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PROJECTIONS OF FUTURE USE OF ELECTRIC CARS

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Abstract

In the article, reference was made to the mandatory now research hybrid and electric cars, and to the current state of the fleet of cars in the country and among others in the European Union. Reference was made also to the existing charging infrastructure for electric cars. Presents forecast of development of these last cars in Poland and Germany in the perspective of 2020-2030 year, presenting the achievements of the European project eMAP (electromobility-based scenario Market potential, Assessment and Policy options) in this area. An evaluation of the capability of the future of automotive industrial development of e-mobility. Attention was drawn to the traction battery and fuel cell system in electric vehicles. An analysis of the necessary policy options required for the development of electric cars. Among the recent policy options include an issues: research & development technology (strategic alliances, cooperations and consortia), financial incentives (vehicle tax, fuel tax, CO_2 tax, insurance incentives), infrastructure, policy regulation (norms and standards, CO_2 regulation) and information & marketing. In the project eMAP, a number of achievements were the participation of the authors of the present article.

Keywords: *transport, road transport, combustion engines, air pollution, environmental protection*

1. Introduction

One of the main provisions of ECE UN is Regulation No 101 [4]. This Regulation applies to vehicles of categories M1 and N1 with regard to:

a) the measurement of the emission of carbon dioxide (CO_2) and fuel consumption and/or to the measurement of electric energy consumption and electric range of vehicles powered by an internal combustion engine only or by a hybrid electric power train,
b) and to the measurement of electric energy, consumption and electric range of vehicles powered by an electric power train only. It does not apply to a category N1 vehicle if both:
   - the engine type fitted to that type of vehicle has received type approval pursuant to Regulation No. 49, and
   - the total annual worldwide production of N1 vehicles of the manufacturer is less than 2,000 units.

This Regulation refers not only to the pure electric vehicle, but also to Hydrogen Fuel Cell Vehicles. These are the types of vehicles with high potential for development, provided the development of charging infrastructure and the development of hydrogen refuelling stations infrastructure.

2. Infrastructure of the charging points for electric cars and the hydrogen FCEV vehicles refuelling stations

According to the 2014/94 / EU [3] Directive of the European Parliament and Council Directive, the EU Member States should adopt national policies on the alternative fuels market development, including electrical energy in the transport sector and the development of charging infrastructure for electric cars. Member States are required to ensure (through their national policy frameworks) that by the 31 December 2020 there are a sufficient number of publicly accessible charging points for electric cars. This is to ensure mobility of electric vehicles, at least in urban and suburban areas and in other areas of dense development. The Directive emphasises the condition that, where appropriate, the construction of charging points for electric cars should allow the use of such vehicles on the road network defined by Member States. With it, the number of charging points should be determined taking into account, among the others, the estimated number of electric cars that will be registered by the end of 2020.

It should be noted that, in accordance with the Regulation of the European Parliament and of the Council (EU) No. 1316/2013 developing new technologies and innovations, particularly in terms of reducing carbon dioxide emissions from transport, is eligible for EU funding [13].

The cited Directive of 24 October 2014 shows that each Member State should submit a report to the Commission on the implementation of the national policy framework as far as the support measures are concerned for the development of alternative energy carriers infrastructure, including charging points for electric cars in the period to 18 November 2019, and after that date, every three years. These reports include information on [1]:

- legal measures taken in this respect,
- policy measures taken to support the implementation of national policy frameworks including among the others:
- direct incentives to acquire, among the others, electric cars and for building charging infrastructure,
- support for the development and production, of electric cars,
- scientific research, technological development and actions to promote electromobility, including the annual public budget designed to support these activities.

A relatively small number of passenger electric cars understood as a BEV (Battery Electric Vehicle) PHEV (Plug-in Hybrid Electric Vehicle), REEV (Range Extender Electric Vehicle), FCEV (Fuel-Cell Electric Vehicle), according to the contemporary forecasts in the time horizon of 2020-2030 or even 2050, forces from both the EU transport sector, as well as this sector in the country, (in order to increase their numbers and to reduce greenhouse gas emissions) the promotional activities, among the others, of a political nature.

One of the impacts of a political nature are impacts related to the promotion of research and development of energy storage technologies, in this case concerning electric vehicles – of storing energy in the batteries [11].

If the highly effective, yet inexpensive batteries are manufactured then the electric cars will have a chance to replace significantly currently in operation, vehicles powered by combustion engines.

The European project with e-MAP acronym (Electromobility – a scenario based Market potential Assessment and Policy options) implemented by an international consortium (Federal Highway Research Institute (BAST), KE-Consult Kurt & Esser GbR and the University of Cologne (UOC), Technical Research Centre of Finland (VTT), the Institute of Applied Social Sciences (INFAS), German Aerospace Centre (DLR), Motor Transport Institute (ITS) refers among the others to the above issues of a political nature.

The UOC and KE-Consult Kurte & Esser GbR with the support of, among the others, ITS and VTT, being responsible for the classification, description, analysis of the political measure,

determining development of passenger electric cars, have made such a classification [6]. The reference is made to this issue in section 5 of this article.

The number of currently operating in Poland public charging points for electric passenger cars is small, approximately several dozen.

The number of these points in Western European countries is now estimated at several thousand (e.g. in Germany, 875 (2010)).

The promising direction for development of electric cars is the development of infrastructure of refuelling stations for hydrogen vehicles.

In 2008, on the EU territory and in the US there were approx. 60 hydrogen stations functioning or was under construction each [5]. In the US, the highest density of hydrogen refuelling stations takes place in California, where there is about 30% of all US stations concentrated. In the recent years, especially after 2010, hydrogen stations began to emerge rapidly around the world, and their total number of (existing and planned) can be estimated currently at approx. 450 stations [5]. In February 2012, on the EU territory there were 143 stations functioning or nearing completion (in the US at that time there were already 128 hydrogen stations functioning) [5].

However, according to [15] estimates in this respect are as follows (Tab. 1).

Tab. 1. Number of hydrogen filling stations, cars, and buses using fuel cells. As of late 2013[8]

	Europe	North America	Asia	Globally
Passenger cars	~ 200	~ 200	~ 100	~ 500
Buses	~ 60	~ 30	~ 10	~ 100
Filling stations Globally	109	90	18	252
Public	25	39	18	82

The European HIT – 2 – CORRIDORS project implemented now by the Motor Transport Institute in Warsaw as part of an international consortium, will contribute, as may be expected, to the creation of a national plan for the implementation of the road hydrogen infrastructure, enabling its use for passenger cars and city buses equipped with fuel cells [10].

3. The number of electric cars in the world, the EU and Poland

In 2011, there were nearly 50 thousand fully electric cars sold worldwide, which accounted for 0.1% of their global sales [8, 12].

In 2011, in the EU countries there were 8700 fully electric passenger cars registered, which accounted for only 0.07% of all newly registered passenger cars [12]. However, in 2014 in Western Europe there were about 40 thousand electric cars registered, and in the United States, about 100 thousand of these cars.

In terms of the hybrid cars in the world, their number is approaching 10 million (in Poland there is estimated to be currently at approx. 5.7 thousand of them).

The development of the electric cars segment observed lags behind most of the projection assumptions made at the beginning of two thousand years stipulating that already in 2020 the share of this type of car in the sales of new cars would reach 20%, in 2030 – 30% and in 2050 – more than 80%.

In the most optimistic scenario, developed by the International Energy Agency, electric cars (including plug-in type hybrids,) in 2050 were to constitute 90% of all cars newly introduced to the market, and their share in the world's fleet was to reach 50-60%.

The leading EU countries have assumed that in 2020 they will already have significant electric cars fleet which, together with electric hybrids was to count: in France 2 million vehicles, in the UK more than 1.5 million vehicles, in Germany and Spain to 1 million vehicles, Sweden 600

thousand vehicles, in Ireland 350 thousand vehicles, Denmark and the Netherlands 200 thousand vehicles, in Portugal 180 thousand vehicles.

The German program from November 2008 assumed that – in the wake of the aforementioned one million electric vehicles in 2020, there would be 5 million such cars operating in 2050. The current development of the electric car segment has forced a radical, negative revision of these views.

The projections for Europe in the recent years have maintained that the share of electric passenger cars in the sales of new passenger cars will fluctuate within 5% in 2020 and up to 25% in 2050 [9, 14].

Even the new cautious European Commission's projection, assuming 3-4% share of electric cars (including hybrid vehicles charged from the grid) in 2020 may raise doubts.

According to S. Jacoby, President of Volvo Car Corporation, achieving even 1% of electric cars by the 2020 is a very ambitious task.

The state of development of electric vehicles segment in Poland is in the early stages of development. In 2011, there were 34 electric cars registered in the country, in 2012 – 36, in 2012 – 32 while in 2014 – 83 vehicles.

The intensive studies on the cars with fuel cells took almost two decades. The first series produced cars with fuel cells (e.g. the Japanese Toyota Mirai) appeared only in 2014.

According to the experts, the dissemination of hydrogen propulsion technology only is growing and it is approx. 10 years behind the development of electric cars. Now, in 2015, we have a pre-commercial phase, which envisages the construction in the Europe itself approx. 200/300 hydrogen stations in various urban areas for 500 passenger cars and approx. 500 buses equipped with fuel cells (so called FCEV). The early commercial phase of hydrogen propulsion technology should appear in Europe, in approx. 2020 and ensure the occurrence of hydrogen infrastructure along strategic transport routes, numbering approx. 2.000 hydrogen filling stations/min. 1000/, serving 500 thousand passenger cars and 1.000 buses equipped with fuel cells. The phase of commercial development of hydrogen power technology should take place in approx. 2025 [5].

In practice, at the end of 2012 in Germany there were approx. 135 passenger cars used equipped with fuel cells, in Scandinavia approx. 35 such cars, in the UK there were two such cars and 5 buses equipped with fuel cells. There has been no registration in Poland of cars equipped with fuel cells.

4. Forecast of development of electric cars including the FCEV

According to European eMAP project, the development of EVs in stock is strongly dependent on region and on scenario. In Germany, for example there are 4.4 Mio. EVs in 2030-stock in scenario BaU (Business as Usual scenario). In scenario TeD (Technology Driven scenario), this will increase to 6.9 Mio. EVs, in scenario PoD (Politically driven scenario) even to 8.2 Mio. EVs (Fig. 1) [16]. In scenario PoD, the German governmental goal of 1 Mio. EVs in 2020 are reached [16]. For comparison, in the Fig. 2 and 3 are shown the analogous situation at that time in Finland and Poland accordance with the above scenarios.

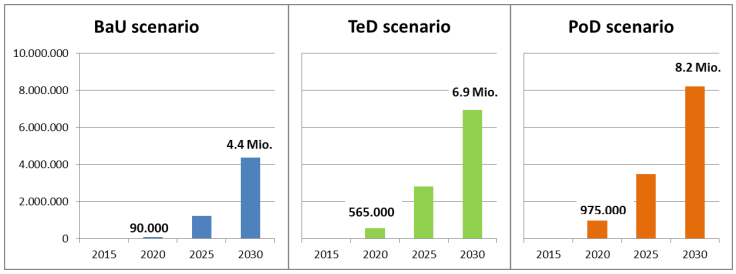

Fig. 1. Development of EVs (German scenarios) (Source: Vector 21, KEC)

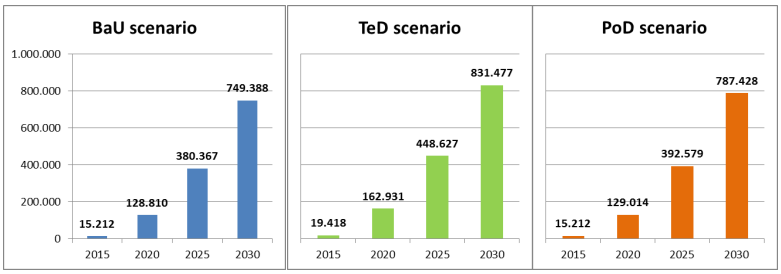

Fig. 2. Development of EVs (Finnish scenarios) (Source: Vector 21, KEC)

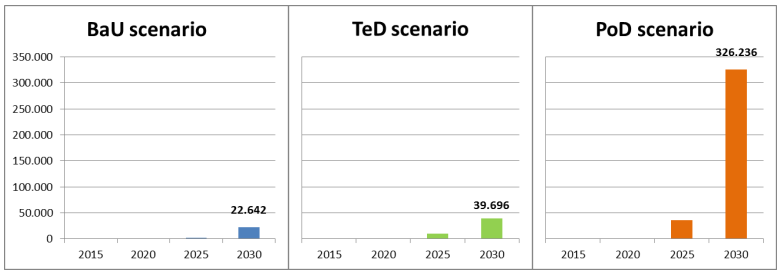

Fig. 3. Development of EVs (Polish scenarios) (Source: Vector 21, KEC)

The BaU scenario incorporates current policies and technologies as can be expected from today (2015). This in turn means that the status of today concerning CO_2 limits, taxation schemes, energy system, infrastructure, powertrain efficiencies and such like is not frozen but does develop over time: e.g. the EU CO_2 limit for passenger cars is assumed to be lowered to 75 g CO_2/km in 2030.

The TeD scenario assumes that the political and economic framework does not change but that electric technologies become more efficient than in BaU and that traction battery costs decrease faster than compared to BaU.

The PoD scenario incorporates a stronger European climate protection policy by further decreasing the EU CO_2 limit for passenger cars to 60 g CO_2/km in 2030, the limit curve thus being 130 g/km in 2015, 95 g/km in 2021 and 60 g/km in 2030. Furthermore, individual measures to promote electrified vehicles are modelled per country.

In contrast, in the drawings 4-9 is showing total new vehicle sales in EU28 and total vehicle stock in EU28 according to these scenarios.

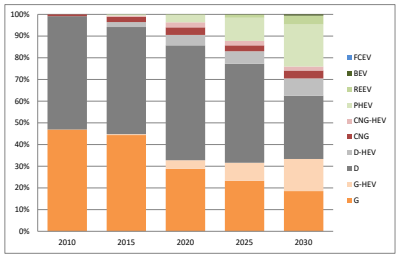

Fig. 4. BaU scenario: total new vehicle sales in EU28

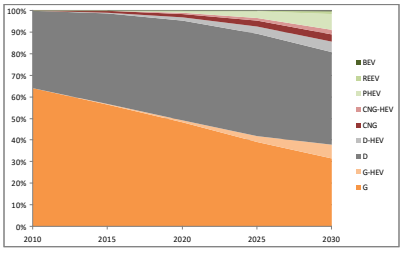

Fig. 5. BaU scenario: total vehicle stock in EU28

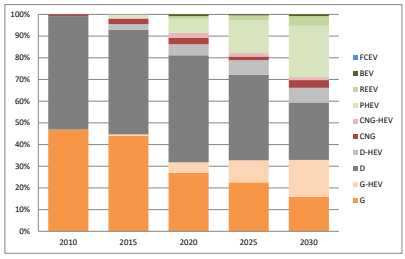

Fig. 6. TeD scenario: Total new vehicle sales in EU28

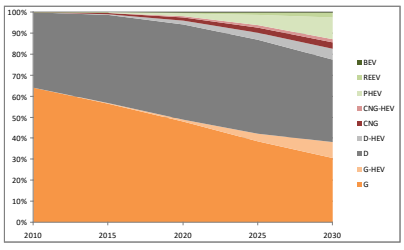

Fig. 7. TeD scenario: total vehicle stock in EU28

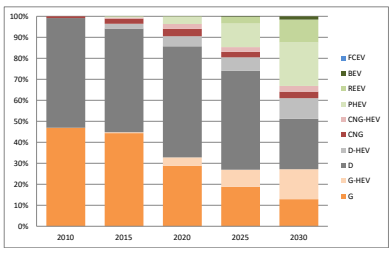

Fig. 8. PoD scenario: Total new vehicle sales in EU28

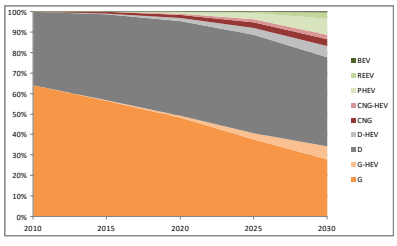

Fig. 9. PoD scenario: total vehicle stock in EU28

5. Actions of political character to support the development of electric cars

The impact of a political nature for the promotion of electric cars has been divided into activities relating to [7]:
- research and development,
- financial initiatives,
- infrastructure development,
- regulatory policy,
- information and marketing.

In Poland the actions implemented in the field of research and development in respect to electric passenger cars, through own initiatives, or international projects include, first of all, research and diagnosing in the field of electric vehicles as such, and the raw materials for manufacturing them (particularly raw materials for manufacturing batteries) and their recycling. More for the future, there is planned an intensification of education, the above-mentioned mass personalization or the development and support of these actions broadly defined "maintenance" actions for electric cars.

With regard to financial incentives there can be distinguished primarily the following ones [2]:
- financial support with a sale of electric cars during the development of their market,
- vehicle tax – exemption or reduction in this type of tax for electric cars,
- fuel tax – increase in this tax for conventional vehicles to boost demand for electric cars,
- tax in relation to carbon dioxide emissions (its increase for conventional vehicles to promote electric cars),
- VAT – eliminating or reducing this type of tax on electric cars,
- insurance initiatives – reducing insurance premiums in the case of electric cars,
- reducing the prices of electric cars by reducing the operating costs of e-vehicles and increase of their attractiveness (in the form of e.g. subsidies for manufacturers of these vehicles),
- financing the production of electric cars based on the worked out concept of sustainable financing,
- financing by the banks – fewer constraints for small and large enterprises that buy electric cars,
- public subsidies − for the manufacture of electric cars,
- financing the sale of electric cars – the developing the appropriate model of conduct,
- loans enabling the purchase of electric cars at favourable prices,
- leasing,
- public tenders, guaranteeing the manufacturers of electric cars, a balanced sale of these cars.

In Poland there are in principle currently no such financial activities, dedicated to electric cars. They are envisaged for intense introduction rather in a slightly longer term, i.e. 2020 and beyond.

Among the pro-development activities in relation to the infrastructure for electric cars, there can be distinguished the following actions [2]:
- construction of infrastructure to enable public use of the charging stations for electric cars − financing with the funds for the development of this infrastructure at the development phase, the system of private financing with a mass development of this infrastructure,
- intermodal and public transport – an innovative concept of using electric cars mainly in urban areas,
- privileges for electric cars in the city traffic (supporting the "penetration" of the market by electric cars; separate lanes, car parks, zones for electric cars).

Exceedingly modest number of charging points for electric passenger cars in the country at present, compared to numbers recommended by the EU for Poland in 2020 in the order of 46 thousand public points [6, 7], make that the policy measures associated with the development of the infrastructure of charging points for these vehicles, are likely to be the subject of analyses and development in the slightly longer term, i.e. approx. 2020 and beyond.

6. Conclusions

Policy implications from the eMAP project [16] results are found strongly dependent on regional characteristics. Policy recommendations are therefore case-specific and influenced by aspects such as national strategies, urban form, climate, mobility patterns and availability of technologies and services. In the following, we present the top three findings from the eMAP research and interpret them into policy recommendations for the EU, Finland, Germany and Poland respectively. Thus, for example [16]:

The baseline market scenario shows that ambitious national electromobility goals (1 million electric vehicles in 2020) will not be met in Germany. Technology-driven scenario improves the situation greatly but only support measures in the policy scenario make it possible to achieve the goal.

Recommendation: Powerful support measures need to be introduced urgently, most importantly to accelerate demand but also to advance technology performance and price-competitiveness.

The current situation in Poland is characterised by lack of political support for electromobility by the state administration, insufficient availability of charging infrastructure and the lack of comprehensive facilities for users of electric cars.

Recommendation: Political support is needed from the state administration. Progressive financial support could be introduced, e.g. grants to purchase or use of electric cars. Furthermore, dynamic development of public charging points is necessitated.

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