HYDROGEN FUEL-CELL VEHICLES ADOPTION : A CHOICE EXPERIMENT

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Overview

French law no. 96-1236 of December 30, 1996 on air and the rational use of energy refers to "the recognized right of everyone to breathe air that is not harmful to their health". However, it is clear that more than 25 years later this law is not fully respected. Indeed, although air pollution has fallen by 48% on average in France since 2000 (Ineris data), it still causes around 30,000 deaths per year in France in 2019 and nearly 7 million worldwide (data EEA). The automobile contributes to two environmental nuisances: air pollution and the emission of greenhouse gases. However, dspite these facts, the green transport market is not enough developed and a policy in favor of green cars is necessary. In this study, we investigate the transition path to clean vehicles by focusing on the buying decision of consumers vis à vis electric, hybrid and hydrogen cars in opposition to traiditon fossil fuel vehicles. We want to investigate in what extent the consumers are ready to switch from usual fossil fuels cars to alternative "green" cars, especially electric and hydrogen one. To this aim, the drivers of the buying decision and the attitude of consumers face to the alternative cars is analysed throughout a statistical analysis of a large survey conducted in France and a choice experiment framework. More precisely, we surveyed 4500 french individuals about their attitude face to alternative cars such as electric, hybrid and hydrogen cars and their motivations to buy or not buy green vehicles. We also control their behavior about climate change and environmental issues and risks in a general manner. By investigating the drivers of the decision to buy a new alternative car to understand, we will be able to draw a better energy transition policy design, espcially about transportation but also urban planning.

The originality and value added of this work are: 1) to assess the attitudes of the consumers face to electric but also hydrogen cars in a choice experiment study for the first time in France 2) to evaluate the potential of the hydrogen market for transportation at a short and medium run horizon for industrialises countries beyond the specific California case 3) to better design the energy transition policy that could lead to encourage consumers to switch from fossils fuels to greens cars.

The survey part has been conducted but the econometric treatment of the choice experiment data are in progress. In the rest of this abstract, we then focus on the methods and framework associated to our work and we present the preliminary results derived from the statistical analysis of the survey.

Methods

We first surveyed 4500 french individuals about their preferences between fossil fuel vs electric vs hydrogen fuel-cell vehicles and then conducted a choice experiment study. The survey was carried out by the private agency Selvitys (Lille, France), and administered online between October 1, 2021 and November 1, 2021. The purposive sampling method by quotas was used to reflect the characteristics of the French population by sex, age and professional category. The stated preferences discrete choice experiment was at the center of the survey, and embraced four fuel types (Hybrid - HV-, Electric-EV-, Hydrogen fuel cell -HFC- and conventional like gasoline or diesel -CV-) vehicles) to cover all technologies, that are already available or will be available in a near future on the French market. Theses vehicles were described by: purchasing price, fuel cost, CO2 emissions, driving range, ..., and policy incentives. To reduce the hypothetical bias, respondents were solicited to treat their choices as if it were a real purchase decision, and instructed to consider they buy a city vehicle identical other than in terms of the attributes described in the experiment.

Results

The econometric analysis associated to the choice experiment is still in progress but will be available soon. However, the descriptive statistics and PCA (Principal Component) analysis of the main drivers and attitdues of the households have already been conducted. We are thus able to identify the main types of consumers and attitudes face alternative cars and environmental/climate change issues as well as some preliminary policy implications concerning the future development of the electric and hydrogen technology cars market. Mainly, we show that the electric and H2 market is very tiny nowadays and that the hydrogen market is not ready at a short-run horizon (5 years or less). Indeed, 64% of respondents run on petrol and 44.5% on diesel and only a minority (a little less than 5%) own an electric or hybrid car, which is in line with the literature (the market for alternative cars represents less than 5% of the volume of the global automobile market). Despite the nice features of electric and H2 cars, especially to reduce the CO2 emissions and achieve the energy transition, the market is thus still tiny, but why? At what horizon can we expect a mature H2 car sector in France?

- A lack of infrastructures for alternative cars:

As previously identified in the existing literature, the relatively lack of infrastructures is a crucial problem for the development of H2 and alternative cars. 37% of people say they have a fast charging station in their city, 22% less than one km away, 13% at home, 11% in their car park or on their street. More than 45% of people think that the lack of infrastructures are an obstacle to the H2

market development. As a a consequence, we confirm that infrastructures need to be developed at a very short-run horizon as a complement to the car market.

- *A lack of knowledge about H2 cars and their environmental impact:*

There is a lack of knowledge about the benefits of H2 cars, espcially about CO2 emissions. Half of respondents of our survey believe that a hydrogen vehicle has no environmental benefits and only 5 to 20% recognize the virtues of a H2 car. This information asymetry must be associated with the fact that around 60% of respondents are not familiar with hydrogen cars at all. A roughly similar proportion don't know whether these cars pollute more or less than battery-electric cars, although only 6% think this is the case. A communication and educational effort around the benefits and interests of hydrogen for the economy and the environment, is a policy necessary in France for the sector to develop.

- *The need to strongly reduce the price of H2 cars to get a mature market in a short-run horizon*

The price of the vehicle is important for 80% of the respundents, so it is a fundamental determinant. The average price of a new vehicle is 26,000 euros in France today but this price is far from the median price of H2 cars. It is a proble since people underestimated the price of H2 vehicles and are not ready to increase their expenditures. An H2 car would therefore imply a price increase of at least 100% at the current best rates. However, the French would not really be inclined to pay more for a hydrogen car: more than 30% refuse any increase and nearly 85% do not wish to pay more than 20% maximum the average price to afford the services of a hydrogen car. More than 70% of respondents think that they should not have to pay more to benefit from a hydrogen car. Thus, reducing the price of the H2 car is an essential prerequisite for hoping to take off this market. In addition, Only 28% of those polled would be ready to buy an H2 car today, but this proportion increases significantly over a 5-year horizon (45%) then 10 years (55%).

- *The great importance of the car caracteristics and of the national brand*

We find that almost half of individuals (about 42% of the respondents) emphasize interest in national (French here) brands and among vehicle owners, more than 40% have a French brand car yet, which are overrepresented compared to other brands. We can think that if households were able to buy a car at H2, the fact of benefiting from a French offer would be a huge facilitator. As a consequence, the development of the H2 car market would be facilitated by the emergence of national hydrogen car models.

- *Attitude face to climate change and environmental issues and social behaviours*

60% of respondents pay attention to the environment to avoid punishment and nearly 50% have pro-environmental behavior to be well regarded by others, with a similar proportion declaring recycled to imitate their neighbours. Explicit or implicit sanctions are therefore quite important determinants of attitudes towards the environment. More than half of individuals think that the appearance of the vehicle is an important or very important outward sign of social status. The development of the H2 market is likely to go faster when the first pionneers consumers will buy a H2 car and when imitation effects will be at work.

Conclusions

Potential size of the H2 car market : a market for only 15 to 20% of the population ?

Overall, it comes from our survey analysis that the H2 car market is not ready to take-off at a very short run horizon. Only 5% of the consumers own an alternative car and not enough incentives exist in favor of electronic and H2 cars. The captive market for hydrogen cars, oriented towards a successful energy transition with less transport pollution, possibly in the context of more rationalized uses (less powerful cars in town for those who travel little, autonomous cars and powerful for those who move a lot) is potentially around 15-20%. Lot of people have no enough incomes to envisage the possibility to buy H2 cars and a large part do not understand the main benefits of H2 cars. Individuals who are too far from the price or to visualize the usefulness of these vehicles represent at least 2/3 of individuals. Incentives policy (price and subventions, infrastructures, educational about green cars) and the development of a national H2 sector with national brand producing H2 cars are needed quickly to accelerate the take-off of the hydrogen sector.

Towards a new transport model ?

We tried to evaluate if potential consumers would be interested by a new transmport model, especially in urban areas, that would be based on new hydrogen cars in a low-speed environment. Indeed, we introduce the possibility for the consumers to consider low-speed hydrogen vehicules that would be less powerful but also less expensive. To gauge their attitude face to a change in the capacity of the vehicles to go fast, we ask them about the speed limitations in urban areas. Nearly 60% of respondents agree or very much agree that speed limits in town (30km/h) are binding, but only 16% totally disagree with this statement. Nearly 65%, however, think that less powerful but in fact less expensive vehicles would be better suited to city driving, which leaves the door open for such a market in a near future. New H2 technology with a new urban transport model is a way to consider for the future.