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FUTURE OF ELECTRIC CARS IN THE EU

Wojciech Gis

Motor Transport Institute
Deputy Director
tel.: 48 22 4385125
e-mail: wojciech.gis@its.waw.pl

Jerzy Waśkiewicz

Motor Transport Institute
Economic Research Department
tel.: 48 22 4385126
e-mail: jerzy.waskiewicz@its.waw.pl

Abstract

The article presents scenarios for the EU and national development of passenger electric and hybrid cars. The forecast for 2030 of the shares of such vehicles in the total number of new passenger cars sold in various categories in the EU, has been presented. The expected carbon dioxide emissions for this time horizon, in so-called, life cycle of cars in the EU and in Poland, in relation to conventionally powered passenger cars and electric and hybrid cars, have also been presented The results of surveys conducted by the Motor Transport Institute on the interest of residents of the Polish agglomerations in the acquisition and operation of the electric cars in the coming years have been d. Questions and answers referred to the socio - demographic structure of the respondents and their households, the number of classes of the cars owned, monthly household income and self-evaluation of the quality of the income management. Also, the questions were asked about the ownership and extent of use (frequency of use of a car owned and the average annual mileage) and the criteria for the current and future choices of passenger cars (e.g. price class, purpose). The questions also concerned the technical and economic knowledge of electric cars (such as the impact on the natural environment, operating costs), as well as willingness to incur possible costs associated with the purchase of an electric car. The focus was also placed on getting to know the vulnerability of the consumers to the influence of the actions of the propaganda, administrative and economic nature, which may affect the consumers' decisions concerning the purchase of electric cars and learning about the reasons for any reluctance to use such vehicles.
Keywords*: cars, transport, carbon dioxide emissions, alternative drives*

1. Introduction

The movement of people is an eternal human need, and a factor that is able to satisfy it is the widely understood transport [7]. The passenger cars, dominating in the transport of people, offer the most convenient opportunities for the movement. However, the vast number of cars (in the world, there are currently about 1 billion of them) leads to environmental pollution as a result of, inter alia, carbon dioxide emissions. The largest carbon dioxide emission from the road transport comes from passenger cars, whose numbers are still growing.

It is anticipated that the number of registered passenger cars in Poland could rise to 19.5-20.5 million in 2020 and to 20-22 million in 2030. Demand for transport by passenger cars will increase by the 2020 by 26-35% compared to 2009 and by 36-54% in 2030 [8]. Therefore, there will be an increase in the demand for motor fuels and the emission of pollutants into the atmosphere from the road transport will increase. The motorism is a huge consumer of energy in and at present its development depends primarily on the availability of petroleum fuels. Transport means receive 25% of the world's total energy, and it should be noted that the global value of the traffic volume doubles every 30 years [4].

The dynamic development of road transport and present trends of growth in demand for fuels derived from petroleum, making the Europe dependent on the import of this raw material, causes concern to the European Commission (EC). The White Paper presented in 2011, is the European Commission's vision of an integrated strategy for the development of the European transport sector by 2050 [5]. The conclusions formulated in this document are intended to reduce, by the 2050 of the greenhouse gas emissions from the transport sector, by at least 60% through the use of alternative energy sources and new car drives technologies. According to the strategy preferred by the European Commission, by the 2030, 50% of cars with conventional internal combustion engines will be eliminated from the use in the cities and by the 2050 they should disappear from European cities.

Now one can critically evaluate the EC's proposals contained in the White Paper cited, if only because the indicated objectives have been determined based primarily on the premise to reduce pollutants emissions from internal combustion engines of vehicles. It did not take into account the fact of the absence of at least sufficiently mature technologies of generation and energy storage to ensure their implementation. Further, it did not incorporates economic and investment capabilities of the EU countries (including Poland's) in the field of new technologies for s production of the energy carriers, and it does not include the expected limited economic capabilities of individual societies in the field of absorbing new technology for transport means.

In view of the assumed higher than the average in the EU-15, rate of development of the Polish economy up to the 2050 and the projected increase in the mobility of the population in Poland, assuming the same rate of the pollutants emissions reduction, as the average for the EU (i.e. by min. 60%) would result in very drastic limitations in this respect in the years 2030 - 2050, which seems unlikely. The solution could be activities leading to a significant reduction in the mobility of society, which, however, would be contrary to the intentions contained in the White Paper [8].

Regardless of a realistic assessment of the conclusions from the White Paper, from the point of view of the Polish economy, the European Commission and some Member States will aim to accept targets of a significant reduction in pollutants emissions from transport. One of the promising alternatives seems to be the electric cars market, provided, however, of the development of energy system based on technologies using renewable energy sources (RES).

As a result of the, created by the politicians, climate creating the impression of superiority of electric cars system over the development of the automotive industry using traditional propulsion system, there are studies being undertaken to assess the real opportunities for the development of electromobility in the forthcoming years. Among the others, DG CLIMA commissioned research institutes to perform studies on the possibility of obtaining, on the large-scale, the effects of the development of the use of electric vehicles [5]. The study covered the evaluation of both, the pure transport elements (such as structure of the fleet), as well as components for the generation of electricity or the impact on the pollutants emissions, including greenhouse gases, costs, etc.

The essential conclusion of the research and studies is that in the near future the share of electric vehicles in the market will remain relatively small compared with that of conventionally powered vehicles. In the long term, most probably, the share of electric vehicles will increase in view of the progress in the construction of this type of vehicles.

2. Scenarios for the EU development of passenger electric and hybrid cars

The popularisation of electric vehicles is currently hampered by two main issues: a small range of cars determined by the capabilities of car batteries and their high costs as well as limited access to the charging infrastructure. These two factors are likely to govern the scenarios for the future development of the electric cars market [6]. Specific scenarios for the development of electromobility enable the assessment of the impact of the operation of such vehicles in the EU, on the energy consumption and carbon dioxide emissions.

It is expected that the spread of electric vehicles, at least up to 2020, will be very limited. The main barrier is the availability of charging infrastructure, both in places of residence, in the workplaces, and in various public places. Faster market growth will occur in the case of PHEV (Plug-in Hybrid Electric Vehicles) type vehicles, which will, however, depend on larger availability of them to the potential users than vehicles FEV (Full Electric Vehicles).

Depending on the variant of the electric passenger cars market development in the EU, it is expected that their shares in the sale of new vehicles in 2030 will be as follows [6]: PHEV 13.5% - 32.6%, FEV 1.9% - 29%.

In the optimistic scenario, the share of FEV cars in the fleet structure will be close to the share of PHEV vehicles. This is the effect resulting from the assumptions regarding costs reduction of the batteries, increase of the range and significant development of the charging infrastructure. These elements would have affected the growth of the competitive of FEV cars to the PHEV ones. Then PHEV vehicles could be only a temporary technology towards full electromobility based on FEV vehicles. This does not change the fact that the increase in the share of electric vehicles in the car fleet of the EU will be slow. A particularly important factor in the success of electric vehicles can be different kinds of business models (e.g. leasing of batteries, vehicles, etc.) contributing to the increase of competitiveness of new technologies compared to conventional vehicles. Also, the national and local policy covering financial and fiscal incentives to consumers, can contribute to the growth of sales of electric cars [6].

The estimated share of electric cars in the structure of total passenger car fleet in the EU in 2030 will be [6]: PHEV 6.3% - 17.9%, FEV 1.0% - 8.7%.

Future average shares of electric cars in the structure of sales of new passenger cars will vary for individual EU countries. The largest shares are expected in Germany, and the smallest in Poland. The factors causing these differences are, among the others: the expected level of income of the population, vehicle taxation, etc. (Tab. 1).

Tab. 1. Projected, for the 2030, share of electric cars sales in the total sales of vehicles in Germany, Spain, France and Poland (optimistic variant) [%] [6]

	Germany	Spain	France	Poland
Conventional	31.8	51.1	45.9	59.7
PHEV	32.2	23.6	21.0	14.7
FEV	29.8	25.3	33.1	25.6

Savings in the consumption of fuels (petroleum derivatives) due to the development of electromobility, in 2030 in the EU can range from 6% to 20% as compared to the use of cars with conventional engines only. By the 2030, the demand for electricity by the EU road transport will reach the level of between 140 000 TJ to 550 000 TJ, which would be a 1 to 4% of the total projected electricity consumption in 2030.

The use of electricity in road transport of people in the EU may affect, by the 2030, the limiting of the carbon dioxide emissions at a level of 4% to 12% of the forecast emissions in the variant not envisaging the development of electromobility in general. The situation in individual countries will be affected to a large extent by the structure of the supply of electricity from various sources, and above all, energy supply from renewable sources.

The differences between conventional mobility based on internal combustion engines (ICE) and BEV in terms of carbon dioxide emissions are summarised in Tab. 2. Especially considering the expected development of the European electricity production mix towards renewables, it is. Evident that EVs may lead to a considerable reduction of carbon dioxide emission [2].

Tab. 2. Comparison of WTW carbon dioxide emissions for conventional gasoline ICE vehicles, biofuels conventional ICE in relation to the electricity mix. EU-27 Electricity mix coal and renewables derived from Eurostat. Emissions from (CONCAWE and JRS) [g/km]

	Well to Tank	Tank (Batteries) to Wheels	Total CO_{2eq} Emissions
Conventional ICE Car*	23	120	143
Biofuels	17-28	97-135	114- 163
Battery Electric Vehicle 27% Nuclear 20% Renewable 53% Fossils (EU-27 mix 2010)	67-84	0	67-84
Battery Electric Vehicle (Coal)	126-155	0	126-155
Battery Electric Vehicle 50% Wind 50% Photo Voltaic (Renewables)	0-4**	0	0-4*

**Definition of conventional ICE from (CONCAWE and JRC)*
*** Emissions for Photovoltaics from EPIA, Wind from EWEA*

Again the impact would not be the same everywhere; for instance in a country where most of electricity is produced by burning coal there would be only minor GHG emission benefit from the EV introduction. The reduction is associated with the use of renewable energies with the lowest values for EVs achieved e.g. in the emerging "carbon free communities", where the electricity is entirely produced by wind, water, photovoltaic, geothermal energy, biomass or animal waste [2].

3. Researching the interest in the acquisition and operation of electric cars in Poland

The work on the European eMAP project (electromobility - scenario based Market potential, Assessment and Policy options) performed in the years 2012 to 2015 by BASt and DLR in Germany, VTT in Finland and ITS in Poland [3] is devoted to problems of development of the use of electric cars and the development of electromobility.

The project aims to present the future of electromobility development scenarios taking into account the specifics of diversification of the EU regions. The study in Poland covered a total of 370 randomly selected households located in urban areas. The questions and answers concerned the socio - demographic structure of the respondents, number and class of cars owned. The questions asked referred to the ranges of use of the car owned and the criteria for current and future choices of cars. Questions also focused on the technical and economic knowledge on electric cars, as well as readiness to incur any costs associated with the purchase of an electric car. The focus was also on getting to know the vulnerability of consumers to the influence of the propaganda, administrative and economic activities that may affect the consumers' decisions on the purchase of electric vehicles and learning the reasons for any reluctance to use such vehicles.

The average age of a household representative responding to the survey questions was 40 years old. The average number of people at the household tested was 3 people while 70% of surveyed households are located in the dense urban area.

The vast majority of surveyed households has cars. Often there are two cars and more. Average number of cars in the household, calculated based on the answers given by the respondents was 1.9. Among the respondents, 2/3 of them drive a car every day or almost every day. The car which

is usually used by half of the respondents, is an average car (price range of e.g. VW Golf) and by a ¼ of respondents is a small car (price range e.g. of VW Polo). One quarter of respondents declare average annual mileage of up to 10 thousand km, 1/4 of 10 - 15 thousand km, and 1/5 annually covers 15 - 20 thousand km.

The majority of respondents (85%) plan to purchase a passenger car that will replace the previously used car or will be an additional car in their household.

Half of the respondents declares that, when planning to purchase a passenger car, will consider buying a car with electric or hybrid "plug-in" type car. The reason is understandable: electric cars are now beyond the reach of even middle-affluent citizens, due to their high price now and the expected price in the coming years. The passenger cars users predict that they will still want to use vehicles with internal combustion engines because they have confidence in this type of drive and these cars are affordable to them. Those planning to purchase passenger cars, which will replace the previously used ones, in majority (2/3), take into account the purchase of used, cheaper vehicles. It seems that this is a realistic look at the matter, in respect to their own economic capabilities.

When it comes to selecting a car that respondents intend to buy taking into account, for example, average carbon dioxide emissions in grams per 1 km of the mileage and the average price of the car, they would choose first of all a variant beneficial to them economically. Only a quarter of respondents in their decisions places first the factor of lesser carbon dioxide emission over the price of the car.

Half of the respondents answered the question about the amount they were willing to spend on buying a car, regardless of the type of power source supplying the vehicle's engine. On average, the declared amount is about 49 thousand PLN. The third of the respondents are willing to spend roughly the same amount of money as on the electric car, and less than half want to spend less money rather than on electric car.

What is causing concern, is that the part of the respondents lacks knowledge on the economic aspects of the operation of electric vehicles. Some respondents expressed the opinion that unit operating costs of electric vehicles are lower than the average unit cost of operating vehicles equipped with combustion engines. Which is not true. Probably the repetition of such opinions is the result of uncritical quoting unreliable sources. There is no reliable knowledge in this respect, i.e. such that the operating costs of vehicles depend not only on the cost of energy sources consumed, but also on other types of costs, such as the loss of the market value of the car.

Also, in the words of a considerable proportion of the respondents, there is an uncritical assessment of the impact of operating electric cars on the human environment. Some respondents do not realize that the Polish electricity in a very large part is and will be in the perspective of many years produced from fossil fuels. Production of renewable energy sources will be gradually developed, but its share will not be as significant in the structure of energy production as to, in the case of the dynamic development of electric cars, "reduce consumption of fossil fuels".

In contrast, responses to questions about the factors contributing to the interest in buying an electric car, under the hypothetical assumption that the respondent would be willing to consider this issue, leads to the conclusion that the economic factor is an essential factor in the development of such vehicles in Poland (other than the wide availability of public charging places for electric cars).

The issue posed to the respondents, assuming that they want to buy an electric car, was to express an opinion on the circumstances, incentives and conditions that would possibly be relevant (or would not matter) for a decision on buying a new or used electric car.

Up to 3/4 of respondents concluded that bonuses and benefits associated with the purchase of electric cars would matter to them when making decisions related to the purchase of an electric car. Selecting traffic lanes, in urban centres, only for electric cars would force to consider the decision, of 40% of respondents, to purchase electric cars. Designation of parking spaces in the city centres only for electric cars would represent an incentive to purchase such vehicles to 1/3 of the respondents who answered this question. Half of the respondents are convinced that free parking for electric cars in city centres would be a factor contributing to the decision to purchase an electric car.

Similar intention had a question on the motivation to buy an electric car in the case of the limited access to certain areas of the city for conventionally powered vehicles. This factor would be important to about one third of the respondents, but the same amount rejects this argument as an incentive to buy an electric car. Probably, this second group of respondents is characterised nevertheless by scepticism in terms of a competitive advantage of electric vehicles in comparison to cars equipped with internal combustion engines. Hence their reluctance to own and operate electric vehicles and the denial of the factors mentioned here discriminating, from the start, the rights of users of cars with internal combustion engines.

In summary, the expression of respondents did not exude the enthusiasm of the domestic car users to the emerging possibility of using electric cars. It is believed that these cars will constitute by the 2030 some solution satisfying the increasing mobility needs of the Polish citizens.

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