2$ emission per km. While other emission types could be relevant, only $CO_2$ emission are considered as it: 1) keeps the design "simple", and 2) new cars today are labelled with a "$CO_2$ emission"-label (in g/km) when purchased (e.g., it is expected that the respondent is able to relate to the values presented in the stated choice experiment), 3) because most other related emissions are strongly correlated with $CO_2$ use.

***Charging infrastructure:***
- **Distance to home charging [Meter]:** Indicates the distance to the nearest public (slow) charger from home. This attribute is only included for individuals who do not have access to private charging at home.
- **Home charging availability:** Indicates the probability that the nearest public (slow) charger(s) has a vacant plug (and is accessible). This attribute is only included for individuals who do not have access to private charging at home.

- **Distance between fast chargers [km]:** Defines the average distance between public fast chargers in the network.
- **Charging speed [km *per 10 minutes of charging*]:** Indicates the charging speed for public fast chargers. In order be applicable for all BEV car segments and varying battery sizes, it is shown as an average driving distance which can be achieved after 10 minutes of charging.

The attributes *Distance to home charging* and *Home charging availability* are only included for individuals who do not have access to private charging at home, e.g. in a garage/carport either through a dedicated charging unit or an emergency charger (so called 'granny charger'). Further, since these two attributes reflect general infrastructure conditions, these are independent of the specific car and thus have the same value for all BEVs and plug-in hybrid electric vehicles (PHEVs) within each choice task. The attributes *Distance between fast chargers* and *Charging speed* (when fast charging) are only presented for BEVs and, as for home charging attributes, these fast charging attributes have the same value across all BEVs within a choice scenario. The reason for not considering attributes related to fast charging in relation to PHEV alternatives is that PHEVs have only small batteries and is not relevant for this type of charging. Indeed, most PHEVs are not able to fast charging and for longer trips they will usually use their ICV engine.

## 4.2 Level value

The attribute levels are defined based on existing literature as well as the car models that are available in the market today and is expected to be available in the future. The Danish Authorities have information on all Danish vehicles, and based on this information the levels were defined. Furthermore, some attribute levels were changed to better represent the future car fleet (e.g. longer range for BEVs). The final attribute levels are presented in the Appendix.

## 4.3 Design versions

The design process is complicated by the fact that conditions are very different across the population. In particular, home charging possibilities will often depend on the respondent's type of house (private house, flat, etc.). To accommodate these differences, two designs where constructed. One design included the two attributes (*Distance to home charging* and *Home charging availability*) while an alternative design did not include these attributes. As PHEV is an alternative where driving range is based on energy from both batteries and gasoline/diesel, it is not obvious how the inclusion of this car type impacts (the robustness of) the parameter estimates. In order to investigate this (and to simplify the task for each respondent), two sub-designs were constructed: a design that only included ICVs and BEVs, and a design that included all three car types (ICV, BEV, and PHEVs). All respondents were presented with four tasks in each sub-design. The advantages of the first design is two-fold: firstly, the design is simpler and expected to be more robust, and secondly it makes it easier for the respondents to relate to the design when starting with only two car types. The most complicated design with three car types is presented last. Clearly, only the second design allows for the estimation of substitution effects for PHEVs. To summarize, a total of four (two main designs each with two different sub-designs) stated choice designs were generated. Table 3 presents an overview of the car types and attributes included in each of these designs, while Figure 4.1 shows an example of the final layout of the actual choice scenarios presented to the respondents.

| Main design | House | | Flat | |
| :--- | :---: | :---: | :---: | :---: |
| **Sub-design** | **1** | **2** | **1** | **2** |
| *Car types* | | | | |
| ICV | • | • | • | • |
| BEV | • | • | • | • |
| PHEV | | • | | • |
| *Attributes* | | | | |
| Purchase price [*DKK*] | • | • | • | • |
| Yearly cost [*DKK/Year*] | • | • | • | • |
| Operation costs [*DKK/km*] | • | • | • | • |
| Range [*km*] | • | • | • | • |
| Acceleration [*s*] | • | • | • | • |
| Boot size | • | • | • | • |
| Carbon emissions [g/km] | • | • | • | • |
| Distance to home charging [*m*] (PHEV and BEV) | | | • | • |
| Home charging availability (PHEV and BEV) | | | • | • |
| Distance between fast chargers [*km*] (BEV) | • | • | • | • |
| Charging speed [*km per 10 minutes of charging*] (BEV) | • | • | • | • |

Table 3: Overview of constructed stated choice designs.

## 4.4 Choice set size

One of the main objectives of this study is to account for substitution effects across car types and car segments. This is particularly relevant as BEVs in the current market are more expensive. Hence, opting for a BEV rather than a traditional ICV can shift some consumers to target a smaller car segment due to budget constraints.

As mentioned, in this study we consider 3 car types each containing 6 car segments. It is however not possible to ask respondents to answer all 18 alternatives, each with 7-11 attributes, as such a task will be too complex. Instead, we decided to present each respondent with the two car segments that were most relevant for them. Thus, the "simple" design (design 1) contains 2*2 alternatives, while the "complex" design (design 2) contains 3*2 alternatives. An example of a scenario from design 2 for a person that does not have access to a private home charger is presented in Figure 4.1.

> ? Forestil dig at disse nye biler er til salg som de bedste muligheder i hver bilklasse.
>
> *Forklaring af bilklasser:*
> - **Mini:** fx Toyota Aygo, Kia Picanto, Volkswagen Up
> - **Lille:** fx Peugeot 208, Toyota Yaris, Renault Zoe
> - **Mellem:** fx Ford Focus, Volkswagen Golf, Nissan Leaf
> - **Stor:** fx Ford Mondeo, Skoda Superb, Tesla 3
> - **Premium:** fx Mercedes E-klasse, Audi A6, Tesla S/X
> - **Luksus/Sport:** fx Mercedes S-klasse, BMW 7 serie, Audi A8

| Ny bil | Benzinbil | Benzinbil | Elbil | Elbil | Plug-in Hybrid | Plug-in Hybrid |
|---|---|---|---|---|---|---|
| Bilklasse | Medium | Stor | Medium | Stor | Medium | Stor |
| **Omkostninger** | | | | | | |
| Købspris | 250.000 kr. | 430.000 kr. | 300.000 kr. | 450.000 kr. | 225.000 kr. | 350.000 kr. |
| Kørselsomkostninger (Omkostninger per 10.000 km) | 1,19 kr / km (11.900 kr) | 1,37 kr / km (13.700 kr) | 0,68 kr / km (6.800 kr) | 0,56 kr / km (5.600 kr) | 1,27 kr / km (12.700 kr) | 1,11 kr / km (11.100 kr) |
| Årlige omkostninger (afgifter, service, forsikring) | 5.978 kr. | 9.083 kr. | 5.899 kr. | 8.881 kr. | 5.072 kr. | 7.529 kr. |
| **Beskrivelse af bilen** | | | | | | |
| Rækkevidde | 898 km | 1097 km | 450 km | 550 km | EL: 40 km Benzin: 600km | EL: 25 km Benzin: 600km |
| Acceleration (0-100km/t) | 14 sek | 12 sek | 5 sek | 11 sek | 5 sek | 9 sek |
| Bagagerum | Stort | Meget stort | Stort | Meget stort | Stort | Meget stort |
| $CO_2$ udledning | 91 g/km | 98 g/km | 33 g/km | 35 g/km | 138 g/km | 150 g/km |
| | | | | *Udledning er beregnet på basis af 70 % vedvarende energi* | | |
| **Infrastruktur** | | | | | | |
| Opladningsmuligheder nær hjemmet | | | Ladepunkt inden for 50m fra hjemmet Ledig 1 ud af 4 gange | | | |
| Distance opnået efter 10 min hurtig opladning | | | 35 km | 125 km | | |
| Distance mellem hurtigladere på hovedvejnetværket (min 50kW) | | | 90km | | | |
| **Hvilken bil ville du vælge i denne situation?** | ● | ● | ● | ● | ● | ● |

Figure 4.1: Choice task example with ICV, BEV, and PHEV for individuals who cannot charge at home.

## 4.5 Final design / Design Type

The designs were generated as efficient designs with zero priors. The reason for using efficient designs is that it allows restrictions on attribute levels for specific attributes. More specifically, for the infrastructure attributes, it was desired to keep levels constant across all (relevant) alternatives within each choice task. That is, if the nearest home charger is 400 meter away, it would be the same independent of the car being an BEV or PHEV. The reason for using zero priors is to maintain robustness of the design as much as possible (Walker et al. 2018/2019).

Each of the final four stated choice designs (listed in Table 3) contained 80 choice tasks. These were divided into 20 blocks of 4 choice tasks each. Hence, each respondent were presented with 2*4 choice scenarios, i.e. four choice scenario from design 1 followed by four choice scenarios from design 2. If home charging is available then they are presented with design 1 and 2 from the "House"-designs, while if home charging is not available they are presented with design 1 and 2 from the "Flat"-designs.

# 5.  Survey description

The coding and hosting of the survey was conducted by Epinion who has a professional setup for online data collections. However, as their standard tool could not handle the stated choice experiment, the users are redirected to another tool, called sawtooth, during the experiment.

The survey begins with an introduction page describing the overall objective of the study. Detailed information about the experiment and the other relevant information (e.g. GDPR) is already described in the invitation letter.

The respondent is asked to read the questions carefully before answering and is informed that it is possible to exit the interview and use the link again later to continue from where the session stopped.

The survey consists of four parts:
1. Intro questions (needed for customizing the SP scenarios)
2. Stated choice experiment
3. Background characteristics and car usage
4. Attitudinal statements

## 5.1  Part 1: Intro questions and customization
In this part of the survey, basic information for the respondent is collected. Some of this information is used for customizing of the stated choice experiment for each specific user. The sections begins with the following text:

*'In this part of the survey, we ask for information about your occupation and cars that you have access to in your household. Besides cars that you may own, this can also be a company car, a leased car, or a car that you often borrow from somebody else.'*

An overview of the survey questions included in this part are found in Table 4 below:

| ID | Description | Type | # categories |
|---|---|---|---|
| q1 | Primary occupation | Categorical | 17 |
| q2 | Car availability in household | Categorical | 5 |
| q2a | Description of cars in household | multiple | |
| | Car segment | Categorical | 6 |
| | Ownership type | Categorical | 7 |
| | Model year | integer | |
| | Propulsion | Categorical | 6 |
| q3 | Parking options at home | Categorical | 20 |
| q4 | Parking options at work | Categorical | 12 |
| q15 | Accessibility to charging at home | Categorical | 4 |
| q15a | Accessibility to charging at work | Categorical | 4 |

| q6 | Future car changes in household (replace existing, additional car or no changes) | Categorical | 3 |
|----|---|---|---|
| q6a | Description of next car in household | | |
| | Ownership type | Categorical | 7 |
| | Condition | Categorical | 3 |
| | Propulsion | Categorical | 6 |
| | Expected time for change | Categorical | 3 |
| q7 | Probability for each car segment | Multiple | 6x6 |

Table 4: Intro questions included in part 1.

q1 is about primary occupation and the categories are similar to the corresponding categories for the Danish National Travel Survey (TU). If a respondent selects a category that indicates that the respondent does not go to work, then following questions about charging at work are not presented. Subsequently, the respondent is asked to describe the available cars in the household. Question q2 is regarding the number of available cars and the answer can be one of the categories: 0, 1, 2, 3 or "more than 3". For each of the available cars, the respondent is now asked to indicate the car segment, type of ownership, model year and propulsion.

The parking opportunities at home and at work are asked in question q3 and q4. Note that work parking options are only asked if 'primary occupation' indicates that the respondent goes to work. We ask specifically for charging options at home and at work in q15 and q15a respectively. Here the respondent can indicate if a charger has already been installed at home or if it is possible or not. For charging at work, the respondent can indicate whether these are accessible and close to the work location.

In q6 the respondent is asked to indicate the likely next car purchase scenario in the household. It is possible to indicate "I will replace car X", "I will acquire another car" and "I do not have plans of acquiring a car". If "replace" is chosen, it is possible to indicate which one of the cars in the household are most likely to be replaced. In q6a, the respondent is asked to further describe the car. It is possible to define type of ownership, condition (new or used), propulsion and when this event will most likely take place.

Finally, for each car segment in the survey, the respondent is asked (q7) to indicate the likelihood that the next car in the household will belong to a given segment as seen in Figure 5.1. This is used to select the two car segments that will be included in the stated choice experiment. The cars with the highest likelihood will be included. In case of cars being equally likely, one of them will be randomly selected.

Figure 5.1: Question on relevance of car segments.

## 5.2 Part 2: Stated choice experiment

Right before the stated choice experiment, the respondent is presented with two pages of information. In the first page, it is stated that the respondent now proceeds to the second part where he/she will face a number of car options and that these options beside conventional cars, also include BEVs and PHEVs. Then follows a brief presentation of these technologies. On the second page, the respondent is reminded about the details for the most likely car purchase as indicated in part 1 and that he/she should pretend to be in that situation now.

After the introduction each respondent is presented with 2*4 stated choice tasks, in which the respondent is asked to select the option he/she would prefer in a real-life situation. As discussed previously, the first four choice tasks contains four alternatives (2 ICVs and 2 BEVs), while the subsequent four choice tasks contains 6 alternatives (2 ICVs, 2 BEVs, and 2 PHEVs). For individuals, who in question q15, indicated that they have (the possibility of installing) a home charger, the "House" main design was used. If on the contrary, they indicated that this is not possible, the "Flat" design was used.

## 5.3 Part 3: Background characteristics

After the stated choice experiment was completed, respondent and household characteristics were collected. In the sample data, we already have information about the age of the respondent, gender and home location.

| ID | Description | Type | # categories |
|---|---|---|---|
| q8x | Highest finished education | Categorical | 11 |
| q8a | Number of persons in household | Integer | |
| q8 | Description of other persons in household | | |
| | Relation | Categorical | 3 |
| | Gender | Categorical | 3 |
| | age group | Categorical | 12 |
| | Possession of driver's license | Categorical | 2 |
| q8_2 | Own possession of driver's license | Categorical | 2 |
| q9 | Annual household income before tax | Categorical | 12 |
| q10 | Annual mileage for each available car in household | Categorical | 7 |
| q11 | Frequence of purpose usage for each car | Multiple categories | 3x5 |
| q12 | Frequency of trip distances for each car | Multiple categories | 6x6 |

Table 5: Background questions included in part 3.

For each member of the household, we ask about the relation to respondent, gender, age group and driver's license status. Furthermore, for each car (current) in the household, we ask about the car usage, e.g. yearly mileage and frequency of trips for certain trip purpose.

## 5.4 Part 4: Attitudinal statements

The final part of the survey collects information based on attitudinal statements. The statements have been developed in previous research projects at DTU. The complete list of attitudinal statements are presented in Table 6. Respondents were asked to rate their agreement to each of the statements on a 1-5 Likert scale where 1=completely disagree, and 5=completely agree. The attitudinal statements are distributed randomly across three survey pages.

| ID | Attitude statements |
|---|---|
| 1 | The need for charging makes electric cars very unpractical for use in everyday life. |
| 2 | Ensuring that an electric car is always charged makes it inconvenient to use. |
| 3 | Using an electric car requires a careful planning of activities. |
| 4 | It is fun to drive an electric car. |
| 5 | The fast acceleration of an electric car is an exciting experience. |
| 6 | I'm fascinated by the technology of electric cars. |
| 7 | Electric cars are not suitable for my lifestyle. |
| 8 | My next car will be an electric car |
| 9 | Using an electric car for longer distances is difficult due to a lack of charging stations along the motorway. |

| 10 | An electric car is well suited to carry out my daily tasks. |
|----|----|
| 11 | The development of public incentives for electric cars is very unpredictable in Denmark/Sweden. |
| 12 | The resale value of electric cars is very unpredictable. |
| 13 | People who are important to me are considering to buy an electric car. |
| 14 | If I buy a car, I feel morally obliged to choose a car that minimises carbon emissions and air pollution. |
| 15 | I feel obliged to take environmental consequences of vehicle use into account when choosing a car. |
| 16 | People who are important to me think that electric cars should play an important role in our transport system. |
| 17 | People who are important to me think that my next car should be an electric car. |
| 18 | People who are important to me own an electric car. |
| 19 | When driving an electric car, I'm always (would always be) worried about running out of charge. |
| 20 | I (would) feel embarrassed when driving an electric car. |
| 21 | I (would) feel proud of having an electric car. |
| 22 | Driving an electric car expresses (my) openness for new technologies. |
| 23 | Driving an electric car is easily compatible with my habits. |
| 24 | Future political support for electric cars is very uncertain in Denmark/Sweden. |

Table 6: Full list of attitudinal statements presented to the respondents.

# 6.  Data description

The respondents were drawn randomly from the Danish population using the same sampling method as applied for the Danish National Travel survey. That is, CPR numbers are drawn randomly and invitations are sent via digital 'e-boks' invitations. For testing purposes of the survey, a pilot were launched in May 2020. In the pilot, 1496 invitations were send out. Of these, 222 were answered (response rate 14.8%). This test led to minor adjustments for the attribute levels for PHEV and a further presentation of the operation costs per 10,000 km as respondents did not seem to evaluate this costs realistically in the pilot. After initial validation of the responses from the revised survey, we launched the full sample in June 2020 in batches of 4000 invitations per day. Table 7 contains a full overview of sent invitations including the date and day of week.

|  | # | Date | Day | Invitations sent |
|---|---|---|---|---|
| Pilot | 1 | 2020-04-27 | Monday | 100 |
|  | 2 | 2020-05-04 | Monday | 100 |
|  | 3 | 2020-05-06 | Wednesday | 550 |
|  | 4 | 2020-05-19 | Tuesday | 745 |
| **Pilot total** |  |  |  | **1,495** |
| Final sample | 5 | 2020-06-08 | Monday | 1,000 |
|  | 6 | 2020-06-10 | Wednesday | 4,000 |
|  | 7 | 2020-06-15 | Monday | 4,000 |
|  | 8 | 2020-06-17 | Wednesday | 4,000 |
|  | 9 | 2020-06-18 | Thursday | 4,000 |
|  | 10 | 2020-06-19 | Friday | 4,209 |
|  | 12 | 2020-06-22 | Monday | 4,000 |
| **Sample total** |  |  |  | **25,209** |

Table 7: Schedule of survey invitations

In total 25,209 invitations were sent out for the main sample, and 2,961 responses were either completely or partially completed by 29 June, i.e. 10 days after the last invitations were sent out. This correspond to a response rate of 11.7% which is in line with expectations. **Error! Reference source not found.** presents some descriptive statistics comparing the full representative sample against the final sample of respondents. Overall the distribution of the respondents who answered the survey seems to match the distribution of the sample well. However, young individuals seems to be slightly underrepresented, while middle-aged and older individuals are slightly overrepresented. In addition, males are overrepresented and females are underrepresented slightly.
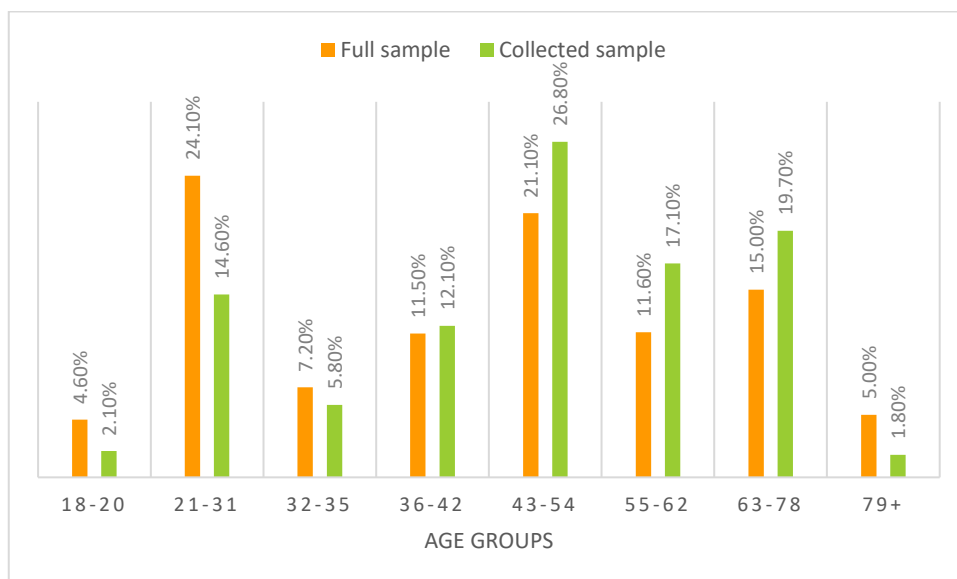
Figure 6.1: Comparison between full (representative sample) and final collected sample with respect to age.
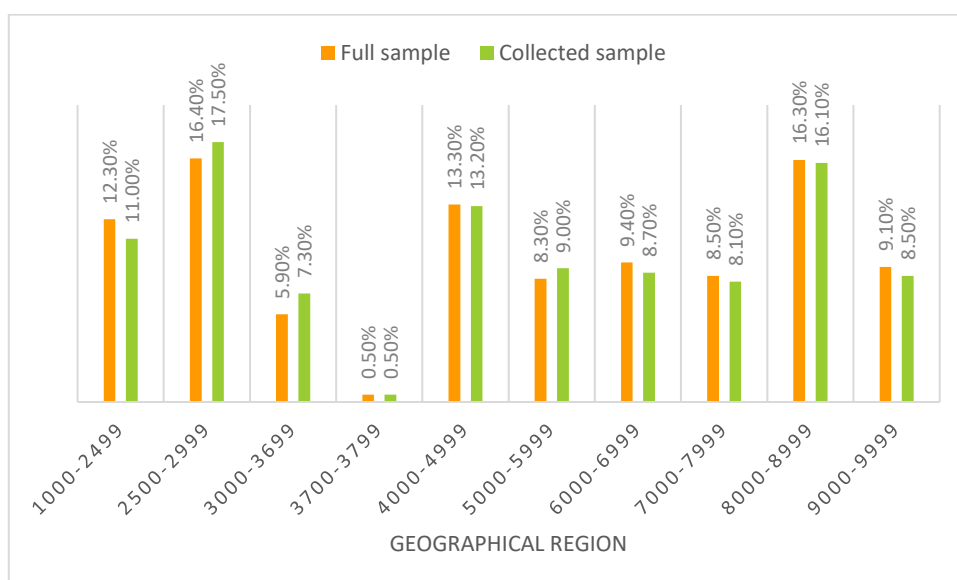


Figure 6.2: Comparison between full (representative sample) and final collected sample with respect to geographical region.

Figure 6.3: Comparison between full (representative sample) and final collected sample with respect to gender.

For home charging units, this is a question that was directly asked in the questioner and exist only for the final sample. A tabulation of the sample properties are provided in Appendix A.

| HOME CHARGING UNIT | Nobs | Pct. |
|---|---|---|
| Possible | 1586 | 53.6% |
| Not Possible | 1375 | 46.4% |

Table 8: Final share of home charging units

It is interesting to consider the share of households with home charging opportunities. Figure 4.1 and Table 8 shows that slightly more than half of the sample can charge at home (either because they have a home charger installed or because they have the possibility of installing one). Interestingly, one fifth of the sample do not know if it is possible to install a home charger (in which case they are presented with the "Flat"-design). It is possible this may represent people who share parking facilities with their neighbors and where no decision has been taken regarding the installation of charger facilities.
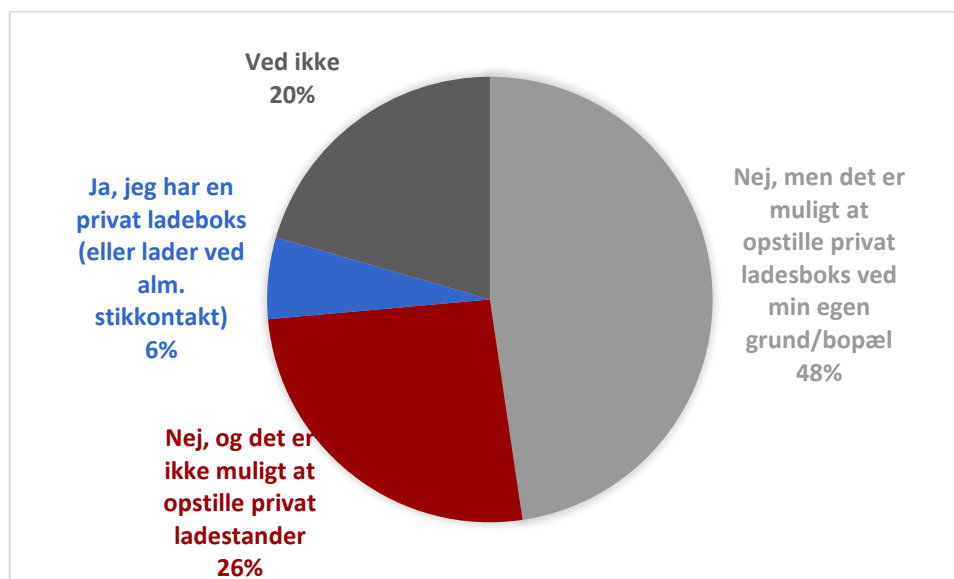
Figure 6.4: Charging possibilities at home.

Table 9 shows the sample shares across car types and car segments of the chosen alternatives in the scenarios. The choices seem to be fairly well distributed across both car segments and car types. For all car types, the highest market share is for medium sized cars. The distribution across car segments are fairly similar for design 1 and design 2.

| | MINI | LIL | MEL | STOR | PREM | LUK | Total |
|---|---|---|---|---|---|---|---|
| ICV | 6.50% | 9.23% | 15.22% | 6.65% | 3.65% | 0.79% | 42.03% |
| BEV | 5.30% | 6.69% | 17.39% | 9.20% | 2.79% | 0.58% | 41.94% |
| PHEV | 2.29% | 2.83% | 7.24% | 2.83% | 0.63% | 0.20% | 16.03% |
| Total | 14.09% | 18.74% | 39.85% | 18.67% | 7.07% | 1.57% | 100.00% |

Table 9: Sample shares across car types and car segments

Figure 6.5 shows the distribution of the propulsion technology within each of the four designs. As expected we see that the share of individuals choosing BEVs is higher for individuals who can charge at home compared to individuals who cannot.
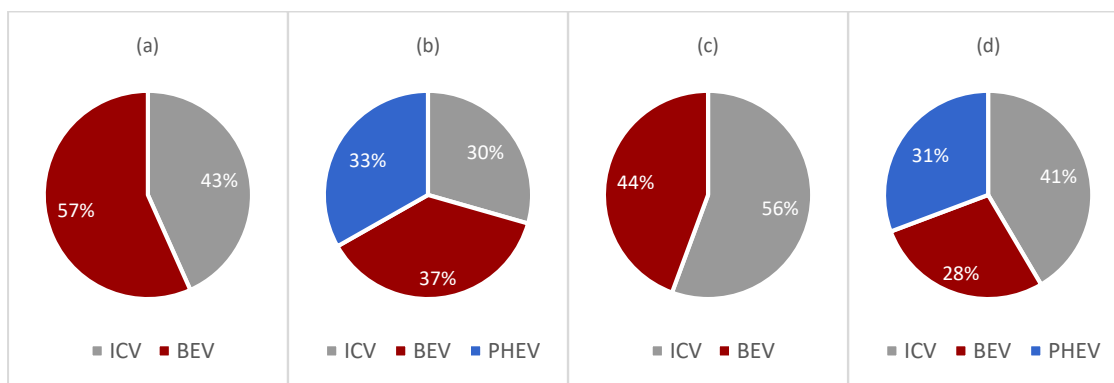
Figure 6.5: Stated "technology" market shares for each of the four design types: (a) House, 4 alternative, (b) House, 6 alternatives, (c) Apartment, 4 alternatives, (d) Apartment, 6 alternatives.

Finally, one key aspect of this study is to be able to capture the substitution effects across car segments. As previously mentioned, only two car segments were selected within each car type. Table 10 reveals that all possible combinations of car segments are present in the data. As expected, respondents mainly consider car segments that are next to each other, e.g. "small and medium" car segments. The most frequent combinations of car segments is "medium and large" (1554 occurrences in the sample), while the least frequent combination is "mini and luxury/sport" (38 occurrences in the sample).

|  | Mini | Small | Medium | Large | Premium | Luxury/sport |
|---|---|---|---|---|---|---|
| Mini |  | 815 | 312 | 184 | 66 | 38 |
| Small | 815 |  | 1216 | 208 | 110 | 98 |
| Medium | 312 | 1216 |  | 1554 | 240 | 158 |
| Large | 184 | 208 | 1554 |  | 570 | 132 |
| Premium | 66 | 110 | 240 | 570 |  | 220 |
| Luxury/sport | 38 | 98 | 158 | 132 | 220 |  |

Table 10: Overview of car segment combinations presented in the stated choice experiment.

# 7. Method

## 7.1 Choice theory

In order to model individual choices and estimate user preferences, we apply models based on random utility maximization, i.e. each individual is assumed to have a random utility function for each alternative, and individuals are assumed to choose the alternative with the highest utility.

The utility for individual $n$, alternative $i$, and choice task $t$ is given by:

$$U_{nti} = V_{nti} + \eta_{ni} + \varepsilon_{nti}$$

where $V_{nti}$ is the systematic part of the utility, $\eta_{ni}$ is a normally distributed error terms that account for panel effects for observations from the same respondents as well as unobserved heterogeneity among alternatives, and $\varepsilon_{nti}$ are IID extreme value type 1 error terms. This model is known as a mixed logit (ML) model. Following Train (2009), the choice probability that individual $n$ chooses alternatives $i = (i_1, \dots, i_t, \dots i_T)$ over $t$ choice tasks is given by:

$$P_{ni} = \int \prod_{t=1}^{T} \frac{\exp(V_{nti} + \eta_{ni})}{\sum_{j=1}^{J} \exp(V_{ntj} + \eta_{nj})} f(\eta) d\eta$$

The model is estimated by maximising the simulated likelihood based on the function:

$$LL = \sum_{n=1}^{N} \sum_{i=1}^{I} \ln(P_{ni}{}^{y_{ni}})$$

where $P_{ni}$ is approximated by simulation, $y_{in} = (y_{in1}, \dots, y_{inT})$ and $y_{in} = 1$ if alternative $i$, i.e. the series of alternatives in $i$, is chosen by individual $n$, 0 otherwise.

## 7.2 Utility specification

In the following, we specify the functional utility form for the choice model.

The full set of alternatives will consist of all combinations of three fuel types and six car segments. Therefore the model considers 18 alternatives as depicted in Figure 7.1. Note that the figure organizes fuel type at an upper level and segment at the lower level. This is only chosen to give an overview and does not necessarily represent the choice structures captured later in the final model.
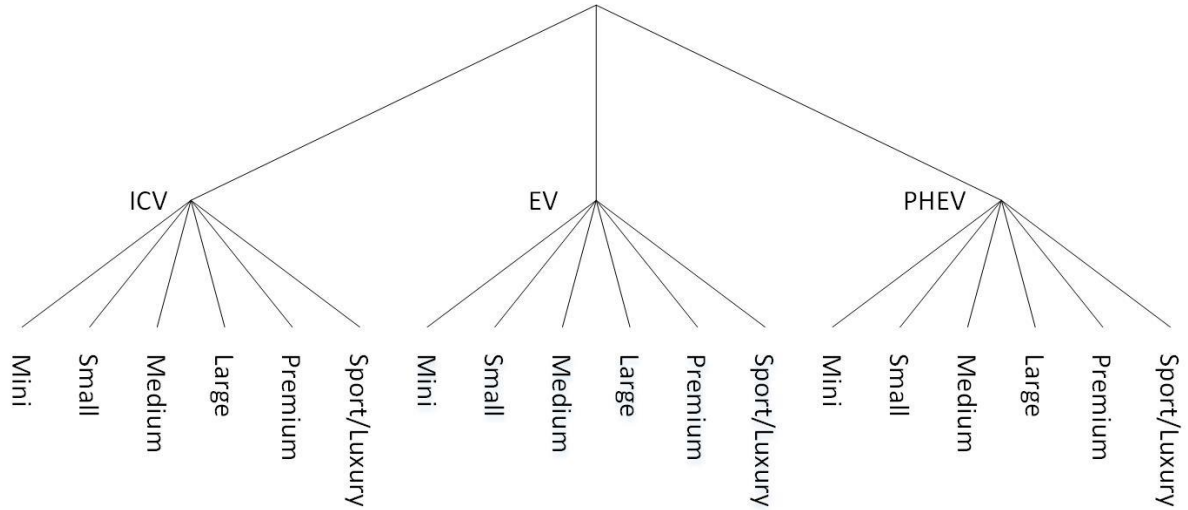
Figure 7.1: Choice structure for type and segment.

The basic utility function varies between different car types, e.g. BEV charging facilities are included for BEV, but not in ICV. Within car types, all car segments follow the same generic utility function. The utility functions for individual *n*, car type *i*={ICV, BEV, PHEV}, car segment *j*={mini, lille, mellem, stor, premium, luxury} in choice task *t* are defined as:

$$
\begin{aligned}
U_{nijt} = \; & ASC_i + \eta_{ni} && + ASC_j + \eta_{nj} \\
& + \beta^{PurchaseCost} && * PurchaseCost_{nijt} \\
& + \beta^{YearlyCost} && * YearlyCost_{nijt} \\
& + \beta^{OperationCost} && * OperationCost_{nijt} \\
& + \beta^{Acceleration} && * Acceleration_{nijt} \\
& + \beta_i^{BootSize,Medium} && * BootSize, Medium_{nijt} \\
& + \beta_i^{BootSize,Large} && * BootSize, Large_{nijt} \\
& + \beta_i^{BootSize,VeryLarge} && * BootSize, VeryLarge_{nijt} \\
& + \beta^{CO2} && * CO2_{nijt} \\
& + \beta_{BEV}^{Range} && * Range_{nijt} * BEV\_Dummy_{nijt} \\
& + \beta_{PHEV}^{\ln(Range)} && * \ln(Range_{nijt}) * PHEV\_Dummy_{nijt} \\
& + \beta_i^{HomeDistNearestCharger} && * HomeDistNearestCharger_{nijt} * (1 - ICV\_Dummy_{nijt}) \\
& + \beta_i^{HomeChargeAvailability} && * HomeChargerAvailability_{nijt} * (1 - ICV\_Dummy_{nijt}) \\
& + \beta_i^{PrHomeChDummy} && * PrHomeChDummy_n \\
& + \beta^{PublicChargingInfrastructure} && * PublicChargingInfrastructure_{nijt} * \\
& && Range\_Dummy_{nijt} * BEV\_Dummy_{nijt} \\
& + \beta^{PublicChargingSpeed} && * PublicChargingSpeed_{nijt} * BEV\_Dummy_{nijt}
\end{aligned}
$$

(brace: ICV, BEV, & PHEV) (brace: BEV & PHEV) (brace: BEV)

Where
- $ASC_i$ and $ASC_j$ are alternative specific constants for car type and segment respectively.
- $\eta_{ni}$ and $\eta_{nj}$ are normally distributed error components that captures correlation across repeated observations from the same respondent (panel effect) as well as correlation across car types and segments (substitution effects). $\sigma_{ii}$ and $\sigma_{jj}$ are the corresponding

parameters to be estimated. Note that each alternative include error components for all car types and segments (although several are normalized for theoretical identification).
- $BEV\_Dummy_{nijt}$ and $PHEV\_Dummy_{nijt}$ are dummy-indicators that are 1 if i=BEV and i=PHEV respectively, 0 otherwise.
- $PrHomeChDummy$ is a dummy-indicator which is 1 if respondents was presented with the "house" design, 0 otherwise. Thus dummy-indicator reflects if respondents have a private charger at home (or has the possibility to install one).
- $Range\_Dummy$ is a dummy-indicator which is 1 if the driving range <=200, 0 otherwise
- $HomeChargeAvailability$ is indicates how many times out of 4 the nearest (public) home charger is available when needed. In the model values 1,2,3, and 4 are used which correspond to a 25%, 50%, 75%, and 100% probability of the charger being available

The specification is advanced in the sense that is allows for panel correlation and unobserved correlation among alternatives. Some other considerations have been
- Cost should be generic across alternatives as specific cost coefficients would break the link to utility theory
- We do not allow for systematic heterogeneity, which would be possible. The only socio-economic characteristics included is the access to home charging.
- We have tested various non-linearities similar to Mabit and Fosgerau (2011) and Ziegler (2012).

# 8. Results and validation

## 8.1 Model estimation

This section presents results for the final ML model as specified in Section 7.2. Estimation results are presented in Table 11 and Table 12. The model contains 51 estimated parameters based on 23,674 observations from 2,961 respondents. To reduce the dimensionality of the model, we decompose the alternative specific constants into type and segment specific constants (using *ICV* and *Stor* as reference).

The model captures linear effects from the cost, car characteristics, and charging infrastructure attributes. It is seen that all parameters have the expected signs and are significant at a 1% level ($p < 0.01$).

In the work with the utility specification more advanced utility functions including non-linear effects and interaction effects has been explored, especially for the interaction between charging infrastructure and driving range. E.g. in the initial model estimated, the distance between fast charging stations was not significant at a 1% level ($p < 0.01$). This was likely due to an average effect of the battery size, where BEV owners with large batteries are less concerned about the infrastructure, while it might be more important for owners of smaller BEVs. Thus, in the final model, this attribute was only estimated for BEVs with a range of 200 km or below.

| Model summary | |
|---|---|
| **Number of estimated parameters**: | 51 |
| **Sample size**: | 2961 |
| **Observations**: | 23674 |
| **Final log likelihood**: | -22576.33 |
| **Akaike Information Criterion**: | 45254.66 |
| **Bayesian Information Criterion**: | 45560.32 |
| **Final gradient norm**: | 5.0452E-02 |
| **Number of draws**: | 1000 |
| **Algorithm**: | CFSQP |
| **Number of iterations**: | 107 |
| **Optimization time**: | 2 days, 1:12:28.970827 |

Table 11: Model summary

| Name | Unit | Value | Rob. Std err | Rob. t-test | Rob. p-value |
|---|---|---|---|---|---|
| **Alternative Specific Constants** | | | | | |
| ASC_BEV | | -3.4382 | 0.1929 | -17.8277 | 0.0000 |
| ASC_PHEV | | -2.3677 | 0.2564 | -9.2327 | 0.0000 |
| ASC_MINI | | 1.2000 | 0.3500 | 3.4283 | 0.0006 |
| ASC_LIL | | 0.1143 | 0.2349 | 0.4867 | 0.6264 |
| ASC_MEL | | 1.0741 | 0.1384 | 7.7630 | 0.0000 |
| ASC_PREM | | -0.3717 | 0.1863 | -1.9954 | 0.0460 |
| ASC_LUK | | -0.5671 | 0.4379 | -1.2950 | 0.1953 |
| **Cost Attributes** | | | | | |
| B_PurchaseCost | 1/DKK | -6.8740E-06 | 0.0407 | -16.8829 | 0.0000 |
| B_YearlyCost | 1/(DKK/year) | -1.2310E-04 | 0.0184 | -6.7014 | 0.0000 |
| B_OperationCost | 1/(DKK/km) | -0.5928 | 0.1021 | -5.8059 | 0.0000 |
| **Car Characteristics** | | | | | |
| B_Range_BEV | 1/km | 0.0031 | 0.0002 | 15.3159 | 0.0000 |
| B_Range_PHEV | 1/km | 0.3045 | 0.0526 | 5.7923 | 0.0000 |
| B_Acceleration | 1/(sec. to 100 km/t) | -0.0311 | 0.0054 | -5.8132 | 0.0000 |
| B_Size_MegetStor | | 0.5412 | 0.1062 | 5.0975 | 0.0000 |
| B_Size_Mellem | | 0.2465 | 0.0768 | 3.2090 | 0.0013 |
| B_Size_Stor | | 0.3438 | 0.1053 | 3.2666 | 0.0011 |
| B_CO2 | 1/(g/km) | -0.0032 | 0.0005 | -6.0410 | 0.0000 |
| **Charging Infrastructure** | | | | | |
| B_HomeDistNear | 1/m | -0.000473 | 0.0175 | -2.7079 | 0.0068 |
| B_HomeChAv | 1/(out of 4) | 0.3469 | 0.0337 | 10.2912 | 0.0000 |
| B_HomeCharDum_BEV | | 1.8806 | 0.1939 | 9.6979 | 0.0000 |
| B_HomeCharDum_PHEV | | 1.5600 | 0.1984 | 7.8622 | 0.0000 |
| B_ChInfra | 1/km | -0.0022 | 0.0712 | -3.1564 | 0.0016 |
| B_ChSpeed | 1/(km/10 min) | 0.0042 | 0.0005 | 9.0800 | 0.0000 |
| **Choleski factors** | | | | | |
| Sigma_BEV_BEV | | 3.9704 | 0.1088 | 36.4768 | 0.0000 |
| Sigma_PHEV_BEV | | 2.4414 | 0.1232 | 19.8156 | 0.0000 |
| Sigma_PHEV_PHEV | | 2.8902 | 0.0990 | 29.1975 | 0.0000 |
| Sigma_MINI_BEV | | 0.4396 | 0.3731 | 1.1784 | 0.2386 |
| Sigma_MINI_PHEV | | -1.0758 | 0.2298 | -4.6807 | 0.0000 |
| Sigma_MINI_MINI | | 8.3261 | 0.5133 | 16.2222 | 0.0000 |
| Sigma_MINI_PREM | | -3.3518 | 0.3939 | -8.5089 | 0.0000 |
| Sigma_MINI_LUK | | 2.3327 | 0.2738 | 8.5184 | 0.0000 |
| Sigma_LIL_BEV | | -0.1728 | 0.3388 | -0.5099 | 0.6101 |
| Sigma_LIL_PHEV | | -0.6592 | 0.2442 | -2.6990 | 0.0070 |
| Sigma_LIL_MINI | | 5.4140 | 0.3202 | 16.9092 | 0.0000 |
| Sigma_LIL_LIL | | 2.2521 | 0.4092 | 5.5034 | 0.0000 |
| Sigma_LIL_PREM | | -2.8264 | 0.5190 | -5.4455 | 0.0000 |
| Sigma_LIL_LUK | | 1.4465 | 0.3679 | 3.9324 | 0.0001 |
| Sigma_MEL_BEV | | -0.0125 | 0.1344 | -0.0931 | 0.9258 |
| Sigma_MEL_PHEV | | -0.1105 | 0.1065 | -1.0376 | 0.2995 |
| Sigma_MEL_MINI | | 2.3869 | 0.2606 | 9.1579 | 0.0000 |
| Sigma_MEL_LIL | | 1.2921 | 0.4217 | 3.0636 | 0.0022 |
| Sigma_MEL_MEL | | -0.3016 | 0.2474 | -1.2194 | 0.2227 |
| Sigma_MEL_PREM | | -0.6065 | 0.2299 | -2.6385 | 0.0083 |
| Sigma_MEL_LUK | | 0.6190 | 0.3313 | 1.8685 | 0.0617 |
| Sigma_PREM_BEV | | -0.0847 | 0.1968 | -0.4305 | 0.6668 |
| Sigma_PREM_PHEV | | -0.0485 | 0.2069 | -0.2344 | 0.8146 |
| Sigma_PREM_PREM | | 2.5605 | 0.1952 | 13.1173 | 0.0000 |
| Sigma_LUK_BEV | | -0.2397 | 0.5443 | -0.4404 | 0.6596 |
| Sigma_LUK_PHEV | | 0.2396 | 0.2950 | 0.8122 | 0.4167 |
| Sigma_LUK_PREM | | -2.4593 | 0.4869 | -5.0507 | 0.0000 |
| Sigma_LUK_LUK | | 4.9098 | 1.0589 | 4.6367 | 0.0000 |

Table 12: Estimation results based on a mixed logit model with error components and linear attribute effects.

The specification for driving range is obtained from several tests with both generic and alternative specifications across BEV and PHEV. As such, a technology generic specification would be preferable, but since driving range has rather different meaning for the two alternatives, it makes sense to keep them alternative specific. Indeed, for BEV, the user is highly dependent on the provided driving range on electricity, while for the PHEV user, it is possible to continue on the driving range provided by the fossil fuel engine. As seen in Figure 8.1, the best specification was obtained with a ln specification for PHEV while a linear specification was obtained for BEV.
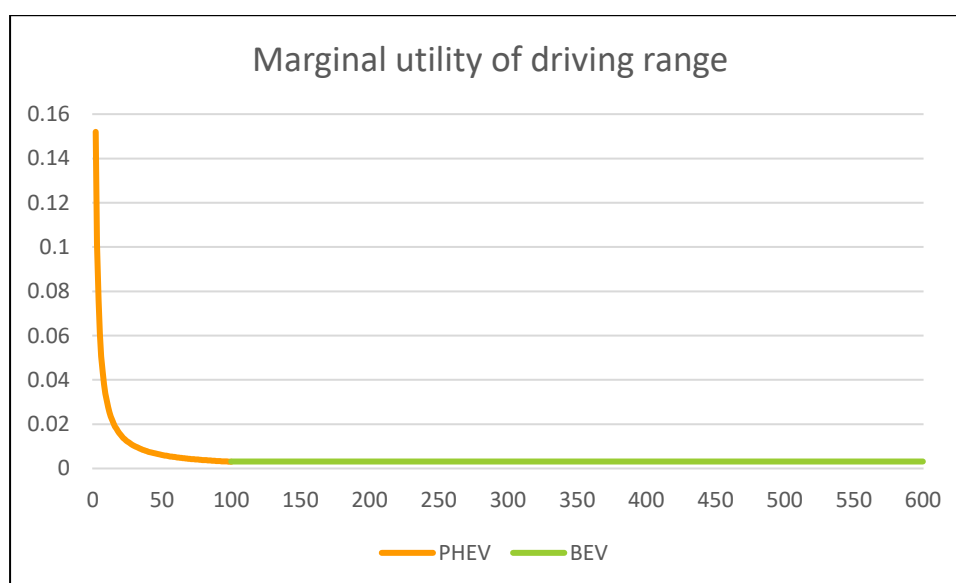


Figure 8.1: Marginal utility of driving range.

Note that the model includes several coefficients for error components (In the table named "Sigma"). The parameters are estimated on the base of normally distributed error terms. The naming convention indicates to which utility function the parameters belong as well as which normal distribution it is based on. The name convention has the following structure: Sigma_X_Y. This indicates that the parameter is included in the utility function of X, where it is multiplied to the draws belong to the normal distribution Y. The coefficients correspond to the Choleski factor of the Variance-Covariance matrix among the error components.

## 8.2   Variance-Covariance Matrix (substitution effects)

In order to interpret the substitution effects related to the Sigma-parameters, we compute the associated Variance-covariance matrix and the corresponding correlation matrix, see Table 13 and Table 14, based on Choleski factors. The following can be noted:
- BEV and PHEV have a positive substitution compared to ICV.
- BEV and MINI have a positive substitution compared to ICV STOR.
- PREM have a negative substitution with respect to MINI, LIL, MEL, and LUK compared to STOR. The latter is somewhat surprising.
- The substitution between MINI, LIL, and MEL is high.

| Var-Covar | BEV | PHEV | PREM | LUK | MINI | LIL | MEL |
|---|---|---|---|---|---|---|---|
| BEV | 15.761 | 9.687 | -0.336 | -0.953 | 1.747 | -0.687 | -0.050 |
| PHEV | 9.687 | 14.306 | -0.347 | 0.108 | -2.048 | -2.327 | -0.351 |
| PREM | -0.336 | -0.347 | 6.563 | -6.289 | -8.561 | -7.198 | -1.545 |
| LUK | -0.953 | 0.108 | -6.289 | 30.275 | 19.317 | 13.965 | 4.506 |
| MINI | 1.747 | -2.048 | -8.561 | 19.317 | 87.400 | 58.560 | 23.495 |
| LIL | -0.687 | -2.327 | -7.198 | 13.965 | 58.560 | 44.906 | 18.520 |
| MEL | -0.050 | -0.351 | -1.545 | 4.506 | 23.495 | 18.520 | 8.230 |

Table 13: Variance-Covariance-matrix. Positive substitution pattern (with respect to "Stor ICV") marked in blue, while negative substitution is marked in red.

| Correlation | BEV | PHEV | PREM | LUK | MINI | LIL | MEL |
|---|---|---|---|---|---|---|---|
| BEV | 1 | 0.645 | -0.033 | -0.044 | 0.047 | -0.026 | -0.004 |
| PHEV | 0.645 | 1 | -0.036 | 0.005 | -0.058 | -0.092 | -0.032 |
| PREM | -0.033 | -0.036 | 1 | -0.446 | -0.357 | -0.419 | -0.210 |
| LUK | -0.044 | 0.005 | -0.446 | 1 | 0.376 | 0.379 | 0.285 |
| MINI | 0.047 | -0.058 | -0.357 | 0.376 | 1 | 0.935 | 0.876 |
| LIL | -0.026 | -0.092 | -0.419 | 0.379 | 0.935 | 1 | 0.963 |
| MEL | -0.004 | -0.032 | -0.210 | 0.285 | 0.876 | 0.963 | 1 |

Table 14: Correlation-matrix. Positive substitution pattern (with respect to "Stor ICV") marked in blue, while negative substitution is marked in red.

## 8.3 Predicted market shares

The model is also validated by calculating the average predicted market shares which is presented in Table 15. As seen they correspond very well with the sample shares presented earlier in Table 9. However, the sample shares in a choice experiment do not necessarily correspond to real market situation, which is also clear in the current study. Thus, a calibration is needed.Table 15: Predicted market shares from the model.

| | MINI | LIL | MEL | STOR | PREM | LUK | Total |
|---|---|---|---|---|---|---|---|
| ICV | 7.24% | 9.13% | 15.95% | 6.46% | 3.29% | 0.66% | 42.72% |
| BEV | 5.10% | 6.74% | 16.92% | 9.00% | 3.07% | 0.70% | 41.52% |
| PHEV | 2.53% | 3.01% | 6.54% | 2.60% | 0.79% | 0.29% | 15.76% |
| Total | 14.86% | 18.88% | 39.41% | 18.06% | 7.14% | 1.65% | 100.00% |

Table 15: Predicted market shares from the model.

## 8.4  Willingness to pay

We derive willingness-to-pay (WTP) measures for the various attributes as the trade-off between the marginal utility of each attribute and the marginal utility of money related to purchase price. For a few attributes this depends on the attribute. In that case we calculate the value for each individual in the sample and average the values. The resulting WTPs are presented in Table 16.

| WTP | Unit | Mean | 90% confidence interval | |
| --- | --- | --- | --- | --- |
| | | | Lower bound | Upper bound |
| Yearly Cost | [DKK/(DKK/year)] | 17.91 | 13.66 | 23.94 |
| Operation Cost | [DKK/(DKK/KM)] | 86,235.38 | 56,291.73 | 119,999.69 |
| Range: BEV | [DKK/KM] | 457.20 | 399.26 | 539.65 |
| Range: PHEV (all segments) | [DKK/KM] | 1,066.10 | 699.55 | 1,394.05 |
| Acceleration | [DKK/sec.] | 4,531.05 | 2,545.28 | 5,955.25 |
| Boot Size: Mellem | [DKK/(size min)] | 35,862.60 | 32,418.79 | 40,640.94 |
| Boot Size: Stor | [DKK/(size min)] | 50,016.77 | 45,213.77 | 56,681.01 |
| Boot Size: Meget Stor | [DKK/(size min)] | 78,738.03 | 71,176.99 | 89,229.10 |
| CO2 | [DKK/(g/KM)] | 460.77 | 302.71 | 588.43 |
| Home Distance Nearest Charger: (BEV + PHEV) | [DKK/m] | 68.77 | 23.89 | 126.20 |
| Home Charging Availability: (BEV + PHEV) | [DKK] | 50,461.16 | 40,431.74 | 60,969.26 |
| Charging Infrastructure (BEV) | [DKK/KM] | 226.10 | 62.69 | 370.39 |
| Charging Speed (BEV) | [DKK/(KM/10 min)] | 612.58 | 478.82 | 788.84 |

Table 16: WTP measures for attributes with respect to purchase price.

The WTP measures in Table 16 all have the expected signs.
- There are two WTP measures related to range. The results show that WTP for extending a PHEV range by 1 km is higher than the WTP for BEV range. We have implicitly assumed that the WTP for ICVs is equal to zero. A previous Danish study (Mabit and Fosgerau 2011) estimated an average WTP of 105 DKK/km for a generic log specification evaluated at 685 km. While this was a slightly different sample collected in 2007-08, the figures are comparable.
- Concerning, acceleration the results also agree with the previous study where WTP for acceleration was found to be 4531 DKK/SEC.
- Yearly cost is evaluated higher in the present study at 17.9 DKK/(DKK/year). The earlier study Mabit and Fosgerau (2011) estimated a value of 4 DKK/(DKK/year). However, the yearly cost variable in the previous study also included operating costs (recalculated to yearly cost) based on individual driving expectations, which could partly explain the difference. However, when compared with Greene (2010), the value of 17.9 DKK/(DKK/Year) is considered high.
- The WTP for operating costs at 86,235 DKK/(DKK/km) indicates that a person that does not depreciate future expenditures is willing to pay 86,235 DKK for a saving of 1 DKK/km. This means that the person has a break-even point at 86,235 km. This is

lower than previous RP studies base on Danish data (Arnberg et al. 2008) who estimate 317,000 km as break-even point, and Mabit (2014) who estimate a value of 308,000 to 436,000 km). However, as both of these studies are based on respondents who only buy new cars, it makes sense that they are somewhat higher. It may also likely depend on the fuel price at the time of collecting the study. Today, the fuel price has been low for several years and expectations might be that this continues.

- The WTP for CO2 indicates that a person driving 15,000 km per year for 10 years in the same car has a WTP of 69.2 DKK per ton CO2 (as 461*0.15=71).
- On average, the respondents are willing to pay resp. DKK 35,863, 50,017 and 78,738 for a boot size of medium, large and very large compared to a small boot.
- For BEVs with a driving range of 200km or less, the respondents are willing to pay 226 DKK for each reduced km between fast chargers at the main road network.
- Charging speed is evaluated at 613 DKK for reach extra km obtained from 10 minutes of charging.

## 8.5 Elasticities

To further validate the model we compute elasticities for selected key attributes. An elasticity is a measure of model sensitivity to changes in attributes. More specifically, the elasticity measures the percentage change in demand as a percentage change in and attribute, and can be calculated (approximately) as:

$$E_{x_{ij}}^{nij} = \frac{\left(P_{nij}^{new} - P_{nij}^{old}\right)/P_{nij}^{old}}{\left(x_{nij}^{new} - x_{nij}^{old}\right)/x_{nij}^{old}}$$

We simulate elasticities by increasing attribute x by 10%, and calculate elasticities as:

$$E_{x_{ij}}^{nij} = \frac{\left(P_{nij}^{new} - P_{nij}^{old}\right)/P_{nij}^{old}}{(110\% - 100\%)/100\%} = \frac{P_{nij}^{new} - P_{nij}^{old}}{P_{nij}^{old}} * 10$$

In the following we present elasticities for purchase price and driving range. We present the full 18x18 matrix containing all alternative as well as some aggregated matrices containing demand elasticities for car type ($E_{x_i}^i$) and car segments ($E_{x_j}^j$). This is to ease interpretation and to make it more straightforward to comparison with existing literature (as few studies captures substitution between both car types and segments). Table 23 (in the Appendix B) presents the full elasticities for all alternatives, while Table 17 presents the aggregated elasticities for car types and Table 18 presents the aggregated elasticities for car segments.

| Attribute | Elast: ICV | Elast: BEV | Elast: PHEV |
|---|---|---|---|
| Purchaseprice: ICV | -0.519 | 0.264 | 0.290 |
| Purchaseprice: BEV | 0.264 | -0.594 | 0.352 |
| Purchaseprice: PHEV | 0.265 | 0.322 | -0.673 |
| Range: ICV | N/A | N/A | N/A |
| Range: BEV | -0.149 | 0.325 | -0.194 |
| Range: PHEV | -0.039 | -0.048 | 0.093 |

Table 17: Direct and cross elasticities for car types

| Attribute | Elast: MINI | Elast: LIL | Elast: MEL | Elast: STOR | Elast: PREM | Elast: LUK |
|---|---|---|---|---|---|---|
| **Purchaseprice: MINI** | **-0.022** | 0.027 | 0.005 | 0.003 | 0.001 | 0.001 |
| **Purchaseprice: LIL** | 0.025 | **-0.104** | 0.043 | 0.006 | 0.003 | 0.005 |
| **Purchaseprice: MEL** | 0.01 | 0.077 | **-0.139** | 0.189 | 0.025 | 0.018 |
| **Purchaseprice: STOR** | 0.006 | 0.009 | 0.088 | **-0.349** | 0.113 | 0.019 |
| **Purchaseprice: PREM** | 0.002 | 0.005 | 0.011 | 0.053 | **-0.221** | 0.027 |
| **Purchaseprice: LUK** | 0.001 | 0.004 | 0.004 | 0.007 | 0.017 | **-0.207** |
| **Range: MINI** | **0.006** | -0.007 | -0.002 | -0.001 | 0 | 0 |
| **Range: LIL** | -0.007 | **0.031** | -0.013 | -0.002 | -0.001 | -0.002 |
| **Range: MEL** | -0.003 | -0.022 | **0.038** | -0.053 | -0.007 | -0.005 |
| **Range: STOR** | -0.001 | -0.002 | -0.02 | **0.074** | -0.022 | -0.004 |
| **Range: PREM** | 0 | -0.001 | -0.002 | -0.008 | **0.032** | -0.004 |
| **Range: LUK** | 0 | 0 | 0 | 0 | -0.001 | **0.016** |

Table 18: Direct and cross elasticities for car segments

The elasticities all seems plausible and have expected signs. When looking at the elasticities across fuel types we see that the own price elasticities are of similar size. We also note that BEVs have more substitution to PHEVs than ICVs, and that the opposite is also true, i.e. PHEVs have more substitution to BEVs than ICVs. Concerning the range elasticities across fuel types, the own range elasticity is much higher for BEVs than for PHEVs, which make sense as BEVs are more dependent on range.

Concerning elasticities split on segments, we see that own price elasticities vary partly due to market shares but also that large cars seem to be most sensitive to own price. It is also apparent that neighbouring segments have higher cross price elasticities as would be expected. The range elasticities are numerically much smaller, which highlight that while range is important to vehicle choices its overall influence on vehicle choice is much lower than the effect of purchase price. Again the pattern that neighbouring segments are most affected by changes in a specific segment appears in the results.

It is generally difficult to compare with literature as there exist very few studies with a similar setup. Most SP studies focus on vehicle choice conditional on segment, e.g. Mabit (2011), Fjendbo et al. (2013). Exceptions to this are Hess et al. (2012) but they do not present any elasticity calculations.
There are several things to note about the elasticities. First, they are calculated on the choice sets incorporated in the SP data. This means that substitution is not only affected by the final model but also by the two car segments that each respondent considered. Therefore the elasticities might change when applied in a context with a full choice set. Given that the elasticities will be affect irrespective of this when applied in another context with different attribute levels and market shares we have decided to present the elasticities in the SP context only. Second, the overall scale of the error term in a discrete choice model is never separately identified. This means that the overall scale of the elasticities is dependent on the hypothetical

nature of the SP, which may not reflect how the scale would have been in a RP setting. So in principle we have only found the relative sizes of elasticities, i.e. the patterns identified above are valid, whereas they might need an common scaling to adjust the model to the real world.

It would be possible to settle this scaling issue if we had earlier studies based on RP data that presented elasticities. The main problem is that only few studies present elasticities and that these elasticities depend on the definition of choice alternative. An example is Cambridge Econometrics (2008) who establish elasticities that are numerically much larger than ours. This is natural and cannot be used for scaling as their analysis is based on much more disaggregated vehicle types, which again lead to higher elasticities.

# 9. Conclusion

This report document work that relates to data collection and model estimation for the ELISA project. The overall goal for ELISA is to support the development of a model that can predict market shares for conventional as well as electric and plug-in hybrids in future scenarios.

A specific aim has been to update the data foundation to facilitate the estimation of such model and predict vehicle demand by fuel type across segments. The report includes the estimation of this model and present the relevant parameters.

A stated choice experiment that use an efficient design and include a series of relevant attributes describing battery electric cars, plug-in hybrid cars as well as conventional gasoline and diesel cars was developed. The experiment was distributed to a random sample of 26,704 respondents of which 2961 answered. This resulted in a total of 23,674 choice task observations.

In order for the respondent to be able to relate to the presented scenarios and make the stated choice experiment as realistic as possible, the design was customized to respondents. Such customization included that the most likely future car purchase (as asked about) is used as a mean to pivot the design with respect to this reference value. Hence, the SP introduce relative changes with respect to the reference value. As changes in levels for attributes for specific car types or segments can result in substitution effects between car types or segments, the two (out of six in total) most relevant car segments for each respondent were included in the experiment. Based on an extensive literature review, the developed experiment included attributes specifically relevant for BEV and PHEV, such as driving specific attributes, pollution and charging. The survey took into account that not all respondents have access to charging at a dedicated parking spot when parked at home (e.g. respondents living in apartments) and that not all attributes are relevant for all car types included in the experiment (e.g. BEV charging infrastructure is not relevant for conventional gasoline and diesel cars).

A final model has been estimated while DTU and ENS have had an ongoing correspondence about the further development of the specification and the implementation of the forecasting model. The final model is a mixed logit model that for each individual assigns probabilities to

each of the 18 alternatives. Consumers are on average willing to pay 1066 DKK per extra km of driving range for a PHEV and 457 DKK/km for a BEV.. The preference for driving range for PHEV was found to be non-linearwhereas the preference for driving range for BEV was found to be linear. The model furthermore indicate a significant effect for other car performance attributes such as acceleration, carbon emissions and boot-size.

Finally, plausible results are obtained for the charging infrastructure. A consumer would pay 613 DKK for each extra km obtained from 10 minutes of charging. Despite several tests, it was not possible to find a non-linear specification that explains behavior with regard to charging speed better. When charging at home for a respondent that does not have a private parking spot, the respondent would be willing to pay 69 DKK for each meter closer to home from the charging location and 50,000 DKK for each extra 25% of availability probability of this charging location. The model only indicated a significant effect of a more dense network of fast chargers for BEVs with a driving range of 200km or less. It might be because the maximum distance used in the experiment (120 km) is sufficiently low so that this is never really an issue for BEVs with high driving range above 200km.

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# 10. Appendix A

|  | SAMPLE 26704 | | FINAL RESPONSE 2961 | |
|---|---|---|---|---|
| AGE | count | Percent | count | percent |
| 18-20 | 1220 | 4.6% | 62 | 2.1% |
| 21-31 | 6425 | 24.1% | 432 | 14.6% |
| 32-35 | 1914 | 7.2% | 171 | 5.8% |
| 36-42 | 3077 | 11.5% | 359 | 12.1% |
| 43-54 | 5629 | 21.1% | 793 | 26.8% |
| 55-62 | 3095 | 11.6% | 507 | 17.1% |
| 63-78 | 4014 | 15.0% | 583 | 19.7% |
| 79+ | 1330 | 5.0% | 54 | 1.8% |
| | | | | |
| GENDER | | | | |
| Male | 13359 | 50.0% | 1618 | 54.6% |
| Female | 13345 | 50.0% | 1343 | 45.4% |
| | | | | |
| POSTAL CODE | | | | |
| 1000-2499 | 3275 | 12.3% | 327 | 11.0% |
| 2500-2999 | 4383 | 16.4% | 518 | 17.5% |
| 3000-3699 | 1566 | 5.9% | 217 | 7.3% |
| 3700-3799 | 137 | 0.5% | 14 | 0.5% |
| 4000-4999 | 3554 | 13.3% | 390 | 13.2% |
| 5000-5999 | 2229 | 8.3% | 266 | 9.0% |
| 6000-6999 | 2515 | 9.4% | 259 | 8.7% |
| 7000-7999 | 2262 | 8.5% | 239 | 8.1% |
| 8000-8999 | 4359 | 16.3% | 478 | 16.1% |
| 9000-9999 | 2424 | 9.1% | 253 | 8.5% |
| | | | | |
| HOME CHARGING UNIT | | | | |
| Possible | | | 1586 | 53.6% |
| Not Possible | | | 1375 | 46.4% |

Table 19: Sample characteristics compared against invitations.

# 11. Appendix B

| | Levels | Purchase price [DKK] | | | Yearly cost [DKK/Year] | | | Fuel costs [DKK/km] | | | Range [km] | | | Acceleration [sec] | | | Boot size ICV/BEV/PHEV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ICV | BEV | PHEV | ICV | BEV | PHEV | ICV | BEV | PHEV | ICV | BEV | PHEV | ICV | BEV | PHEV | |
| Mini | 1 | 84,000 | 90,000 | 84,000 | 3,458 | 3,610 | 3,500 | 0.81 | 0.49 | 0.75 | 735 | 100 | 20 | 10 | 7 | 7 | Small |
| | 2 | 100,000 | 100,000 | 120,000 | 3,891 | 4,061 | 4,000 | 0.91 | 0.55 | 0.85 | 812 | 130 | 40 | 12 | 9 | 9 | Small |
| | 3 | 120,000 | 125,000 | 135,000 | 4,323 | 4,512 | 4,500 | 1.01 | 0.61 | 0.95 | 855 | 180 | 60 | 14 | 11 | 11 | Small |
| | 4 | 145,000 | 160,000 | 150,000 | 4,755 | 4,963 | 5,000 | 1.11 | 0.67 | 1.05 | 898 | 230 | 80 | 16 | 13 | 13 | Small |
| Small | 1 | 150,000 | 180,000 | 160,000 | 4,300 | 4,441 | 4,385 | 0.88 | 0.51 | 0.85 | 735 | 180 | 20 | 10 | 6 | 6 | Small |
| | 2 | 165,000 | 200,000 | 180,000 | 4,837 | 4,997 | 4,933 | 0.99 | 0.57 | 0.95 | 898 | 250 | 40 | 12 | 8 | 8 | Small |
| | 3 | 185,000 | 220,000 | 200,000 | 5,375 | 5,552 | 5,482 | 1.11 | 0.63 | 1.06 | 997 | 350 | 60 | 14 | 10 | 10 | Medium |
| | 4 | 200,000 | 240,000 | 220,000 | 5,912 | 6,107 | 6,030 | 1.22 | 0.70 | 1.16 | 1097 | 450 | 80 | 16 | 12 | 12 | Medium |
| Medium | 1 | 210,000 | 245,000 | 225,000 | 4,783 | 4,719 | 4,509 | 0.95 | 0.55 | 0.93 | 735 | 180 | 20 | 10 | 5 | 5 | Medium |
| | 2 | 250,000 | 260,000 | 250,000 | 5,381 | 5,309 | 5,072 | 1.07 | 0.62 | 1.04 | 898 | 300 | 40 | 12 | 7 | 7 | Large |
| | 3 | 287,500 | 275,000 | 287,500 | 5,978 | 5,899 | 5,636 | 1.19 | 0.68 | 1.16 | 997 | 450 | 60 | 14 | 9 | 9 | Large |
| | 4 | 325,000 | 300,000 | 325,000 | 6,576 | 6,489 | 6,200 | 1.30 | 0.75 | 1.27 | 1097 | 550 | 80 | 16 | 11 | 11 | Extra Large |
| Large | 1 | 350,000 | 310,000 | 350,000 | 7,267 | 7,104 | 6,692 | 1.00 | 0.56 | 0.99 | 735 | 250 | 25 | 8 | 5 | 5 | Large |
| | 2 | 430,000 | 350,000 | 430,000 | 8,175 | 7,992 | 7,529 | 1.12 | 0.63 | 1.11 | 898 | 350 | 50 | 10 | 7 | 7 | Large |
| | 3 | 470,000 | 450,000 | 502,500 | 9,083 | 8,881 | 8,366 | 1.25 | 0.70 | 1.23 | 997 | 450 | 75 | 12 | 9 | 9 | Extra Large |
| | 4 | 500,000 | 500,000 | 575,000 | 9,992 | 9,769 | 9,202 | 1.37 | 0.77 | 1.36 | 1097 | 550 | 100 | 14 | 11 | 11 | Extra Large |
| Premium | 1 | 510,000 | 510,000 | 580,000 | 10,166 | 11,511 | 9,955 | 1.04 | 0.69 | 1.12 | 735 | 285 | 25 | 6 | 4 | 4 | Extra Large |
| | 2 | 550,000 | 540,000 | 650,000 | 11,437 | 12,950 | 11,199 | 1.17 | 0.77 | 1.26 | 898 | 350 | 50 | 8 | 6 | 6 | Extra Large |
| | 3 | 575,000 | 575,000 | 750,000 | 12,708 | 14,389 | 12,444 | 1.30 | 0.86 | 1.40 | 997 | 450 | 75 | 10 | 8 | 8 | Extra Large |
| | 4 | 600,000 | 700,000 | 800,000 | 13,979 | 15,827 | 13,688 | 1.43 | 0.94 | 1.54 | 1097 | 600 | 100 | 12 | 10 | 10 | Extra Large |
| Luksus/Sport | 1 | 1,000,000 | 1,000,000 | 1,000,000 | 10,114 | 11,511 | 9,955 | 1.40 | 0.72 | 1.30 | 735 | 285 | 25 | 6 | 3 | 3 | Extra Large |
| | 2 | 1,200,000 | 1,200,000 | 1,200,000 | 11,379 | 12,950 | 11,199 | 1.58 | 0.81 | 1.47 | 898 | 350 | 50 | 8 | 5 | 5 | Extra Large |
| | 3 | 1,400,000 | 1,400,000 | 1,400,000 | 12,643 | 14,389 | 12,444 | 1.76 | 0.90 | 1.63 | 997 | 450 | 75 | 10 | 7 | 7 | Extra Large |
| | 4 | 1,600,000 | 1,600,000 | 1,600,000 | 13,907 | 15,827 | 13,688 | 1.93 | 0.99 | 1.79 | 1097 | 600 | 100 | 12 | 10 | 10 | Extra Large |

Table 20: Examples of car models currently available for the different car types and segments

| | Levels | Carbon emissions [g/km] | | | Distance to home charging [m] | Home charge availability [Available out of 4 times] | Dist. between fast chargers [km] | Max charging speed [km/10min] |
|---|---|---|---|---|---|---|---|---|
| | | BEV | ICV | PHEV | BEV/PHEV | BEV/PHEV | BEV | BEV |
| Mini | 1 | 0 | 70 | 70 | 50 | 1 | 30 | 35 |
| | 2 | 13 | 100 | 100 | 300 | 2 | 60 | 75 |
| | 3 | 25 | 115 | 115 | 450 | 3 | 90 | 100 |
| | 4 | 50 | 130 | 130 | 600 | 4 | 120 | 150 |
| Small | 1 | 0 | 84 | 77 | 50 | 1 | 30 | 35 |
| | 2 | 15 | 120 | 110 | 300 | 2 | 60 | 75 |
| | 3 | 30 | 138 | 127 | 450 | 3 | 90 | 100 |
| | 4 | 60 | 156 | 143 | 600 | 4 | 120 | 150 |
| Medium | 1 | 0 | 91 | 84 | 50 | 1 | 30 | 35 |
| | 2 | 17 | 130 | 120 | 300 | 2 | 60 | 75 |
| | 3 | 33 | 150 | 138 | 450 | 3 | 90 | 100 |
| | 4 | 65 | 169 | 156 | 600 | 4 | 120 | 150 |
| Large | 1 | 0 | 98 | 91 | 50 | 1 | 30 | 60 |
| | 2 | 18 | 140 | 130 | 300 | 2 | 60 | 85 |
| | 3 | 35 | 161 | 150 | 450 | 3 | 90 | 125 |
| | 4 | 70 | 182 | 169 | 600 | 4 | 120 | 160 |
| Premium | 1 | 0 | 98 | 91 | 50 | 1 | 30 | 60 |
| | 2 | 18 | 140 | 130 | 300 | 2 | 60 | 85 |
| | 3 | 35 | 161 | 150 | 450 | 3 | 90 | 125 |
| | 4 | 70 | 182 | 169 | 600 | 4 | 120 | 160 |
| Luksus/Sport | 1 | 0 | 98 | 91 | 50 | 1 | 30 | 60 |
| | 2 | 18 | 140 | 130 | 300 | 2 | 60 | 85 |
| | 3 | 35 | 161 | 150 | 450 | 3 | 90 | 125 |
| | 4 | 70 | 182 | 169 | 600 | 4 | 120 | 160 |

Table 21: Level values for each combination of car type and segment.

| variable | min | mean | max | std |
|---|---|---|---|---|
| Purchaseprice_BEV_MINI | 90000 | 118686.4 | 160000 | 26966.76 |
| Purchaseprice_ICV_MINI | 84000 | 112456.71 | 145000 | 22880.58 |
| Purchaseprice_PHEV_MINI | 84000 | 122497.9 | 150000 | 24233.1 |
| Purchaseprice_BEV_LIL | 180000 | 209705.64 | 240000 | 22281.12 |
| Purchaseprice_ICV_LIL | 150000 | 174925.9 | 200000 | 19072.65 |
| Purchaseprice_PHEV_LIL | 160000 | 189468.52 | 220000 | 22447.91 |
| Purchaseprice_BEV_MEL | 245000 | 270020.49 | 300000 | 20396.12 |
| Purchaseprice_ICV_MEL | 210000 | 268014.02 | 325000 | 42802.79 |
| Purchaseprice_PHEV_MEL | 225000 | 272062.42 | 325000 | 37981.19 |
| Purchaseprice_BEV_STOR | 310000 | 403222.18 | 500000 | 75918.06 |
| Purchaseprice_ICV_STOR | 350000 | 437043.26 | 500000 | 56117.88 |
| Purchaseprice_PHEV_STOR | 350000 | 465761.4 | 575000 | 83617.3 |
| Purchaseprice_BEV_PREM | 510000 | 580497.51 | 700000 | 72022.71 |
| Purchaseprice_ICV_PREM | 510000 | 558817.37 | 600000 | 32862.05 |
| Purchaseprice_PHEV_PREM | 580000 | 690854.06 | 800000 | 85938.93 |
| Purchaseprice_BEV_LUK | 1000000 | 1299690 | 1600000 | 223442 |
| Purchaseprice_ICV_LUK | 1000000 | 1297600.6 | 1600000 | 223290.7 |
| Purchaseprice_PHEV_LUK | 1000000 | 1304644 | 1600000 | 221836.8 |
| Operationcost_BEV_MINI | 0.49 | 0.58 | 0.67 | 0.07 |
| Operationcost_ICV_MINI | 0.81 | 0.96 | 1.11 | 0.11 |
| Operationcost_PHEV_MINI | 0.75 | 0.90 | 1.05 | 0.11 |
| Operationcost_BEV_LIL | 0.51 | 0.60 | 0.70 | 0.07 |
| Operationcost_ICV_LIL | 0.88 | 1.05 | 1.22 | 0.13 |
| Operationcost_PHEV_LIL | 0.85 | 1.01 | 1.16 | 0.12 |
| Operationcost_BEV_MEL | 0.55 | 0.65 | 0.75 | 0.07 |
| Operationcost_ICV_MEL | 0.95 | 1.13 | 1.30 | 0.13 |
| Operationcost_PHEV_MEL | 0.93 | 1.10 | 1.27 | 0.13 |
| Operationcost_BEV_STOR | 0.56 | 0.67 | 0.77 | 0.08 |
| Operationcost_ICV_STOR | 1.00 | 1.19 | 1.37 | 0.14 |
| Operationcost_PHEV_STOR | 0.99 | 1.17 | 1.36 | 0.14 |
| Operationcost_BEV_PREM | 0.69 | 0.81 | 0.94 | 0.09 |
| Operationcost_ICV_PREM | 1.04 | 1.24 | 1.43 | 0.15 |
| Operationcost_PHEV_PREM | 1.12 | 1.33 | 1.54 | 0.16 |
| Operationcost_BEV_LUK | 0.72 | 0.85 | 0.99 | 0.10 |
| Operationcost_ICV_LUK | 1.40 | 1.67 | 1.93 | 0.20 |
| Operationcost_PHEV_LUK | 1.30 | 1.55 | 1.79 | 0.18 |
| Yearlycost__BEV_MINI | 3610 | 4288 | 4963 | 501.3 |
| Yearlycost__ICV_MINI | 3458 | 4101 | 4755 | 482.6 |
| Yearlycost__PHEV_MINI | 3500 | 4232 | 5000 | 560.9 |
| Yearlycost__BEV_LIL | 4441 | 5277 | 6107 | 621.4 |
| Yearlycost__ICV_LIL | 4300 | 5097 | 5912 | 599.3 |
| Yearlycost__PHEV_LIL | 4385 | 5209 | 6030 | 615.8 |
| Yearlycost__BEV_MEL | 4719 | 5602 | 6489 | 660.0 |
| Yearlycost__ICV_MEL | 4783 | 5682 | 6576 | 668.4 |
| Yearlycost__PHEV_MEL | 4509 | 5354 | 6200 | 629.4 |
| Yearlycost__BEV_STOR | 7104 | 8436 | 9769 | 992.1 |
| Yearlycost__ICV_STOR | 7267 | 8631 | 9992 | 1015.6 |
| Yearlycost__PHEV_STOR | 6692 | 7927 | 9202 | 936.3 |
| Yearlycost__BEV_PREM | 11511 | 13668 | 15827 | 1611.3 |
| Yearlycost__ICV_PREM | 10166 | 12078 | 13979 | 1426.8 |
| Yearlycost__PHEV_PREM | 9955 | 11840 | 13688 | 1394.7 |
| Yearlycost__BEV_LUK | 11511 | 13626 | 15827 | 1625.1 |
| Yearlycost__ICV_LUK | 10114 | 11973 | 13907 | 1407.6 |
| Yearlycost__PHEV_LUK | 9955 | 11847 | 13688 | 1375.1 |
| Range_BEV_MINI | 100.0 | 160.2 | 230.0 | 49.6 |
| Range_ICV_MINI | 735.0 | 824.8 | 898.0 | 60.1 |
| Range_PHEV_MINI | 20.0 | 49.8 | 80.0 | 22.1 |
| Range_BEV_LIL | 180.0 | 305.0 | 450.0 | 101.9 |
| Range_ICV_LIL | 735.0 | 931.9 | 1097.0 | 133.2 |
| Range_PHEV_LIL | 20.0 | 50.1 | 80.0 | 22.0 |
| Range_BEV_MEL | 180.0 | 370.9 | 550.0 | 141.4 |
| Range_ICV_MEL | 735.0 | 931.3 | 1097.0 | 133.4 |
| Range_PHEV_MEL | 20.0 | 49.9 | 80.0 | 22.5 |

| | | | | |
|---|---|---|---|---|
| Range_BEV_STOR | 250.0 | 400.6 | 550.0 | 112.6 |
| Range_ICV_STOR | 735.0 | 932.9 | 1097.0 | 133.9 |
| Range_PHEV_STOR | 25.0 | 62.0 | 100.0 | 27.9 |
| Range_BEV_PREM | 285.0 | 419.2 | 600.0 | 117.3 |
| Range_ICV_PREM | 735.0 | 930.1 | 1097.0 | 133.6 |
| Range_PHEV_PREM | 25.0 | 62.5 | 100.0 | 28.1 |
| Range_BEV_LUK | 285.0 | 422.7 | 600.0 | 119.0 |
| Range_ICV_LUK | 735.0 | 934.9 | 1097.0 | 134.6 |
| Range_PHEV_LUK | 25.0 | 64.0 | 100.0 | 28.7 |
| Acceleration_BEV_MINI | 7.0 | 10.0 | 13.0 | 2.2 |
| Acceleration_ICV_MINI | 10.0 | 13.0 | 16.0 | 2.3 |
| Acceleration_PHEV_MINI | 7.0 | 10.0 | 13.0 | 2.2 |
| Acceleration_BEV_LIL | 6.0 | 9.0 | 12.0 | 2.2 |
| Acceleration_ICV_LIL | 10.0 | 13.0 | 16.0 | 2.2 |
| Acceleration_PHEV_LIL | 6.0 | 9.0 | 12.0 | 2.2 |
| Acceleration_BEV_MEL | 5.0 | 8.0 | 11.0 | 2.2 |
| Acceleration_ICV_MEL | 10.0 | 13.0 | 16.0 | 2.2 |
| Acceleration_PHEV_MEL | 5.0 | 8.0 | 11.0 | 2.2 |
| Acceleration_BEV_STOR | 5.0 | 8.0 | 11.0 | 2.3 |
| Acceleration_ICV_STOR | 8.0 | 11.0 | 14.0 | 2.2 |
| Acceleration_PHEV_STOR | 5.0 | 8.0 | 11.0 | 2.2 |
| Acceleration_BEV_PREM | 4.0 | 7.0 | 10.0 | 2.2 |
| Acceleration_ICV_PREM | 6.0 | 9.1 | 12.0 | 2.2 |
| Acceleration_PHEV_PREM | 4.0 | 7.0 | 10.0 | 2.2 |
| Acceleration_BEV_LUK | 3.0 | 6.3 | 10.0 | 2.6 |
| Acceleration_ICV_LUK | 6.0 | 9.0 | 12.0 | 2.2 |
| Acceleration_PHEV_LUK | 3.0 | 6.2 | 10.0 | 2.6 |
| CO2_BEV_MINI | 0.0 | 22.4 | 50.0 | 18.6 |
| CO2_ICV_MINI | 70.0 | 103.9 | 130.0 | 21.9 |
| CO2_PHEV_MINI | 70.0 | 104.5 | 130.0 | 22.1 |
| CO2_BEV_LIL | 0.0 | 26.1 | 60.0 | 22.2 |
| CO2_ICV_LIL | 84.0 | 124.1 | 156.0 | 27.0 |
| CO2_PHEV_LIL | 77.0 | 114.4 | 143.0 | 24.5 |
| CO2_BEV_MEL | 0.0 | 28.7 | 65.0 | 24.0 |
| CO2_ICV_MEL | 91.0 | 135.6 | 169.0 | 28.8 |
| CO2_PHEV_MEL | 84.0 | 124.5 | 156.0 | 26.6 |
| CO2_BEV_STOR | 0.0 | 30.5 | 70.0 | 26.0 |
| CO2_ICV_STOR | 98.0 | 145.1 | 182.0 | 31.0 |
| CO2_PHEV_STOR | 91.0 | 134.5 | 169.0 | 29.1 |
| CO2_BEV_PREM | 0.0 | 30.5 | 70.0 | 25.7 |
| CO2_ICV_PREM | 98.0 | 145.1 | 182.0 | 31.0 |
| CO2_PHEV_PREM | 91.0 | 134.9 | 169.0 | 28.8 |
| CO2_BEV_LUK | 0.0 | 30.7 | 70.0 | 25.8 |
| CO2_ICV_LUK | 98.0 | 145.0 | 182.0 | 30.9 |
| CO2_PHEV_LUK | 91.0 | 134.2 | 169.0 | 28.6 |
| Size_BEV_MINI | 2.0 | 2.0 | 2.0 | 0.0 |
| Size_ICV_MINI | 2.0 | 2.0 | 2.0 | 0.0 |
| Size_PHEV_MINI | 2.0 | 2.0 | 2.0 | 0.0 |
| Size_BEV_LIL | 2.0 | 2.5 | 3.0 | 0.5 |
| Size_ICV_LIL | 2.0 | 2.5 | 3.0 | 0.5 |
| Size_PHEV_LIL | 2.0 | 2.5 | 3.0 | 0.5 |
| Size_BEV_MEL | 3.0 | 4.0 | 5.0 | 0.7 |
| Size_ICV_MEL | 3.0 | 4.0 | 5.0 | 0.7 |
| Size_PHEV_MEL | 3.0 | 4.0 | 5.0 | 0.7 |
| Size_BEV_STOR | 4.0 | 4.5 | 5.0 | 0.5 |
| Size_ICV_STOR | 4.0 | 4.5 | 5.0 | 0.5 |
| Size_PHEV_STOR | 4.0 | 4.5 | 5.0 | 0.5 |
| Size_BEV_PREM | 5.0 | 5.0 | 5.0 | 0.0 |
| Size_ICV_PREM | 5.0 | 5.0 | 5.0 | 0.0 |
| Size_PHEV_PREM | 5.0 | 5.0 | 5.0 | 0.0 |
| Size_BEV_LUK | 5.0 | 5.0 | 5.0 | 0.0 |
| Size_ICV_LUK | 5.0 | 5.0 | 5.0 | 0.0 |
| Size_PHEV_LUK | 5.0 | 5.0 | 5.0 | 0.0 |
| Homechargeravailability_BEV_MINI | 1 | 2.5 | 4 | 1.1 |

| | | | | |
|---|---|---|---|---|
| Homechargeravailability_PHEV_MINI | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_BEV_LIL | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_PHEV_LIL | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_BEV_MEL | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_PHEV_MEL | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_BEV_STOR | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_PHEV_STOR | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_BEV_PREM | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_PHEV_PREM | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_BEV_LUK | 1 | 2.5 | 4 | 1.1 |
| Homechargeravailability_PHEV_LUK | 1 | 2.5 | 4 | 1.1 |
| Homedistnearestcharger_BEV_MINI | 50 | 350.3 | 600 | 201.2 |
| Homedistnearestcharger_PHEV_MINI | 50 | 352.2 | 600 | 201.9 |
| Homedistnearestcharger_BEV_LIL | 50 | 350.9 | 600 | 201.8 |
| Homedistnearestcharger_PHEV_LIL | 50 | 350.8 | 600 | 202.8 |
| Homedistnearestcharger_BEV_MEL | 50 | 349.9 | 600 | 203.7 |
| Homedistnearestcharger_PHEV_MEL | 50 | 351.0 | 600 | 203.3 |
| Homedistnearestcharger_BEV_STOR | 50 | 347.7 | 600 | 205.7 |
| Homedistnearestcharger_PHEV_STOR | 50 | 352.0 | 600 | 202.8 |
| Homedistnearestcharger_BEV_PREM | 50 | 349.9 | 600 | 201.6 |
| Homedistnearestcharger_PHEV_PREM | 50 | 346.3 | 600 | 200.5 |
| Homedistnearestcharger_BEV_LUK | 50 | 348.4 | 600 | 204.2 |
| Homedistnearestcharger_PHEV_LUK | 50 | 342.9 | 600 | 206.2 |
| Charginginfrastructure_BEV_MINI | 30 | 74.8 | 120 | 33.5 |
| Charginginfrastructure_BEV_LIL | 30 | 74.7 | 120 | 33.5 |
| Charginginfrastructure_BEV_MEL | 30 | 75.1 | 120 | 33.5 |
| Charginginfrastructure_BEV_STOR | 30 | 75.5 | 120 | 33.4 |
| Charginginfrastructure_BEV_PREM | 30 | 75.0 | 120 | 33.8 |
| Charginginfrastructure_BEV_LUK | 30 | 74.4 | 120 | 33.8 |
| Chargingspeed_BEV_MINI | 35 | 89.3 | 150 | 41.9 |
| Chargingspeed_BEV_LIL | 35 | 90.4 | 150 | 41.5 |
| Chargingspeed_BEV_MEL | 35 | 90.0 | 150 | 41.8 |
| Chargingspeed_BEV_STOR | 60 | 107.9 | 160 | 38.2 |
| Chargingspeed_BEV_PREM | 60 | 108.0 | 160 | 38.1 |
| Chargingspeed_BEV_LUK | 60 | 107.6 | 160 | 38.2 |

Table 22: Average attribute values presented to the respondents

| Attribute | elast: ICV MINI | elast: ICV LIL | elast: ICV MEL | elast: ICV STOR | elast: ICV PREM | elast: ICV LUK | elast: BEV MINI | elast: BEV LIL | elast: BEV MEL | elast: BEV STOR | elast: BEV PREM | elast: BEV LUK | elast: PHEV MINI | elast: PHEV LIL | elast: PHEV MEL | elast: PHEV STOR | elast: PHEV PREM | elast: PHEV LUK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Purchaseprice: ICV MINI | -0.062 | 0.020 | 0.004 | 0.002 | 0.001 | 0.001 | 0.026 | 0.005 | 0.001 | 0.001 | 0.000 | 0.000 | 0.026 | 0.004 | 0.001 | 0.000 | 0.000 | 0.000 |
| Purchaseprice: ICV LIL | 0.018 | -0.188 | 0.033 | 0.005 | 0.002 | 0.004 | 0.003 | 0.064 | 0.007 | 0.001 | 0.000 | 0.001 | 0.004 | 0.067 | 0.006 | 0.001 | 0.000 | 0.000 |
| Purchaseprice: ICV MEL | 0.006 | 0.049 | -0.398 | 0.142 | 0.017 | 0.016 | 0.001 | 0.009 | 0.120 | 0.025 | 0.003 | 0.003 | 0.001 | 0.011 | 0.130 | 0.026 | 0.003 | 0.002 |
| Purchaseprice: ICV STOR | 0.003 | 0.006 | 0.060 | -0.649 | 0.072 | 0.015 | 0.000 | 0.001 | 0.010 | 0.108 | 0.012 | 0.003 | 0.001 | 0.001 | 0.012 | 0.126 | 0.013 | 0.001 |
| Purchaseprice: ICV PREM | 0.002 | 0.003 | 0.009 | 0.046 | -0.329 | 0.022 | 0.000 | 0.001 | 0.002 | 0.008 | 0.085 | 0.004 | 0.000 | 0.001 | 0.002 | 0.010 | 0.099 | 0.003 |
| Purchaseprice: ICV LUK | 0.001 | 0.002 | 0.003 | 0.005 | 0.010 | -0.423 | 0.000 | 0.000 | 0.000 | 0.001 | 0.002 | 0.087 | 0.000 | 0.000 | 0.001 | 0.001 | 0.002 | 0.058 |
| Purchaseprice: BEV MINI | 0.018 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | -0.080 | 0.018 | 0.003 | 0.002 | 0.001 | 0.001 | 0.024 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 |
| Purchaseprice: BEV LIL | 0.003 | 0.052 | 0.005 | 0.001 | 0.000 | 0.001 | 0.016 | -0.279 | 0.030 | 0.004 | 0.002 | 0.004 | 0.004 | 0.069 | 0.006 | 0.001 | 0.000 | 0.000 |
| Purchaseprice: BEV MEL | 0.002 | 0.011 | 0.123 | 0.023 | 0.003 | 0.003 | 0.007 | 0.057 | -0.425 | 0.126 | 0.017 | 0.014 | 0.002 | 0.016 | 0.159 | 0.029 | 0.004 | 0.002 |
| Purchaseprice: BEV STOR | 0.001 | 0.002 | 0.014 | 0.134 | 0.017 | 0.003 | 0.004 | 0.007 | 0.067 | -0.563 | 0.081 | 0.015 | 0.002 | 0.002 | 0.019 | 0.172 | 0.022 | 0.002 |
| Purchaseprice: BEV PREM | 0.000 | 0.001 | 0.001 | 0.007 | 0.075 | 0.003 | 0.002 | 0.004 | 0.008 | 0.035 | -0.377 | 0.020 | 0.001 | 0.001 | 0.002 | 0.009 | 0.112 | 0.003 |
| Purchaseprice: BEV LUK | 0.000 | 0.001 | 0.001 | 0.001 | 0.002 | 0.090 | 0.001 | 0.003 | 0.002 | 0.004 | 0.010 | -0.435 | 0.000 | 0.001 | 0.001 | 0.001 | 0.003 | 0.071 |
| Purchaseprice: PHEV MINI | 0.024 | 0.004 | 0.001 | 0.000 | 0.000 | 0.000 | 0.033 | 0.007 | 0.001 | 0.001 | 0.000 | 0.000 | -0.079 | 0.020 | 0.004 | 0.002 | 0.001 | 0.000 |
| Purchaseprice: PHEV LIL | 0.004 | 0.057 | 0.006 | 0.001 | 0.001 | 0.001 | 0.004 | 0.074 | 0.008 | 0.001 | 0.001 | 0.001 | 0.017 | -0.244 | 0.027 | 0.005 | 0.002 | 0.002 |
| Purchaseprice: PHEV MEL | 0.001 | 0.010 | 0.132 | 0.027 | 0.004 | 0.003 | 0.001 | 0.011 | 0.159 | 0.033 | 0.005 | 0.004 | 0.007 | 0.056 | -0.429 | 0.136 | 0.019 | 0.007 |
| Purchaseprice: PHEV STOR | 0.001 | 0.001 | 0.011 | 0.126 | 0.016 | 0.002 | 0.001 | 0.001 | 0.012 | 0.138 | 0.017 | 0.003 | 0.004 | 0.006 | 0.058 | -0.720 | 0.087 | 0.006 |
| Purchaseprice: PHEV PREM | 0.000 | 0.000 | 0.001 | 0.005 | 0.062 | 0.002 | 0.000 | 0.000 | 0.001 | 0.006 | 0.078 | 0.003 | 0.001 | 0.003 | 0.006 | 0.031 | -0.505 | 0.009 |
| Purchaseprice: PHEV LUK | 0.000 | 0.001 | 0.001 | 0.001 | 0.003 | 0.110 | 0.000 | 0.001 | 0.001 | 0.001 | 0.003 | 0.127 | 0.001 | 0.003 | 0.002 | 0.005 | 0.013 | -0.223 |

Table 23: Direct and cross elasticities wrt. purchase price for car types and segments.

| Attribute | elast: ICV MINI | elast: ICV LIL | elast: ICV MEL | elast: ICV STOR | elast: ICV PREM | elast: ICV LUK | elast: BEV MINI | elast: BEV LIL | elast: BEV MEL | elast: BEV STOR | elast: BEV PREM | elast: BEV LUK | elast: PHEV MINI | elast: PHEV LIL | elast: PHEV MEL | elast: PHEV STOR | elast: PHEV PREM | elast: PHEV LUK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Range: BEV MINI | -0.012 | -0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.049 | -0.012 | -0.002 | -0.001 | 0.000 | 0.000 | -0.016 | -0.002 | 0.000 | 0.000 | 0.000 | 0.000 |
| Range: BEV LIL | -0.003 | -0.037 | -0.004 | -0.001 | 0.000 | 0.000 | -0.012 | 0.188 | -0.022 | -0.003 | -0.002 | -0.003 | -0.003 | -0.049 | -0.005 | -0.001 | 0.000 | 0.000 |
| Range: BEV MEL | -0.001 | -0.008 | -0.086 | -0.017 | -0.002 | -0.002 | -0.005 | -0.039 | 0.265 | -0.083 | -0.012 | -0.009 | -0.002 | -0.012 | -0.109 | -0.021 | -0.003 | -0.001 |
| Range: BEV STOR | -0.001 | -0.001 | -0.008 | -0.068 | -0.009 | -0.002 | -0.002 | -0.004 | -0.035 | 0.264 | -0.039 | -0.007 | -0.001 | -0.001 | -0.011 | -0.087 | -0.012 | -0.001 |
| Range: BEV PREM | 0.000 | 0.000 | -0.001 | -0.003 | -0.028 | -0.001 | -0.001 | -0.001 | -0.003 | -0.013 | 0.135 | -0.007 | 0.000 | 0.000 | -0.001 | -0.004 | -0.041 | -0.001 |
| Range: BEV LUK | 0.000 | 0.000 | 0.000 | 0.000 | -0.001 | -0.017 | 0.000 | 0.000 | -0.001 | -0.001 | -0.002 | 0.080 | 0.000 | 0.000 | 0.000 | 0.000 | -0.001 | -0.012 |
| Range: PHEV MINI | -0.008 | -0.001 | 0.000 | 0.000 | 0.000 | 0.000 | -0.011 | -0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.027 | -0.007 | -0.001 | -0.001 | 0.000 | 0.000 |
| Range: PHEV LIL | -0.001 | -0.013 | -0.001 | 0.000 | 0.000 | 0.000 | -0.001 | -0.017 | -0.002 | 0.000 | 0.000 | 0.000 | -0.004 | 0.055 | -0.006 | -0.001 | -0.001 | 0.000 |
| Range: PHEV MEL | 0.000 | -0.002 | -0.021 | -0.005 | -0.001 | -0.001 | 0.000 | -0.002 | -0.025 | -0.005 | -0.001 | -0.001 | -0.001 | -0.009 | 0.068 | -0.021 | -0.003 | -0.001 |
| Range: PHEV STOR | 0.000 | 0.000 | -0.001 | -0.013 | -0.002 | 0.000 | 0.000 | 0.000 | -0.001 | -0.014 | -0.002 | 0.000 | 0.000 | -0.001 | -0.006 | 0.069 | -0.008 | -0.001 |
| Range: PHEV PREM | 0.000 | 0.000 | 0.000 | 0.000 | -0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.005 | 0.000 | 0.000 | 0.000 | 0.000 | -0.002 | 0.035 | -0.001 |
| Range: PHEV LUK | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | -0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.009 |

Table 24: Direct and cross elasticities wrt. driving range for car types and segments.