

# STATED PREFERENCES AND WILLINGNESS-TO-PAY FOR ALTERNATIVE FUEL VEHICLES AND ATTRIBUTE IMPROVEMENTS: THE CASE OF GERMANY

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## **(1) Overview**

At the present, the transportation sector accounts for a large share of the final energy demand and of the total greenhouse gas emissions in Germany, since it is almost exclusively dependent on fossil fuels. Consequently, the German government promotes the substitution of alternative fuels or electricity for gasoline and diesel and has set the goal to get one million electric vehicles on the roads by 2020. Therefore, several monetary and non-monetary incentives were already introduced (e.g. tax exemption for electric vehicles, tax reduction for natural gas, biofuel quotas) or are under consideration (e.g. special parking areas or the permission for bus lane usage for electric vehicles) to accelerate the diffusion of alternative fuel vehicles (AFVs), which today account for only about 1% of the overall vehicle stock in Germany. Necessary to that end, however, is that the features of AFVs sufficiently match consumer preferences, which is a non-trivial task, as vehicle buyers' tastes are presumably very heterogeneous. Hence, the goal of this study is the assessment of the preference differences in the population regarding the most important vehicle characteristics (e.g. fuel cost, driving range, CO<sub>2</sub> emissions, vehicle tax, and a fast-charging infrastructure for electric vehicles) and the amount the different groups of vehicle buyers are willing to pay for attribute improvement, since the results could be particularly helpful for policy-makers and industrial decision-makers to increase the adoption rate of AFVs in the future, by specifically adjusting their products or incentive schemes to differences in preferences between consumer segments.

## **(2) Methods**

Our study builds on the rich body of literature on the demand for AFVs (e.g. Batley et al., 2004; Potoglou and Kanaroglou, 2007; Hidrue et al., 2011; Mabit and Fosgerau, 2011; Achtnicht, 2012; Ziegler, 2012; Hackbarth and Madlener, 2012) and focuses on the German market. Our analysis is based on a nationwide web-based stated preferences discrete choice experiment, carried out among 711 potential car buyers in July and August of 2011 for a broad variety of hypothetical fossil and alternative fuel vehicles (gasoline/diesel, natural gas, hybrid, plug-in hybrid (PHEV), electric, biofuel, and hydrogen). The seven types of vehicles considered were additionally described by up to eight attributes: (1) purchase price, (2) fuel cost, (3) CO<sub>2</sub> emissions, (4) driving range, (5) fuel availability, (6) refueling time, (7) battery recharging time, and (8) policy incentives. We estimate a mixed logit (random parameters) model to assess the preferences for the different propulsion technologies/fuel types and the vehicle features and especially to take the preference heterogeneity in the population into account. To further examine this taste heterogeneity, the alternative fuel vehicles and their attributes are interacted with socio-demographic and attitudinal characteristics of the respondents. Finally, willingness-to-pay (WTP) measures for the improvement of the various vehicle attributes are calculated for the different consumer groups.

## **(3) Results**

Our preliminary estimation results show that preference heterogeneity in the population of potential vehicle buyers exists regarding the different propulsion technologies/fuel types and the importance of vehicle attributes, and that several socio-demographic variables have an impact on vehicle choice decisions, e.g.: (1) Individuals that are younger than 44 years of age strongly prefer electric vehicles, but their vehicle choice is to a lesser extent influenced by tax exemptions; (2) Women are less likely to choose biofueled vehicles, perceive increases in charging time and CO<sub>2</sub> emissions more negatively, and prefer tax-exempt vehicles with longer driving ranges; (3) Higher education positively affects the choice of PHEVs and biofuel vehicles, dampens the influence of both monetary and non-monetary incentives and fuel costs, and intensifies the negative effect of increases in CO<sub>2</sub> emissions and recharging time; (4) Highly environmentally aware car buyers value emissions reductions significantly higher and have a higher demand for PHEVs, hybrid, electric, biofuel and hydrogen vehicles; (5) Having a daily mileage of more than 100 km raises the likelihood of choosing PHEVs, natural gas, electric and hydrogen vehicles; (6) Buyers of small vehicles have a higher probability to choose electric vehicles, but select hybrid vehicles less often; and (7) Living in a city or urban area increases the likelihood of purchasing an electric vehicle.

This preference heterogeneity is also reflected by the WTP values of German car buyers for the different fuel types and the improvement of the most important vehicle attributes. For instance, (1) Individuals with a stated purchase price below €20,000 are willing to pay less than half as much for changes in other vehicle features, compared to respondents who indicated the purchase of a more expensive car; (2) While some consumer groups strongly reject all kinds of AFVs (negative WTP), others are willing to additionally pay up to €10,000 for (fully) electrified vehicles; and (3) Depending on their socio-demographic characteristics, car buyers' WTP for the improvement of vehicle attributes differs by up to a

factor of 20 – e.g. between €500 to €6,900 for a 100 km extension of the cruising range, and between €100 and €2,000 for a CO<sub>2</sub> emissions abatement of 10% of a current average car. These findings can help to identify potential early adopters of AFVs and to differentiate and tailor incentive schemes, products, and marketing activities to the different individual consumers. Furthermore, the WTP values can provide an indication of the order of priority of the different vehicle attributes.

#### **(4) Conclusions**

Our research shows that vehicle buyers are not a homogeneous group, but assess the various propulsion technologies/fuel types and other vehicle features differently, depending on socio-demographic characteristics. In the light of the very ambitious goal of the German government to have one million electric vehicles in use in 2020, our findings show that potential early adopters of electric vehicles are young and environmentally aware individuals who intend to purchase a small car and live in cities. All other groups are more reluctant against electric vehicles (and mostly also against other AFVs) and, thus, would need more or less substantial governmental incentives and/or improvements of crucial vehicle features. The derived values could also help to identify the gap between consumers' WTP for the improvement of specific vehicle attributes (e.g. charging time, driving range) and the current market-based costs for their provision, and, thus, could provide an indication for the area and magnitude of intensified R&D activities.

#### **References**

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