Individual preference for the alternative fuel vehicles and their attributes in Poland

Submitted to the EcoMod2015 Conference, Boston College, USA, July 15-17, 2015.

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Abstract

Electromobility is seen as part of strategy to reduce dependence of the European Union on oil and other fossil fuels, improve air quality, reduce noise in urban/suburban agglomerations, and contribute to a CO2 reduction. The Directive 2014/94/EU sets that each Member State shall adopt a national policy framework for the development of the alternative fuel market and submit to the Commission a report on its implementation, including the policy measures taken. The objective of this paper is to estimate willingness to pay for three electricity driven vehicles, specifically hybrid, plug-in hybrid and electric vehicles. A discrete choice experiment is used to elicit consumer preferences for several vehicle attributes and policy incentives. Quota sampling was used to draw a representative sample of the Polish adult population in terms of several socio-demographic characteristics and a sample who intend to buy a passenger car within next three years. The survey took form of structured computer-assisted web interviews. This survey is the first on this topic and using discrete choice experiment in Central and Eastern Europe. We found that preferences of Polish consumers for hybrid and electric vehicles are significantly lower than for a conventional vehicle, even under a scenario that would implement a public program that would allow slow mode recharging an electric or plug-in hybrid vehicle in the place where people usually park their car. Charging time, availability of charging stations and driving range are currently the most important barriers to development of market for electricity driven vehicles. On average, Polish drivers are willing to pay about 1,260 zł for each additional 100 km of driving range about 500 zł for each hour saved for recharging; drivers who intend to buy a second-hand car value the driving range less. Preference for AFVs markedly rose, when availability of fast-mode recharging improved from low level to medium or even high level. Corresponding willingness to pay for medium or high availability is about 4,649 zł and 8,817 zł, respectively. Providing other benefits, such as free parking and public transport, increases the probability to choose the electricity driven vehicles only in some segments, however.

1 Introduction

Electromobility is seen as part of strategy to reduce dependence of the European Union on oil and other fossil fuels, improve air quality, reduce noise in urban/suburban agglomerations, and contribute to a CO_2 reduction (Directive 2014/94/EU). Same EU directive also considers the electric vehicles should be integrated to smart grid to contribute to the stability of the electric grid by recharging batteries in case of low demand and in more distant future to feed power from the batteries back into the grid in case of high demand.

To fulfil these targets, the Directive sets that each Member State shall adopt a national policy framework for the development of the alternative fuel market and the relevant infrastructure and submit to the Commission a report on its implementation that should among others describe the policy measures taken in a Member State to support build-up of alternative fuels infrastructure, such as direct incentives for the purchase of means of transport using alternative fuels or for building the infrastructure, availability of tax incentives to promote means of transport using alternative fuels and the relevant infrastructure, use of public procurement in support of alternative fuels, including joint procurement, and demand-side non-financial incentives, for example preferential access to restricted areas, parking policy and dedicated lanes, etc. To encourage the development of the market for alternative fuel vehicles, including electricity driven vehicles, effective policy measures should be carefully selected, proposed and implemented.

To prepare a national policy framework for the development of the alternative fuel market, among others, understanding of consumer behaviour and preferences for alternative fuel vehicles is crucial. With the onset of alternative fuel vehicles (AFVs) on the market, large amount of studies focusing on consumer preferences for AFVs have been already conducted worldwide. Consumers' demand for vehicle described with several specific characteristics can be modelled using existing data on market penetration or consumption decisions, i.e. through analysis of revealed preferences. However, if the supply of certain durable goods is constraint or almost zero as is the case for new device or not yet existing technology, potential demand can be examined using stated preference methods.

In our case, the main aim of this article is to elicit individual consumer's preferences for passenger vehicles, specifically for vehicles that is recently characterized by negligible market penetration. This article contributes to knowledge about preferences of Polish consumers for three electricity driven vehicles, specifically hybrid (HV), plug-in hybrid (PHEV) and electric vehicles (EV) based on an original stated preference survey conducted in Poland.

In our discrete choice experiments, Polish respondents with an intention to buy a car are asked to choose their preferred option among four presented types of cars that include conventional, electric, hybrid car and hybrid car with plug-in. These cars then differ from one another in the levels of several attributes. Purchasing price of a car is one of the attributes, which allows us to estimate marginal willingness-to-pay for each specific attribute of a vehicle. Except price, further attributes include operational and fuel costs, driving range, refuelling / recharging time, and availability of fast-mode recharging infrastructure. We also examine whether policy incentives, such as free parking and public transport for family members for free, can motivate consumers to buy these vehicles. As far as we know, this survey is the first of its kind conducted in Poland and in Central and Eastern European region.

Considering the importance of second-hand market on passenger vehicles in Poland, preferences are elicited from consumers who intend to buy a new car as well as from consumers who plan to rather buy a used car. In our contingent scenario, we asked respondents to imagine that a public program would be introduced and slow mode charging sockets with electricity use meters would be installed, thus they would be able to charge an electric or plug-in hybrid vehicle in the place where they usually park it, even if they don't own a garage. However, preferences of Polish consumers for hybrid and electric vehicles were still significantly lower than for conventional vehicles.

We also find that driving range is important attributes of a passenger car which Polish consumers intend to buy, and, on average, Polish drivers are willing to pay about 1,500 zł (€390) for each additional 100 km of driving range. Recharging time and availability of fast-mode charging stations are currently the most important barriers to larger spread of electric and plug-in hybrid vehicles. On average, Polish drivers are willing to pay slightly less than 1,000 zł for each hour saved for recharging (€240). Preference for AFVs markedly rose, when availability of fast-mode recharging improved from low level (20% of fuel stations at few public places) to medium level (60% of fuel stations at half of public places) or even high level (90% of fuel stations at almost all public places) with corresponding willingness to pay values of about 5,600 zł (€1,340) and 8,600 zł (€2,060), respectively. Providing other benefits, such as free parking and free public transport, increases the probability to choose the AFVs. Marginal willingness to pay as derived for the used-car segment are always smaller than the corresponding values derived for the new-car segment. Results of the models with interactions and of the mixed logit models indicate on large observed and unobserved consumer preference heterogeneity.

The rest of our paper is structured as follows. Chapter 2 provides a review of relevant studies. Next chapter the theoretical model, our valuation method and experimental design. Chapter 3 and 4 describes data and summarise the results. Last chapter concludes.

2 Literature review: Discrete choice experiments studies on preferences for alternative fuel vehicles

The first discrete choice experiments on clean-fuel vehicles have been undertaken already in early 90's (Bunch et al., 1993; Kurani et al., 1996; Golob et al., 1997; Brownstone, Train, 1999), the pioneering work took place predominantly in United States. Our list of studies consists of twenty seven items and the vast majority of them has been published since 2011 (see Appendix for a review, or Scasny et al., 2015 for the details). Nevertheless, some authors such as Daziano and Chiew (2012), Caulfield et al. (2010) or Mabit and Fosgerau (2011) worked with data that were collected much earlier and thus may seem outdated at the time of the publication, since the progression in AFVs technologies was rapid. The most recent research on preferences for AVF is undertaken under the ERA-NET DEFINE project which one part is just presented in this article.

Considering the location of the study, 11 studies were exercised in Western Europe, 13 studies in Northern America and 3 in Asia. No study, except ours, has been conducted in the region of Central and Eastern Europe yet. The surveys that we included in our literature review were usually targeted on recent or potential car buyers. Hoen and Koetse (2012) included only those members of surveyed households that drive the car most frequently, Dagsvik et al. (2002) and Lebeau et al. (2012) targeted general public, Golob et al. (1997) and Chorus, Koetse, Hoen (2013) focused on private companies.

The fuel types of the vehicles introduced to respondents in the discrete choice experiments reflected current and also possible technologies in concerned countries. In most of the studies, there is one side a conventional vehicle represented by petrol (or additionally by diesel), the other fuel types, such as compressed natural gas, liquefied petroleum gas), and on the other side low carbon vehicles represented by hybrid, electric or hydrogen vehicles. Most of the studies also provide the willingness to pay estimates for different attributes that ranged between three and twelve, with six as the median.

Considering the reviewed studies, we find no sufficient evidence whether consumers prefer AFVs to conventional vehicles. In fact, consumers' preferences depend on both characteristics of the respondents, and characteristics of the vehicles.

As a consequence, the evidence on the effects of sociodemographic variables is far to be conclusive; the results are country and study specific. However, several studies found that early adopters of AFVs are more likely home owners and those who live in detached or semi-detached family homes; people owning more than one vehicle; and higher educated, younger to middle aged, higher income, environmentally conscious.

Preference for AFVs also increases with the length of driving range, fuel availability (such as percentage share of fuel stations), car performance (such as engine power), greenhouse gas emissions reduction, policy incentives (such as remission of vehicle tax, free parking, bus lane access), whereas WTP for AFVs decreases with length of charging (refuelling) time, purchase (capital) costs, fuel and maintenance costs. The values of marginal willingness to pay differ not only among the studies, but the values are distinct also within individual studies, for instance, the authors usually observe preference heterogeneity across socio-demographic characteristics (see, for instance, Hanappi et al. 2012).

Short driving range and long battery charging time are very important barriers of purchase of AFVs, since both are bringing significant dis-utility to car buyers. Marginal utility of increasing driving range by 1km ranges about €10 to €60. Utility from reducing battery charging time by one minute lies in similar range, however, the disutility related to refuelling hydrogen vehicles is larger compared to the disutility from battery charging of electric or plug-in hybrids. Consumers are willing to pay more if they do not have to refuel their vehicle every day but only every other day, or even once a week. The barriers associated with driving range and charging time seem to be the main reason why people tend to prefer hybrid technology over electric vehicles. Because of the limited driving range of electric cars these are perceived as insufficient for special journeys such as holidays or weekends away. Alternative mobility options for “long journeys” are therefore needed to enhance the acceptance of electric vehicles.

There are several measures tested in the studies, how governments may attempt to achieve higher share of AFVs on the market. Policy incentives consist of free parking (e.g. Ewing, Sarigollu, 2000), an access to express or bus lanes (e.g. Horne, Jaccark, Tiedeman, 2005) and a reduction or an abolishment of vehicle taxes (e.g. Caulfield et al., 2010). Hoen and Koetse (2012) examine the hypothesis whether an increase in the number of available vehicle models, from which a consumer can choose when purchasing a new vehicle, have any effect, the results show that the effect is positive, but not substantial. Ito, Takeushi, Managi (2010) elicit values of WTP for the brand/manufacturer of the vehicle and find it significantly important.

Further in this review, we focus on the most interesting results that are in some cases unexpected. However, one should be careful about generalisations of the results based on a review of studies relying on different context, scenario or site characteristics. For instance, Kurani et al. (1996) found strong support for the “hybrid household hypothesis” that a driving range limit of one household’s vehicle will not be an important barrier to the purchase of an EV by a potential hybrid household. Hypothesis is applicable on households that own two or more vehicles. About 38% of the sample would have to choose an EV over conventional gasoline-fuel vehicle. Authors find no statistically significant relationships between vehicle choices and household's commute trip distances, longest weekly trips, or distances to critical destinations.

According to Golob et al. (1997), who focused on commercial fleet demand for AFVs, there are substantial differences among fleet market segments in terms of preference trade-offs for other vehicle attributes. The trade-off between range and capital cost is approximately 80 USD per mile. Reductions of tailpipe emissions were found to be a significant predictor of vehicle choice only for the government and school sectors. Higher capital or operating costs, or smaller vehicle range, can be compensated for by a larger number of alternative fuel service stations.

Results of Ewing and Sarigollu (2000) conclude that other critical fuel-rated variables (e.g., quiet engine, smooth acceleration) were omitted in the experimental design. Comparing with previous studies, Canadians have more positive relation to EVs and HEVs. Individual coefficient of refuelling rate did not have expected sign, it was probably due to inaccurate values in the choice experiment.

Dagsvik et al. (2002) states that alternative fuel vehicles appear to be fully competitive alternatives compared to conventional gasoline vehicles. In addition to purchase price, driving range seems to be the most relevant attribute. Unless the limited driving range for electric vehicles is increased substantially this technology will not be fully competitive in the market. Regarding electric vehicles, men are more reserved towards this technology than women.

Horne, Jaccark, Tiedemann (2005) used the elasticities to provide notion of relative importance of the attributes. Capital costs seem to carry the greatest significance followed by fuel costs and fuel availability. Authors used mode choice model for testing different commuting variants - vehicle (alone), vehicle (carpool), public transit, park and ride, walk or cycle. Attributes used were travel time, cost, pick-up/drop-off time, walking/waiting time, number of transfers, bike route access. The most important seems to be non-driving time, driving time and commuting costs.

Axsen (2007) introduces the diffusion theory and neighbour effect. The author states that dynamic preferences proved to be more realistic than static preferences in hybrid-electric vehicle market, due to current low share of AFVs on total market for all kinds of vehicles. Both theories predict that consumers' preferences will increase with higher penetration into the total market. When the government speculates about supporting new technology, non-financial attributes (e.g. regulation) may be more efficient than financial strategies (e.g. subsidies or taxes).

Potoglou, Kanaroglou (2007) derive that consumers are attracted to "tax-free purchase" incentives and to vehicles with significantly reduced emission levels. Free parking and permission to drive special lanes in the city (originally exclusively for vehicles with more than one passenger) do not affect preferences. Segmentation variables including gender, age, education level, household size and type were significant and revealed differences in preferences between segments.

In study of Caulfield et al. (2010) vehicle registration tax and CO2 emissions were not considered important attributes by the respondents, meanwhile fuel consumption was considered important.

Hidrue et al. (2011) derived that the propensity to buy an EV increases with youth, education, green life style, believing gas prices will rise significantly in the future, and with living in a place where a plug is easily accessible at home. Consumer preferences were driven more by expected fuel savings than by a desire to be environmentally friendly. Range anxiety, long charging time and high purchase price remain consumer's main concern about EV. Battery costs need to drop considerably if EVs are to be competitive without subsidy at current US gasoline prices. The United States' federal tax credit of $7500 is likely to be sufficient to close the gap between costs and the WTP if battery costs decline to $300/kWh, which is the cost level projected for 2014.

Hackbarth, Madlener (2011) stated that German car buyers are currently very reluctant towards AFVs, especially electric and hydrogen vehicles. Younger, highly educated, and environmentally conscious consumers, and to some extent also urban drivers of small cars with access to a parking lot equipped with a socket, are more prone to buy new vehicle technologies in general. Hence, marketing strategies could be tailored such that they target specifically these consumer groups for effectively increasing the adoption rates. Financial incentives as they are used in some European countries today, and also lobbied for by German car manufacturers, are found to be insufficient to significantly increase adoption rates.

Stix, Hanappi (2013) designed 4 future scenarios of demand for AFVs until 2050. Concerning on the socio-economic characteristics, age has a negative effect on purchase of AFVs, on the other hand income, education, daily usage, environmental awareness of respondents, high service station availability have positive effect.

Mabit, Fosgerau (2011) predict that consumers will be more likely to choose environmentally friendly AFVs in future in place of conventional vehicles. This may be interpreted as a sign of environmental concerns and/or a strategic signal about the valuation of pollution in the sample as a public good. The high registration tax in Denmark leaves room for government as large rebates to AFVs.

Qian, Soopramanien (2011) derived, similarly to other studies, that consumers are more likely to consider hybrid and conventional vehicles than electric vehicles. The parameters of government incentives such as cash subsidy, free parking or priority lane access are insignificant.

Following results of Daziano, Chiew (2012) consumers expect driving range parity between electric vehicles and gas vehicles. Consumers desire an electric battery with average range of 330 miles. Introducing transportation cost savings, consumers are willing to buy an electric car instead of a standard gas vehicle if, on average, the electric driving range equals at least 114 miles.

Lebeau et al. (2012) show future scenarios of EVs market shares in case when certain technological progress occurs (e.g. increase of EV’s driving range from 100 to 200 km). By 2020, number of new purchases could rise to 5% for BEVs and 7% for PHEVs because of technological improvements and a decline in purchase costs. In 2030, electrified transport could attain a market share of 15% for BEVs and 29% for PHEVs.

Link et al. (2012) derived that cost attributes have a higher impact on the purchase decision than technical characteristics of vehicles. The outsized meaning assigned to range and charging time in public perception cannot be confirmed. Market penetration of medium-sized electric cars will be higher compared to small-sized car, hybrid cars have better market opportunities than electric cars.

Results of study by Ziegler (2012) support the notion that a taxation of conventional gasoline and diesel vehicles, or a subsidization of alternative energy sources and propulsion technologies could be successful directions to promote hybrid, hydrogen, and electric vehicles. In contrary to other studies the potential car buyers in Germany have a low stated preference for electric, hydrogen, and hybrid vehicles relative to conventional vehicles.

Achtnicht (2012) examined whether CO2 emissions per km is a relevant attribute in vehicle choices. Emissions performance of vehicle matter substantially, but its consideration varies heavily across the sampled population. Knowing people's preferences with respect to public goods generally helps do design effective and economically efficient policy instruments.

Hoen, Koetse (2012) derived that preferences for AFVs are substantially lower than those for the conventional technology. Limited driving range, long refuelling times and limited availability of refuelling opportunities are to a large extent responsible for these findings. These barriers are most substantial for the electric car and hydrogen (fuel cell) car. Average stated preferences for AFVs increase considerably when improvements in driving range, refuelling time and additional detour time are made. An increase in the number of available models from which a consumer can choose and measures such as free parking have a positive but not substantial effect. The results clearly show that, also when substantial improvements on these issues occur, average negative preferences remain. The fact, that most technologies are relatively unknown and their performance and comfort levels are uncertain, are likely contributing factors in this respect.

Ida et al. (2013) concludes that US consumers are more sensitive than Japanese consumers about fuel cost reduction and fuel station availability. Japanese consumers are more sensitive about driving range and emission reduction. Comparing four US states (California, Texas, Michigan, New York), WTP for fuel cost reduction varies significantly and is the greatest in California.

Chorus, Koetse, Hoen (2013) compared conventional linear-additive Random utility maximization model (RUM) and Random regret minimization model (RRM). Models generate rather different choice probabilities and policy implications. Regret-based model accommodates compromise-effect. It assigns relatively high choice probabilities to alternative fuel vehicles that perform reasonably well on each dimension instead of having a strong performance on some dimensions and a poor performance on the others. Joint use of the models may lead to more robust policy-development if policies are selected that perform well under both the RUM and RRM regime.

Ito, Takeushi, Managi (2013) derived that consumers' WTP for certain driving ranges increases with an increase in infrastructural development (introduction of exchangeable batteries, higher share of recharging stations), which is not consistent with the predictions. One possible reason for this is the effect of a change in the distance that respondents travel in their cars. If the infrastructure for an AFV is so inadequate that the consumer will switch to public transportation, the distance travelled in the AFV decreases, as does the value of the vehicle. In this case, the substitute relationship between cruising range and infrastructure improvement changes to a complementary relationship a cruising range increases (complementary relationship was found between the driving ranges and the infrastructure established). Their results indicate that infrastructural development of battery-exchange stations can be efficient when electric vehicle sales exceed 5.63% of all new vehicle sales.

3 Method and theoretical model

3.1 Theoretical model

One of the objectives of this study is to utilize stated preference methods to estimate willingness-to-pay of Polish consumers for alternative fuel vehicles described by specific attributes.

To understand consumers' choices among conventional and three types of alternative fuel vehicles we used the discrete choice experiment method, specifically sequences of multinomial choice questions. The choice responses are assumed to be driven by an underlying random utility model.

The theoretical model is random utility model (McFadden 1974; Hanemann 1984) in that individual chooses the alternative with the highest indirect utility, V

$$V_{ij} = \beta_0 + \mathbf{x}_{ij}\boldsymbol{\beta}_1 + (y_i - C_{ij})\beta_2 + \varepsilon_{ij}$$

where x denotes the attributes of the good, y is the income of the individual, C is willingness to pay for the contingent good, the subscripts i and j denotes the individual and the alternative respectively. The coefficients β_1 is the marginal utility of the attribute, β_2 is the marginal utility of income, which need to be estimated.

Discrete choice model is used to estimate the probability for choosing the alternative. If the stochastic term, ε, is independently and identically distributed, having extreme value I distribution, the probability that respondent i chooses the alternative k out of K alternatives is

$$\Pr(k) = \frac{\exp(\beta_0 + \mathbf{x}_{ik}\boldsymbol{\beta}_1 - C_{ik}\beta_2)}{\sum_{j=1}^{K}\exp(\beta_0 + \mathbf{x}_{jk}\boldsymbol{\beta}_1 - C_{jk}\beta_2)}$$

This probability is a contribution to loglikelihood in a conditional logit

$$\log L = \sum_{i=1}^{n}\sum_{k=1}^{K} ch_{ik} \log \Pr(k)$$

where ch is a dummy indicator that equals to one if respondent selects the alternative k, and zero otherwise. The loglikelihood is maximized. Marginal willingness to pay is given as the negative of ratio between the coefficient of marginal utility of the attribute x and the marginal utility of income. The standard error around the mean WTP can be computed by use of the delta method or Krinsky-Robb method.

To allow heterogeneity in tastes among the respondents, the socio-demographic and other variables, including the internal factors (attitudes, subjective perception of norms, etc), enter into the logit via interactions with the attribute, i.e. multionomial logit.

The assumption of the independence of irrelevant alternatives (IIA) is implicit in both of these discrete models. In the case of outcomes that violate the IIA assumption, the estimates might be biased. Nested logit, GEV model, random parameter (mixed logit), or latent class logit models relax this assumption. We use mixed logit (random parameter) model that allows capturing heterogeneity in the preferences across individuals (see Alberini, Ščasný, et al., 2012).

3.2 Valuation method and study design

In our discrete choice experiment (Hanley et al., 2001; Bateman et al., 2004), respondents were shown conventional car (fuelled by petrol, diesel, or oil derivatives such as LPG) and three types of electricity driven cars, specifically electric, hybrid car and hybrid car with plug-in, described by a set of six attributes, and were asked to choose their preferred car.

The cars differ from one another in the levels taken by two or more of the attributes. Price (or cost to the respondent) is one of the attributes, which allows us to estimate marginal willingness-to-pay for specific attributes of vehicles. Further attributes that we selected were: operational costs, driving range, refuelling / recharging time, availability of fast-mode recharging infrastructure, and additional benefits, particularly free parking, free public transport. Attributes and their levels used to describe the contingent scenario in the discrete choice experiment are summarized in **Chyba! Nenalezen zdroj odkazů.**.

An example of a choice set that was presented to respondents is shown in Appendix II. All respondents who indicated that they intend to buy a car within three years participated in the discrete choice experiment. Each respondent evaluated eight choice sets.

3.3 Experimental design

The experimental design of our study consisted of 40 choice-tasks, each with 4 alternatives per respondent, blocked into 5 questionnaire versions; there were therefore 5 questionnaire versions (blocks) with 8 choice tasks per respondent. The order of choice tasks in each version, as well as the order of alternatives was randomized for each respondent, to mitigate potential anchoring or framing effects. The alternatives were labelled - each alternative represented a different fuel technology (conventional, hybrid, hybrid plug-in, electric). Since our respondents aimed at purchasing very different cars we used pivotal designs (Rose et al., 2008) - after eliciting main information about the car they intend to buy (new/used, price) and their expected use patterns (annual mileage) the attribute levels where made individual specific, i.e. they represented different (and alternative-specific) levels of deviations from the values expected by the respondent.

The design was optimized for D-efficiency (Sándor and Wedel, 2001; Ferrini and Scarpa, 2007) of the multinomial logit model using Bayesian priors (Huber and Zwerina, 1996; Scarpa and Rose, 2008). The efficiency was evaluated by simulation - we used a median of 1000 Sobol draws as an indicator of the central tendency (Bliemer et al., 2008). All prior estimates were assumed to be normally distributed, with the exception of the priors for alternative specific constants - which were assumed to be uniformly distributed to represent potentially larger heterogeneity of respondents' preferences with respect to propulsion technologies. The means of the Bayesian priors were derived from the MNL model estimated on the dataset from the pilot survey, and standard deviations equal to 0.25 of each parameter mean. The experimental design for the discrete choice experiment used in the main wave of data collection is described in the following table (Table 10).

3.4 The structure of the questionnaire

The final version of the questionnaire, including contingent valuation scenarios, was prepared based on a pre-survey (11 semi-structured interviews) and pilot testing of previous version. The questionnaire structure follows a common ordering (e.g. Bateman et al., 2004). However, a few questions on socio-demographic characteristics were placed in the beginning of the questionnaire to be able to monitor quota attainment, as recommended for computer-assisted web interviewing.

The questionnaire was composed of eleven parts that are briefly described in Appendix II.

Figure 1*: Design of the choice experiment on alternative fuel vehicle preferences*

Attribute/Label	CV	HV	PHEV	EV
Purchase price / PP/	P(CV)= midpoint(**QC5**)	-2=80%*P(CV) -1=90%*P(CV) 0=P(CV) 1=110%*P(CV) 2=120%*P(CV) 3=130%*P(CV) 4=140%*P(CV)	-2=80%*P(CV) -1=90%*P(CV) 0=P(CV) 1=110%*P(CV) 2=120%*P(CV) 3=130%*P(CV) 4=140%*P(CV)	-2=80%*P(CV) -1=90%*P(CV) 0=P(CV) 1=110%*P(CV) 2=125%*P(CV) 3=133%*P(CV) 4=145%*P(CV)
Operational costs /OC/	1: FF=25 & OC(CV)= 25+4000/(KM/100) 2: FF=30 & OC(CV)= 30+4000/(KM/100) 3: FF=40 & OC(CV)= 40+4000/(KM/100) 4: FF=50 & OC(CV)= 50+4000/(KM/100) OCM(CV)=(OC(CV)/100)*KM/12)	1= OC(HV)= FF{i}*.9 + 5000/(KM/100) 2= OC(HV)= FF{i}*1.0 + 5000/(KM/100) OCM(HV)=OC(HV)/100*(KM/12)	1: OC(PHEV)= FF{i}*0.7 + 5000/(KM/100) 2: OC(PHEV)= FF{i}*0.9 + 5000/(KM/100) 3: OC(PHEV)= FF{i}*1 + 5000/(KM/100) OCM(PHEV)=OC(PHEV)/100*(KM/12)	1: OC(EV)= FF{i}*0.25 + 2000/(KM/100) 2: OC(EV)= FF{i}*0.4 + 2000/(KM/100) 3: OC(EV)= FF{i}*0.75 + 2000/(KM/100) OCM(EV)=OC(EV)/100*(KM/12)
Driving range /DR/	1=500 2=700 3=900	1=500 2=700 3=900	1=500 2=700 3=900	1=150 2=250 3=350 4=500
Refueling / recharging time /RT/	1= 2 minutes	1= 2 minutes	1=3h 2=1h 3=30min	1=7h 2=4h 3=2h
Availability of fast-mode recharging /INFR2=60%/ /INFR3=90%/	NA	NA	1 = low (20% of fuel stations + at few public places) 2 = medium (60% of fuel stations + at half of public places) 3 = high (90% of fuel stations + at almost all public places)	1 = low (20% of fuel stations + at few public places) 2 = medium (60% of fuel stations + at half of public places) 3 = high (90% of fuel stations + at almost all public places)
Free parking /FP/	0='blank'	0=none 1=free parking	0=none 1=free parking	0=none 1=free parking
Free public transport /FT/	0='blank'	0=none 1=free public transport	0=none 1=free public transport	0=none 1=free public transport

4 Data description

4.1 Data collection and sampling technique

The data exploited in this study comes from a questionnaire survey of the adult population of Poland. The data were collected by Millward Brown in compliance with ICC/ESOMAR Code on Market and Social Research1. The survey took the form of Computer-assisted web interviewing (CAWI). In total slightly more than 2,613 interviews were carried out, including 407 interviews conducted in the pilot.

Data consists of two independent samples.

- Sample (A) consists of Polish respondents who intend to buy a passenger car within next three years. A screening question was placed just at very beginning of the questionnaire (see Appendix 2). Further, we set arbitrarily the shares of people who plan to buy a new or second-hand passenger car in order to have sufficient number of new passenger car buyers that will allow us to employ statistical analysis. One half of the respondents of sample A plan to buy a new passenger car (A1), while the second half of the respondents plan to buy a second-hand passenger car (A2) within next three years.
- Sample (B) is representative of the general population of Poland in terms of several socio-demographic characteristics. Respondents who plan to buy a new or second-hand passenger car are also a part of the sub-sample B. Respondents for sample A and for sample B were selected independently one on the other.

The samples were drawn from the populations using quota sampling with quotas for age, gender, region and size of place of residence. In the case of sample B, the quota was based also on education.

The collected raw data were cleaned. Incomplete cases were excluded. All logical conjunctions in the questionnaires were verified and approved. In total, sample A consists of 1,760 observations and sample B of 853 observations.

For the identification of speeders, we followed the recommendation of SSI (Survey Sampling International, 2013) to define as speeders those who complete the survey in 48 % of the median time. The median time was computed for both samples, separately for those with and without a car buying intention and with and without a car that requires different time spent. At the end, about 5% and 6% of respondents were excluded from Sample A, or Sample B, respectively.

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[1] Millward Brown's online panel IBIS has been operating since 2006. The panel size at the moment is N=83,000 active respondents. An active panellist is a person who has taken part in at least one study in the preceding year. All research projects carried out by Millward Brown comply with the ICC/ESOMAR Code on Market and Social Research and the ISO 20252 standard. Millward Brown's panel has also been certified with the ISO 26362 for access panels. Millward Brown fully respects and abides generally applicable provisions of law, including the Civil Code, the Law on Personal Data Protection, the Law on Unfair Competition Law on Copyright and Related Rights. The incentive system applied to Millward Brown's panel is a loyalty program.

4.2 Descriptive statistics: Socio-economic characteristics

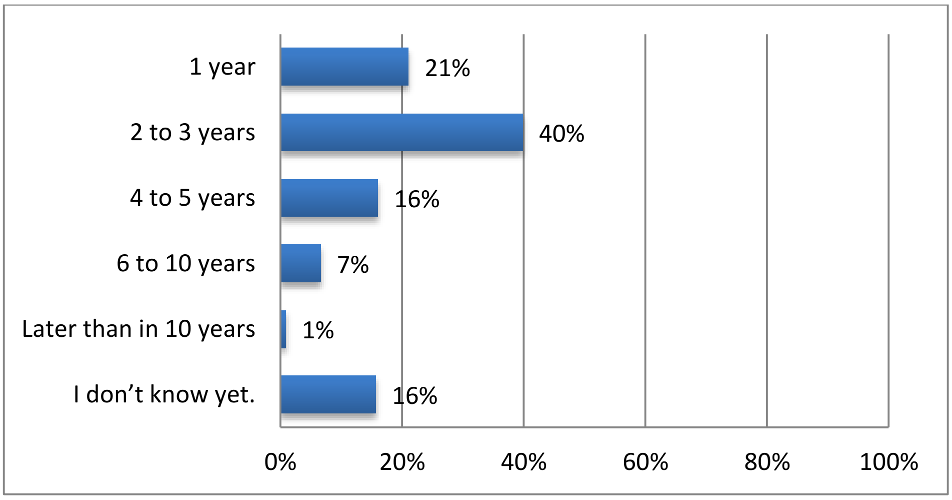
In the representative sample of Polish population (N=853), there are even number of males and females (51.8% males), on average, there are 3.3 persons living in a family with 0.7 children. Only 6.2% present a single-occupied household. About 66% of respondents are employed full-time or part-time and 10% are self-employed. About 16% of respondents are retired persons, and 10% are recently unemployed. There are 6.3% respondents without any own income and median personal net income ranges between 1,800-2,299 zł per month. Median household net income ranges between 3,500 and 4,500 zł per month, the mean is 3,919 zł. In both cases, there are about 12% respondents who would prefer not to answer on income question.

About 19% live in centre and another 21% live in broader centre of a city or town (they constitute a dummy variable URBAN used later). Then 32% live in village or small town or in remote village or house (RURAL). Remaining 28% live in suburbs of a city or town (SUBURB).

4.3 Descriptive statistics: Car purchase

About 71% of respondents form a representative sample of Polish population like to buy a passenger car sometimes in the future. This car can be bought by the respondent or any other member of respondent's family. Those who plan to buy a car sometimes in the future, we asked then when they like to do so (see Figure 1).

Figure 1: Percentages of households who intend to buy a car according to expected time of purchase, general population



Nine percent of respondents do not have a car and also do not intend to buy a car in future, whereas 5% don't have a car now but like to have a car later. Less than one third of our sample have a car now but do not plan to buy a car later. Major part of our respondents has a car and would like to buy another car sometime in the future. Fifteen percent respondents intend the car they plan to buy will serve as an additional one, while 73% plan to buy a car in the future to replace the car they already have (12% don't know it yet).

Our survey has confirmed general knowledge on Polish car market that the most passenger cars have been purchasing a used car. Indeed, two thirds of our respondents (66%) plan to buy a second-hand car, whereas only 14% plan to buy a new car. Remaining 20% don't know yet whether their next car should be new or rather second-hand car. The share of new car buyers is much larger in the pooled data is due to our sampling construct, since we explicitly set even quota on used car segment vs. new car and undecided segment in the sample A. Table 1 also reports the shares of technologies that the intended car should be equipped. In the representative sample B, majority considers gasoline (58%), 35% is thinking about diesel car and 32% considered LPG gas fitting or to install fitting after purchase (multiple choice option). Only 3.3% consider electricity as the fuel of their future car; 1.8% thought about hybrid car, 1.4% about plug-in hybrid, and the share of electric cars is negligible (0.2%).

Table 1: Characteristics of a car that respondents plan to buy (N=511)

		Pooled sample A+B	Sample B
Are you going to buy new or used car?	New	22%	14%
	Used	54%	66%
	I don't know yet	23%	20%
What kind of fuel or alternative technology the car you plan to buy should use?	Gasoline	66%	58%
	Diesel	40%	35%
	Natural gas (CNG)	9%	8%
	With LPG gas fittings / I am going to install fittings after purchase	35%	32%
	Biofuels	2%	1%
	Electricity (electric or hybrid car)	4%	3%
	Other	1%	0.4%
What alternative fuel vehicle do you plan to buy? (percentage from the entire sample)	Electric car	0.3%	0.2%
	Hybrid car	2.1%	1.8%
	Plug-in hybrid car	1.9%	1.4%

The mean purchasing price of a new car that is planned is about 70,336 zł / €17,000 (with median = 55,000 zł / €13,000), while the mean price of second-hand car is only one third of the new car price (21,587 zł, median=17 500 zł). Regarding the vehicle size category, small family size car (for instance, Skoda Octavia, VW Golf, Honda Civic or Ford Focus) is preferable most by Polish respondents (33%), followed by small cars (e.g., Ford Fiesta, Opel Corsa, Peugeot 208) and large size car (e.g., Audi A4, Ford Mondeo, VW Passat) with 18% and 17% shares. An executive or luxury cars – most of the hybrid cars – plan to buy 4% respondents only. About 6% is thinking to buy SUV and 7% planning to buy VAN or multi-purpose vehicle.

Using the 7-point Lickert scale, we asked then for importance of vehicle's characteristics taking into consideration when one is going to purchase it. Fuel consumption, low failure rate and car safety are considered the most important, while engine size, extended car warranty, high maximum speed, colour, but also low CO2 emissions are rated as least important car characteristics. Purchase price, fuel costs and maintenance costs are rated same by 6 points, but they are both less important than the fuel efficiency and car safety.

5 Results

The results presented here are based on responds provided by respondents sampled from general population (Sample B) who declared that they intend to buy a new car. Excluding the speeders, it results in total of 489 respondents, giving us 3,912 observations (8 responses from each respondent).

Table 2a presents a general overview of respondents' preferences. The first panel presents the results of a simple multinomial logit model (MNL), the second gives the results of a mixed logit model (MXL) which is superior in being able to take the respondents' unobserved heterogeneity into account (i.e., it does not assume that every respondent has exactly the same preferences, but instead models respondents' preferences as normal distributions – and hence provides an estimate of the mean and standard deviation of the distribution of parameters for each attribute).

The first three parameters represent alternative specific constants associated with one of the alternative fuel technologies: HV – hybrid, PV – plug-in hybrid, and EV – electric vehicles. Since all the coefficients are negative we conclude that respondents are, in general, reluctant to choose alternative fuelled cars and prefer a conventional car (reference). The relative values of the coefficients indicate, that respondents are more likely to buy hybrid plugin cars, then hybrid, and consider electric vehicles as the most (unfavourably) different to conventional fuelled ones. We note, however, that there is considerable preference heterogeneity with respect to these parameters, as indicated by relatively large standard deviations – even though the estimates of the means are negative, a substantial share of the population would have positive preferences for the alternative fuel vehicles.

The next set of parameters describes respondents' preferences for the purchase price (PP, in 10,000 PLN), operating and fuel cost (OC, in 100 of PLN per month), driving range (DR, in 100 km) and recharge/refuel time (RT, in hours). The purchase price (in 10,000 PLN) is naturally negative since higher costs are associated with negative utility. Similarly, higher operating and fuel costs and recharge time make respondents' worse off. Larger driving range, on the other hand is, as expected, preferred. All this parameters are statistically significant.

The next set of parameters describes additional perks included in the experiment to see if there are easily achievable policies which could make respondents more likely to buy alternative fuel cars. We found that offering free public transport (FT) and free parking (FP) were to a large extent insignificant, although considerable preference heterogeneity indicates that there are some respondents for whom the attributes are highly demanded.

Finally, the last two attributes represent the influence of the availability of fast-charge infrastructure (medium availability – INFR2 or high availability – INFR3, vs. low availability – the reference) for choosing a particular alternatives. We only observe a significant effect for high availability of this kind of infrastructure, potentially indicating high non-linearities in respondents' preferences (only high enough level of charging infrastructure is perceived by respondents as beneficial).

Table 2a. Estimation results – basic model

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-0.8069*** (0.0593)	-1.3769*** (0.1760)	2.2669*** (0.1640)
PV	-0.7015*** (0.0719)	-1.1513*** (0.1734)	2.1792*** (0.1529)
EV	-0.6490*** (0.1239)	-2.8017*** (0.2962)	3.1392*** (0.2119)
PP	-0.4388*** (0.0291)	-1.3103*** (0.0839)	1.0240*** (0.1019)
OC	-1.0836*** (0.1551)	-4.0224*** (0.4468)	1.4732*** (0.5457)
DR	0.1144*** (0.0118)	0.1881*** (0.0193)	0.1058*** (0.0367)
RT	-0.0311** (0.0147)	-0.1066*** (0.0331)	0.2568*** (0.0406)
FT	0.1195*** (0.0412)	0.1048 (0.0809)	0.6350*** (0.1166)
FP	0.1837*** (0.0411)	0.2675*** (0.0761)	0.6057*** (0.1288)
INFR2	0.3169*** (0.0694)	0.6517*** (0.1093)	0.0003 (0.3889)
INFR3	0.6082*** (0.0665)	1.1472*** (0.1105)	0.6111*** (0.1675)
Model characteristics			
Log-likelihood (constants only)	-5273.54	-5273.54	
Log-likelihood	-5032.09	-3895.54	
McFadden's pseudo-R^2	0.05	0.26	
AIC/n	2.58	2.00	
n (observations)	3912.00	3912.00	
k (parameters)	11.00	22.00	

To make it easier to interpret our results, we also present the same models estimated in monetary-space – i.e., all utility function parameters were represented in relation to the (negative) purchase price coefficient. This allows for interpreting parameters in Table 2b as if they were marginal rates of substitution of each attribute for the purchase price, i.e. the trade-off that makes respondents indifferent – how much more they would have to pay for a car to get each of the attributes to have the same utility level (this is analogue to the willingness to pay measure).

The results provided in Table 2b allow for convenient interpretation but are otherwise equivalent of those presented in Table 2a. To provide an example – the coefficient of -1.2998 for the mean preferences for *HV* means, that purchasing a hybrid vehicle would be an equivalent of purchasing a conventional vehicle but having had to pay 12,998 PLN more (on average for entire sample). The same interpretation can be used for all the other coefficients. We note that PP is expressed in 10,000 PLN, so each value should be multiplied by 10,000 to get money equivalent in PLN. Operation cost and driving range are measured in PLN per 100 km or in 100 km, so one needs additionally to divide the values by 100 to get WTP per unit; WTP for OC is estimated at about 360 PLN per 1 PLN of OC per km, and WTP for DR is 12.6 PLN per additional km driving range (i.e., x10,000/100 in both cases).

WTP for additional benefits are 748 PLN for free public transport and 2,850 PLN for free parking, however the coefficient of the former is not statistically significant. WTP for fast-mode recharging infrastructure is 4,649 PLN (medium) and 8,817 PLN (high). The last coefficient (PP) presents the non-normalized value for the underlying normal distribution of the lognormally distributed purchase price in preference space and as such does not have a direct interpretation.

Table 3b: Estimation results – basic model in WTP-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-1.8387*** (0.1817)	-1.2998*** (0.1316)	2.2540*** (0.1657)
PV	-1.5985*** (0.1914)	-1.1996*** (0.1009)	1.9881*** (0.1208)
EV	-1.4788*** (0.3003)	-2.8692*** (0.2645)	2.8796*** (0.1679)
OC	-2.4692*** (0.3840)	-3.5978*** (0.3752)	1.6698*** (0.1627)
DR	0.2607*** (0.0309)	0.1258*** (0.0194)	0.1076*** (0.0140)
RT	-0.0708** (0.0334)	-0.0520** (0.0204)	0.1549*** (0.0182)
FT	0.2723*** (0.0951)	0.0748 (0.0547)	0.2469*** (0.0943)
FP	0.4186*** (0.0967)	0.2850*** (0.0548)	0.0802 (0.0712)
INFR2	0.7221*** (0.1625)	0.4649*** (0.0835)	0.4678*** (0.0811)
INFR3	1.3860*** (0.1645)	0.8817*** (0.0864)	0.5406*** (0.1466)
PP	0.4388*** (0.0291)	0.2098*** (0.0798)	1.1516*** (0.1035)
Model characteristics			
Log-likelihood (constants only)	-5273.54	-5273.54	
Log-likelihood	-5032.09	-3918.69	
McFadden's pseudo-R^2	0.05	0.26	
AIC/n	2.58	2.01	
n (observations)	3912.00	3912.00	
k (parameters)	11.00	22.00	

We next consider the possibility that respondents' preferences for all choice attributes are alternative-specific. Table 3 presents the results in which all attributes were interacted with alternative specific constants for alternative fuel technologies. The results show that in some cases respondents are indeed more or less sensitive to some attributes when purchasing a particular type of car. For example, respondents appear to be less sensitive to the purchase price of hybrid vehicles (as indicated by a positive and significant interaction PP*HV) in the MNL model – these result goes away, however, once preference heterogeneity is accounted for. Most of the interaction effects in the MXL model are in fact insignificant – showing that the attributes are fairly generic and preferences for them do not depend on the kind of the car respondents were thinking of purchasing – with one exception: when considering electric vehicles, respondents were much (three times) more sensitive to the driving range, and somewhat more sensitive to high availability of fast-charge infrastructure. These results are understandable, considering that electric vehicles have, on average, lower range.

We now turn to investigating how the preferences of our respondents' differed with respect to their socio-demographic characteristics as well as with respect to the type of car they intended to buy. Table 4presents the results of the models estimated for respondents who intended to buy a new or used car, or were still undecided, respectively.

By inspecting relative values (absolute values of coefficients are not comparable between different models) we find that respondents who intend to buy a used car about half less generally opposed to purchasing alternative fuel vehicles (relative to the purchase price). They are also less sensitive to operating cost and much less sensitive to recharging time. On the other hand, respondents who intend to buy new cars are much more interested in accompanying bonus policies, such as free parking or public transport, as well as to the availability of fast-mode charging infrastructure. The results also make it possible to establish whether the respondents who are undecided whether they want to buy a new or used car are more similar to one or the other category, with respect to each of the attributes.

Tables 5 – 6 present the results of the three separate models for respondents' with low, medium and high level of education, and for respondents who declared to be living in urban, sub-urban and rural neighborhoods, respectively.

Last model, Table 7, reports the estimation results when the vehicle attributes are interacted with income. Variables with "NaN" ending denotes dummy variable equal to one if respondent did not provided information on income. We find that richer people are more in favor of hybrid cars and less favor in electric cars (those who did not provided income information are even less favor in EV). They are also less sensitive on operational and fuel costs.

Table 4: Estimation results – model with alternative specific attributes, preference-space

	MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-1.8595*** (0.2970)	-0.8899 (0.5770)	1.3082*** (0.2824)
PV	-1.1730*** (0.2846)	-1.7030*** (0.5927)	1.6799*** (0.2314)
EV	-0.9328*** (0.2488)	-4.1261*** (0.7379)	3.0771*** (0.3049)
PP	-0.4668*** (0.0318)	-1.3875*** (0.1005)	1.2319*** (0.1255)
PP*HV	0.0903*** (0.0170)	-0.0169 (0.0512)	0.2043*** (0.0531)
PP*PV	0.0203 (0.0160)	-0.0489 (0.0455)	0.1426*** (0.0449)
PP*EV	-0.0306 (0.0168)	-0.1178 (0.0805)	0.3062*** (0.0688)
OC	-1.7283*** (0.2634)	-5.3359*** (0.5893)	1.1320** (0.5607)
OC*HV	0.4819*** (0.1503)	0.1235 (0.4421)	0.8914*** (0.2750)
OC*PV	0.2506 (0.1393)	0.4645 (0.4222)	1.1794*** (0.2858)
OC*EV	-0.7840** (0.3117)	-0.5743 (1.0723)	5.4000*** (0.7995)
DR	0.0795*** (0.0208)	0.1496*** (0.0366)	0.1174*** (0.0422)
DR*HV	0.0439 (0.0325)	-0.0848 (0.0629)	0.2043*** (0.0352)
DR*PV	0.0260 (0.0307)	0.0296 (0.0529)	0.1857*** (0.0331)
DR*EV	0.1024*** (0.0352)	0.3188*** (0.0699)	0.0681 (0.0948)
RT	-0.0020 (0.0378)	-0.0524 (0.0655)	0.1941*** (0.0501)
RT*EV	-0.0425 (0.0454)	-0.1130 (0.0857)	0.3385*** (0.0622)
FT	0.1509 (0.0924)	0.2521 (0.1588)	0.6348*** (0.1215)
FT*PV	-0.0666 (0.1297)	-0.0666 (0.2265)	0.0617 (0.3839)
FT*EV	0.0010 (0.1277)	-0.2678 (0.2598)	0.9495*** (0.3018)
FP	0.2157** (0.0918)	0.3042** (0.1482)	0.7260*** (0.1303)
FP*PV	0.1185 (0.1251)	0.1862 (0.2045)	0.0434 (0.4503)
FP*EV	-0.1949 (0.1302)	-0.2358 (0.2427)	0.0835 (0.4727)
INFR2	0.3217*** (0.0991)	0.6894*** (0.1658)	0.0000 (0.2894)
INFR2*EV	-0.0133 (0.1403)	-0.0996 (0.2970)	1.0754*** (0.3675)
INFR3	0.4410*** (0.0963)	1.0194*** (0.1681)	0.8136*** (0.1898)
INFR3*EV	0.3700*** (0.1375)	0.7165*** (0.2761)	1.2464*** (0.3635)
Model characteristics			
Log-likelihood (constants only)	-5273.54	-5273.54	
Log-likelihood	-4994.32	-3838.28	
McFadden's pseudo-R^2	0.05	0.27	
AIC/n	2.57	1.99	
n (observations)	3912.00	3912.00	

Table 5: Estimation results – new car and used car segment, WTP-space

	NEW car segment			USED car segment		
	MNL model	MXL model		MNL model	MXL model	
	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)	Coef. (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-0.8590*** (0.1257)	-1.8021*** (0.4508)	2.7663*** (0.5153)	-0.8813*** (0.0838)	-1.4485*** (0.2654)	2.4727*** (0.2883)
PV	-0.5811*** (0.1496)	-1.4077*** (0.4022)	2.4778*** (0.3837)	-0.8238*** (0.1022)	-1.2571*** (0.2518)	2.3698*** (0.2245)
EV	-0.7104*** (0.2657)	-3.0534*** (0.8028)	3.7707*** (0.5438)	-0.5571*** (0.1720)	-2.4655*** (0.4273)	2.9553*** (0.2908)
PP	-0.3016*** (0.0370)	-1.0233*** (0.1380)	0.9077*** (0.1417)	-0.5919*** (0.0710)	-1.6407*** (0.1896)	1.5792*** (0.2491)
OC	-1.2825*** (0.3869)	-4.2054*** (1.2326)	0.1647 (2.0700)	-0.8188*** (0.1995)	-3.4320*** (0.6284)	0.4621 (0.9599)
DR	0.0975*** (0.0247)	0.1652*** (0.0506)	0.0000 (0.1140)	0.1284*** (0.0165)	0.2199*** (0.0285)	0.1472*** (0.0515)
RT	-0.0353 (0.0312)	-0.1784** (0.0899)	0.3354*** (0.1037)	-0.0280 (0.0205)	-0.0806 (0.0422)	0.2757*** (0.0587)
FT	0.0797 (0.0876)	0.1212 (0.2545)	0.8041** (0.3451)	0.1146** (0.0582)	0.1064 (0.1123)	0.4985*** (0.1736)
FP	0.2099** (0.0874)	0.3257 (0.2178)	0.5482 (0.3659)	0.1426** (0.0579)	0.1343 (0.1147)	0.7411*** (0.1634)
INFR2	0.1355 (0.1468)	0.5843 (0.4059)	0.6766 (0.6666)	0.4268*** (0.0968)	0.7594*** (0.1527)	0.0001 (0.4997)
INFR3	0.4667*** (0.1408)	1.2376*** (0.2848)	0.0552 (0.6315)	0.6296*** (0.0934)	1.1624*** (0.1437)	0.2504 (0.3692)
Model characteristics						
Log-likelihood (constants only)	-1179.97	-1179.97		-2697.74	-2697.74	
Log-likelihood	-1123.40	-813.64		-2598.99	-2055.00	
McFadden's pseudo-R^2	0.05	0.31		0.04	0.24	
AIC/n	2.58	1.90		2.59	2.06	
n (observations)	880.00	880.00		2016.00	2016.00	
k (parameters)	11.00	22.00		11.00	22.00	

Table 5: Estimation results – MXL for low medium and high level of education, preference-space

	Low education		Medium education		High education	
	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-3.3532 (6.6353)	2.7082 (2.2181)	-0.4117 (1.2382)	1.4670** (0.5787)	-1.4585** (0.6065)	1.9862*** (0.2511)
PV	-4.0477 (4.7209)	1.2629 (2.5876)	-0.2125 (1.1311)	2.8202*** (0.5688)	-1.9955*** (0.5282)	1.6424*** (0.2593)
EV	-0.8471 (10.0933)	3.5251 (3.8009)	-2.0050 (1.1474)	3.1463*** (0.5422)	-4.1085*** (0.6921)	3.0509*** (0.3373)
PP	-0.4077 (2.2026)	1.5099 (1.7969)	-1.4452*** (0.2612)	0.8597*** (0.3185)	-1.5593*** (0.1306)	1.2575*** (0.1271)
PP*HV	-0.0169 (1.2489)	0.1724 (1.3825)	0.0392 (0.1920)	0.4145*** (0.1514)	-0.0116 (0.0621)	0.2495*** (0.0578)
PP*PV	-0.3348 (1.1196)	0.8553 (0.9273)	-0.2091 (0.1756)	0.1376 (0.1689)	-0.0744 (0.0539)	0.1942*** (0.0571)
PP*EV	0.1426 (1.4572)	0.0035 (1.8547)	-0.1279 (0.1992)	0.4530*** (0.1517)	0.0171 (0.0740)	0.2040*** (0.0693)
OC	-2.8646 (9.6157)	0.0000 (10.4927)	-2.3717** (1.1702)	0.0000 (1.8243)	-6.3968*** (0.6781)	0.0357 (0.9834)
OC*HV	1.9233 (7.3161)	0.0000 (3.3661)	-1.3135 (1.1774)	1.7406** (0.7117)	0.2504 (0.6350)	0.8781** (0.3633)
OC*PV	3.4809 (3.2140)	1.8697 (3.4864)	-0.9644 (0.9003)	0.0451 (0.7192)	1.4575*** (0.5182)	1.1000*** (0.3936)
OC*EV	0.3813 (7.3754)	1.7681 (8.9147)	0.5170 (1.9385)	1.4377 (2.4539)	0.4619 (1.2452)	4.2807*** (1.1067)
DR	0.1838 (0.2320)	0.0000 (1.3502)	0.2060*** (0.0537)	0.1640** (0.0814)	0.2090*** (0.0256)	0.1345*** (0.0467)
RT	-0.0683 (0.4184)	0.3153 (0.4322)	-0.1128 (0.0705)	0.1340 (0.0956)	-0.1173** (0.0485)	0.3529*** (0.0522)
FT	0.5621 (1.0742)	0.3828 (2.9623)	0.0869 (0.1620)	0.0002 (0.4068)	0.1239 (0.1122)	0.7266*** (0.1434)
FP	-0.1197 (0.7992)	0.0094 (4.7057)	0.0676 (0.1900)	0.8638*** (0.3112)	0.4014*** (0.1047)	0.6481*** (0.1575)
INFR2	0.3055 (1.1611)	0.0000 (9.5908)	1.0450*** (0.2512)	0.0406 (1.2957)	0.5259*** (0.1530)	0.3878 (0.3293)
INFR3	1.4203 (1.4164)	1.3854 (2.4279)	1.3474*** (0.3253)	1.2544*** (0.3535)	1.1571*** (0.1364)	0.3955 (0.2768)
Model characteristics						
Log-likelihood (constants only)						
Log-likelihood	-295.18		-957.27		-2576.71	
McFadden's pseudo-R^2	0.30		0.26		0.27	
AIC/n	2.08		2.05		1.99	
n (observations)	320.00		968.00		2624.00	
k (parameters)	34.00		34.00		34.00	

Table 6: Estimation results – MXL for urban, suburban, rural residence area, preference-space

	Urban		Suburban		Rural	
	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)	Mean (s.e.)	Standard deviation (s.e.)
HV	-1.4258*** (0.2723)	2.1291*** (0.1299)	-2.0900** (0.9256)	2.4176*** (0.4742)	-1.9334** (0.9274)	1.4238*** (0.5167)
PV	-1.0528*** (0.2829)	1.7702*** (0.1490)	-1.0064 (1.0979)	1.9276*** (0.6108)	-3.0086*** (0.8884)	2.2738*** (0.3182)
EV	-1.4637*** (0.3589)	3.1394*** (0.1624)	-2.2471** (1.1058)	2.5913*** (0.6172)	-4.2281*** (1.2204)	3.9225*** (0.6184)
PP	-1.1424*** (0.0714)	0.9495*** (0.0623)	-1.5178*** (0.2382)	1.4536*** (0.2869)	-1.7289*** (0.2297)	1.4775*** (0.2707)
PP*HV	0.0166 (0.0318)	0.1661*** (0.0385)	-0.0471 (0.1301)	0.2487** (0.1055)	-0.0500 (0.1243)	0.4638*** (0.1479)
PP*PV	0.0053 (0.0245)	0.0172 (0.0265)	-0.1960 (0.1020)	0.2031 (0.1424)	0.1092 (0.1067)	0.0936 (0.1105)
PP*EV	-0.1171*** (0.0257)	0.3265*** (0.0559)	-0.1324 (0.1314)	0.2569 (0.1313)	0.0480 (0.1334)	0.2075 (0.1428)
OC	-3.5925*** (0.3815)	0.0000 (0.0000)	-4.1852*** (1.2305)	0.9923 (1.4044)	-6.1621*** (1.0174)	0.0000 (1.7788)
OC*HV	-0.0152 (0.2631)	0.0000 (0.0000)	0.4862 (0.8137)	0.8800 (0.7030)	1.0902 (1.0201)	1.4138** (0.6458)
OC*PV	-0.0419 (0.3155)	1.6170*** (0.2054)	0.3464 (1.2227)	2.5648*** (0.8139)	1.5771** (0.8024)	0.3280 (0.9157)
OC*EV	-1.8505*** (0.5922)	2.2780*** (0.4572)	0.5755 (2.0615)	4.8778*** (1.6460)	0.8969 (2.2070)	5.6194*** (1.6425)
DR	0.1597*** (0.0145)	0.1055*** (0.0372)	0.2152*** (0.0490)	0.1952*** (0.0704)	0.1891*** (0.0379)	0.0000 (0.1298)
RT	-0.1197*** (0.0220)	0.2093*** (0.0336)	-0.1190 (0.0687)	0.2013** (0.0978)	-0.0680 (0.0561)	0.1918** (0.0831)
FT	0.1176 (0.0608)	0.8322*** (0.0810)	0.3196** (0.1600)	0.2806 (0.4496)	0.0685 (0.1538)	0.5546 (0.2981)
FP	0.2987*** (0.0575)	0.6762*** (0.0983)	0.1573 (0.1917)	0.8836*** (0.2838)	0.3754** (0.1581)	0.8624*** (0.2185)
INFR2	0.6156*** (0.0860)	0.0000 (0.0000)	0.4454 (0.2331)	0.5336 (0.5493)	0.7034*** (0.2533)	0.5288 (0.4225)
INFR3	0.9239*** (0.0881)	0.8741*** (0.1257)	1.1759*** (0.2728)	0.9653** (0.4184)	1.4611*** (0.2623)	0.9849*** (0.3015)
Model characteristics						
Log-likelihood (constants only)						
Log-likelihood	-6654.96		-1070.01		-1304.56	
McFadden's pseudo-R^2	0.26		0.28		0.27	
AIC/n	1.99		1.99		2.03	
n (observations)	6712.00		1112.00		1320.00	
k (parameters)	34.00		34.00		34.00	

Table 7: Estimation results – attributes specific to income level, preference-space

	MNL		MXL			
	coef.	st.err.	coef. (mean)	st.err. (mean)	coef. (std)	st.err. (std)
HV	-0.8453	*0.0711*	-1.5133	*0.2081*	2.2058	*0.2063*
HV*INCOME	0.2936	*0.0739*	0.3832	*0.2335*	0.8186	*0.3682*
HV*INCOME_NaN	0.1409	*0.1899*	0.2129	*0.6149*	1.1448	*0.9266*
PV	-0.6919	*0.0846*	-1.2106	*0.2049*	2.2379	*0.1915*
PV*INCOME	0.0857	*0.0952*	-0.1466	*0.2396*	0.8577	*0.3676*
PV*INCOME_NaN	-0.1223	*0.2294*	-0.7572	*0.6614*	1.4304	*0.8727*
EV	-0.6678	*0.1453*	-2.4335	*0.3488*	3.2283	*0.2541*
EV*INCOME	-0.5789	*0.1814*	-1.6554	*0.4734*	0.9953	*0.4544*
EV*INCOME_NaN	-0.2274	*0.3925*	-2.9578	*1.2090*	3.6411	*0.9626*
PP	-0.4889	*0.0409*	-1.3166	*0.1161*	1.1241	*0.1286*
PP*INCOME	0.0795	*0.0276*	-0.0136	*0.1038*	0.0688	*0.2466*
PP*INCOME_NaN	0.0746	*0.0965*	-0.4886	*0.3870*	1.4033	*0.4394*
OC	-1.3779	*0.1811*	-3.9368	*0.5009*	0.0000	*0.8590*
OC*INCOME	-0.8992	*0.2764*	-2.2802	*0.8070*	0.7487	*0.9190*
OC*INCOME_NaN	0.7085	*0.5088*	-1.5416	*1.9570*	1.8630	*1.9535*
DR	0.1272	*0.0139*	0.1969	*0.0230*	0.1203	*0.0443*
DR*INCOME	-0.0231	*0.0152*	-0.0451	*0.0335*	0.0334	*0.0880*
DR*INCOME_NaN	-0.0636	*0.0372*	-0.0520	*0.0830*	0.0067	*0.1433*
RT	-0.0477	*0.0170*	-0.1273	*0.0350*	0.1341	*0.0530*
RT*INCOME	0.0326	*0.0199*	0.0134	*0.0578*	0.3299	*0.0575*
RT*INCOME_NaN	0.0975	*0.0465*	0.1069	*0.1404*	0.0319	*0.2189*
FT	0.0993	*0.0484*	0.1072	*0.0961*	0.5076	*0.1552*
FT*INCOME	0.0483	*0.0527*	0.2074	*0.1357*	0.5444	*0.2070*
FT*INCOME_NaN	0.0971	*0.1317*	0.2009	*0.3181*	0.0341	*0.7766*
FP	0.1673	*0.0483*	0.2680	*0.0922*	0.4858	*0.1612*
FP*INCOME	0.0227	*0.0528*	0.0355	*0.1236*	0.0002	*0.3762*
FP*INCOME_NaN	0.0923	*0.1314*	0.0007	*0.3583*	1.3857	*0.3336*
INFR 2	0.3853	*0.0811*	0.7091	*0.1403*	0.5074	*0.2466*
INFR 2*INCOME	-0.1145	*0.0922*	0.1230	*0.1796*	0.0001	*0.5378*
INFR 2*INCOME_NaN	-0.3100	*0.2210*	-0.2087	*0.4487*	0.0139	*0.9512*
INFR 3	0.6785	*0.0779*	1.2553	*0.1262*	0.6633	*0.1790*
INFR 3*INCOME	-0.0814	*0.0884*	0.0172	*0.1657*	0.0611	*0.4834*
INFR 3*INCOME_NaN	-0.3376	*0.2117*	-0.4014	*0.4629*	0.6221	*0.7589*
Model characteristics						
LL0	-5273.54		-5273.54			
LL	-4991.18		-3842.68			
McFadden's R^2	0.05		0.27			
AIC/n	2.57		2.00			
n (observations)	3912		3912			
k (parameters)	33		66			

6 Conclusion

We provide the estimate of willingness-to-pay of Polish consumers for several specific attribute of hybrid, plug-in hybrid and electric passenger vehicles using the discrete choice experiments. We found preferences of Polish consumers for hybrid and electric vehicles were still significantly lower than for conventional vehicles.

Driving range and recharging time are important attributes of a passenger car which Polish consumers intend to buy. On average, Polish drivers are willing to pay about 2,500 zł for each additional 100 km of driving range. Drivers who intend to buy a second-hand car value the driving range less (1,668 zł per each 100 km) than consumers who intend to buy a new car (3,262 zł).

Recharging time and availability of charging stations are currently the most important barriers to larger spread of electric and plug-in hybrid vehicles. On average, Polish drivers are willing to pay slightly less than 1,000 zł for each hour saved for recharging. Those who intend to buy a new car are again willing to pay more than second-hand car segment (1,300 zł vs. 500 zł).

Preference for AFVs markedly rose, when availability of fast-mode recharging improved from low level (20% of fuel stations + at few public places) to medium level (60% of fuel stations + at half of public places) or even high level (90% of fuel stations + at almost all public places). Their willingness to pay for medium availability of fast mode recharging infrastructure is slightly more than 6,000 zł, and it is twice large for high availability (new care segment).

Providing other benefits, such as free parking and public transport, increases the probability to choose the AFVs. The second-hand car drivers stated implicit WTP value for free public transport for all family members of 1,700 zł and for free parking in Poland at 2,550 zł. The new car segment stated higher WTPs - 5,300 zł and 6,600 zł.

After controlling for all vehicle attributes, the most favoured AFV label is electric car, whereas hybrid car would be chosen the least often.

Results of the mixed logit models indicate that consumer preferences for AFVs and their characteristics are highly diverse. An interaction model reveals that higher levels of income increase probability to purchase HV and PHEV and weaken the effect of operational cost attribute. Effect of income on other attributes seems to be not significant. Having at least one child in a family reduces importance of other benefits (public transport and parking).

Acknowledgement

This research received funding from the European Union’s ERA-NET TRANSPORT Transnational Call Electromobility+ Programme under the project DEFINE project “*Development of an Evaluation Framework for the Introduction of Electromobility*” This support is gratefully acknowledged. Responsibility for any errors remains with the authors.

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Appendix I. List of reviewed studies

Table 6: Literature review – key characteristics of studies

	Location	Survey year	Survey method	Respondents	Target population	Choice tasks	Profiles	Attributes
Bunch et al. (1993)	United States	1991	POSTAL	343+367	random	5	3	6
Kurani et al. (1996)	United States	NA	CAWI - EMAIL SURVEY	454	owns two or more vehicles	1	2	7
Golob et al. (1997)	United States	1994	CATI + POSTAL	2023	fleet sites	according to fleet size	3	6
Brownstone, Train (1999)	United States	1993	CATI	4747	general public	NA	3	6
Brownstone, Bunch, Train (2000)	United States	1995	CATI	607	vehicle purchase since first SP inverview	1	3	9
Ewing, Sarigollu (2000)	Canada	NA	CAWI - EMAIL SURVEY	881	regular drivers	9	3	10 - 12
Dagsvik et al. (2002)	Norway	1995	CAPI	642	general public	15	28	10 - 12
Horne, Jaccark, Tiedemann (2005)	Canada	2002-2003	CAWI - EMAIL SURVEY	886	cities with population over 250000	4	3	3
Axsen (2007)	Canada, United States	2002-2006	CAWI - WEB SURVEY	544+422	gasoline vehicle owners	18	3	4
Potoglou, Kanaroglou (2007)	Canada	2005	CAWI - WEB SURVEY	426	prospective buyers	8	3	6
Caulfield et al. (2010)	Ireland	2000	CAWI - EMAIL SURVEY	168	recent buyers	6	3	8
Hackbarth, Madlener (2011)	Germany	2011	CAWI - WEB SURVEY	711	prospective buyers	15	3	8
Hidrue et al. (2011)	United States	2008-2009	CAWI - WEB SURVEY	3029	over 17 years	2	2	3
Mabit and Fosgerau (2011)	Denmark	2007	CAWI - WEB SURVEY	2146	new-car buyers	12	3	6
Qian, Soopramanien (2011)	China	2011	CAWI - WEB SURVEY + PAPI	527	random	8	3	8
Achtnicht (2012)	Germany	2007-2008	CAPI	598	prospective buyers	6	NA	4 of 8
Daziano, Chiew (2012)	United States	2000	CAWI - WEB SURVEY	500	prospective buyers	15	4-5	6
Hoen, Koetse (2012)	Netherlands	2011	CAWI - WEB SURVEY	1802	own one or more vehicles	8	3	7

Lebeau et al. (2012)	Belgium	2011	CAWI - WEB SURVEY	1197	over 18 years	10	2	6
Link et al. (2012)	Austria	2011	PAPI	274	prospective buyers	8	3	5
Shin (2012)	South Korea	2009	CAPI	250	own one or more vehicles	NA	4	4
Ziegler (2012)	Germany	2012	CAPI	598	prospective buyers	6	7	5
Daziano (2013)	United States	2000	NA	500	NA	up to 15	7	6
Chorus, Koetse, Hoen (2013)	Netherlands	2011	CAWI - WEB SURVEY	616	Company car leasers	8	3	8
Ida et al. (2013)	United States, Japan	2012	CAWI - WEB SURVEY	4202+4000	general public	8	6	7
Ito, Takeushi, Managi (2013)	Japan	2010	CAWI - WEB SURVEY	361	general public	8	30	9
Stix, Hanappi (2013)	Austria	NA	NA	714	new-car buyers	9	3	9
Our study	Poland	2014	CASI – web survey	2271	prospective buyers (sampled from general public and screened sample]	8	4	6

Appendix II. The questionnaire

SECTION A. Personal characteristics of the respondent and the respondent's partner

In case of sample A, the first question was a screening question whether respondent or any member of the respondent's household intend to buy something from a list, which included an apartment, a house or common household goods such as a car, a motorbike or a moped, a washing machine, or a dishwasher, within the next 3 years or not. We let respondents to pick up those that are planning to buy from a list to avoid something similar to "yea-saying" bias grounded in this case in the motivation of participants of e-panels who would like to participate in the survey to get a bonus for filling out the questionnaire. When we provided a list, they couldn't know which items were subject of our survey. Only respondents who chose that they intend to buy a car could continue filling the questionnaire.

Both in case of sample A and B, socio-demographic characteristics of respondents were gathered to be able to monitor quota attainment to meet quota requirements. We included the questions on education; region of the residence; size of the municipality; gender; age; a steady life partner; monthly net personal income after tax and compulsory deductions, from all sources.

SECTION B. DRIVING HABITS

- holding a driving license
- frequency of driving of a respondent and household members
- frequency of short distance trips (up to 100 km one-way), medium-long trips (up to 500 km one-way), and long distance trips

SECTION C. Characteristics of car/cars that a household possess or can use

- number of cars in the respondent's household
- usage of a company car by the respondent's household
- to which vehicle segment the car belongs to
- purchase price of the car
- fuel or alternative technology that the vehicle uses
- engine size of the car
- how many kilometres was the vehicle driven in the last 12 months
- availability of parking at a garage at home and at workplace

SECTION D. Decision-making about purchase of a car

intention to buy a car

- reasons for car purchase
- type of car
- expectations about purchase price, fuel or alternative technology, engine size, how many kilometres will be the vehicle driven per a year
- importance of various car characteristics for the purchase
- decision-making about technical parameters of the car in the household

SECTION E. Preferences for electric, hybrid car, and hybrid car with plug-in

As alternative fuel vehicles are still at an early stage of diffusion in many countries including Poland, we provided respondents with description of three types of electric driven vehicles and compared them to conventional car (see the following figure for information given in the questionnaire).

Definitions of cars as shown to respondents

1. ***Conventional car***

drives on an internal combustion engine that can be fuelled by petrol, diesel, or oil derivatives.

2. ***Electric car***

is a vehicle set in motion by an electric motor and that is powered by electricity. It has a battery which can be recharged from a regular electric socket.

3. ***Hybrid car***

is a vehicle with batteries but without a plug. It has both an internal combustion engine and electric one. The combination allows the electric motor and batteries to help the conventional engine operate more efficiently, reducing fuel use. Switching between the two engines occurs automatically without the driver's intervention. The battery is charged from the energy produced by a combustion engine during driving or while braking. A hybrid car drives several kilometres solely on electricity.

4. ***Hybrid car with plug-in***

is a vehicle with an internal combustion engine (petrol or diesel) and its batteries can also be charged from a regular electric socket (like electric cars). The car can drive several tens kilometres solely on electricity. When the batteries are empty, the car automatically switches to the internal combustion engine.

Attributes of the vehicles introduced to respondents in the discrete choice experiment

Attribute	***Description***
Purchase price	– *represents all one-time expenses associated with the purchase (including the price, taxes, registration fees, etc.).* – *The purchase price of alternative electric vehicles (electric, hybrid, and hybrid plug-in) can be lower in the future than it is now if government provides a subsidy to buy them or the alternative vehicles are exempted from an excise duty. The price of alternative vehicles can be also reduced due to technological progress.* – *On the other hand, the purchase price of conventional vehicles can be higher than it is now because of increased registration fee or if government will introduce new or revise current tax on vehicles that use fossil fuels.*
Operating costs	– *represent an average cost of driving 100 km (including all expenditures, such as the cost of fuel, maintenance and repairs, tires, technical checks, insurance and others.* – *Cost of fuel may be different in future due to shortage in worldwide supply or if environmental policy is introduced to reduce fossil fuel consumption and emissions. Therefore, operating costs will vary across the options we are going to show you.*
Driving range	– *represents the maximum distance that can be covered by a car after it is fully fuelled or charged.* – *If fully tanked, the conventional and hybrid vehicles may drive from 500 km up to 1,000 km.* – *Electric cars – with fully recharged batteries – can drive shorter distance from 150 km to approximately 500 km.*
Refueling / recharging time	– *is time required to refuel or recharge your car from empty to full. We are presenting several levels of slow mode of recharging electric or plug-in hybrid vehicles that ranges between 2h and 7 h for electric cars, and between 30 min and 3 h for a plug-in hybrid car.*
Availability of fast-mode recharging infrastructure (10 min electric car/5 min hybrid car)	– *Recently there are already known very fast recharging devices, which make recharging faster.* – *Recharging electric vehicle entirely takes only 10 minutes compared to 6 to 8 hours if recharged from an AC socket at home. Hybrid vehicle with plug-in can be then recharged within 5 minutes only.* – *The fast-mode charging stations can be available to users to various degrees. They can be located at some of existing petrol stations, for example, 20%, 60%, or 90% of petrol stations, or other frequently visited places (e.g. supermarkets, cinemas and sport stadiums).*
Additional benefits	*We would like to ask you to consider following two benefits you might get as a governmental support for promotion of purchase of alternative fuel vehicles:* – ***free parking*** *- those who would drive an electric or a hybrid car (with or without plug-in) might park their car at any public parking places in Poland for free,* – ***free public transport*** *- all family members of a person who owns an electric or hybrid car could use public transportation system, including railway or busses, and park-and-ride (PR) system fully for free.*

An example of a choice set that was presented to respondents is shown in the following figure. Each respondent evaluated eight choice sets. (The wording of the first question: "If you had to buy another car for your household and you would have only those 4 options, which car would you select?" The wording of the second and the third question: "Which car from the rest of cars do you consider the best for your household?")

	Samochód hybrydowy z możliwością ładowania	**Samochód hybrydowy**	**Samochód elektryczny**	**Tradycyjny samochód**
Koszt zakupu	**103 500 zł**	**138 000 zł**	**92 000 zł**	**115 000 zł**
Koszty eksploatacji	**50 zł** na 100 km (**1042 zł** na miesiąc)	**47 zł** na 100 km (**979 zł** na miesiąc)	**31 zł** na 100 km (**646 zł** na miesiąc)	**46 zł** na 100 km (**958 zł** na miesiąc)
Zasięg samochodu	**700 km**	**700 km**	**150 km**	**500 km**
Czas tankowania / ładowania	**2 min / 3 godz.**	**2 min**	**2 godz.**	**2 min**
Dostępność infrastruktury szybkiego ładowania *(10 min elektryczny / 5 min hybrydowy)*	**niska** (**20%** stacji benzynowych + kilka miejsc publicznych)	-	**wysoka** (**90%** stacji benzynowych + większość miejsc publicznych)	-
Inne korzyści	brak	darmowy transport publiczny	darmowe parkowanie i transport publiczny	brak
Pierwszy najlepszy	**1.**			
Druga najlepsza		**2.**		

Który z pozostałych samochodów uważa Pan(i) za najlepszy z pozostałych dla swojego gospodarstwa domowego?

Wybór			○	○

dalej

SECTION F. De-briefing questions
Debriefing questions are put at the end of the valuation section to allow for an opportunity to express disagreement with the valuation scenarios (i.e. protest votes), and to identify whether certain response patterns are legitimate or imply protest. We also let respondents to indicate to what extent characteristics of the cars were difficult or easy to understand.

SECTION G. Motivations
Section G includes both direct and indirect measures of latent constructs of the Theory of planned behavior: intention, attitudes, subjective norms, and perceived behaviour control (not used here).

SECTION H. ABOUT YOUR HOME AND TRAVEL HABITS
- type of house where the respondent live
- ownership of a house or a flat
- character of the area of the respondent's residence
- commuting by different means of transport (frequency, purpose)
- perception of technological development
- awareness of consequences of private car use
- ascription of responsibility for negative environmental effects of car use

SECTION I. Willingness to participate in car-sharing systems (not used in the paper)
Two car-sharing systems were briefly described to respondents and they were asked to decide whether they would participate in these systems under given conditions (single-bounded discrete choice question).

***SECTION* J. Socio-demographic characteristics of respondents**
- household net monthly personal income
- social status (such as single, retired, student etc.)
- marital status
- number of household members
- number of children for several age categories
- number of employed and retired household members
- postal code

***SECTION K*. Perception of the respondent of the instrument**
Finally, a question whether the respondent perceives the information that was obtained from him/her in the questionnaire should be used for the formulation of policy measures or not and specific comments on the questionnaire are placed at the end of the instrument.