Current state and development determinants of electromobility [1]

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Abstract

The support of the environmental approach of the automotive industry is represented by the concept of electromobility, or more precisely production of ecological cars. The importance of electromobility in the world has been growing for a long time now. The main determinants that currently determine the development of electromobility in the world are mainly the mileage range of electric vehicles, their price and charging speed. The aim of this paper is to analyze and evaluate the global and European electric car markets. At the same time, we will be using the PESTLE analysis to identify key factors that affect the development of electromobility and the number of electric cars.

Key words

electromobility, electric car market, factors of electromobility development

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Introduction

Today, up to a quarter of global energy production is consumed by transport, which also accounts for a fifth of global carbon dioxide production. That is why automotive companies, battery manufacturers, innovators, cities and states are working hard to make transport greener. Increasingly stringent emissions regulation is forcing the massive introduction of low- or zero-emission vehicles. The support of the environmental approach in the automotive industry is represented by the concept of electromobility, or more precisely production of ecological cars. At present, electric cars are the only commercially available vehicles with zero emissions. Although electromobility is not the only way to meet emission limits, it is the most ready-to-use solution available for series production. Other alternative drives (especially hydrogen fuel cell cars) are not yet ready for mass production.

Because of that, the importance of electromobility at present time is constantly growing. We call electromobility the whole concept involving battery manufacturers, electric vehicle manufacturers, cities and states, energy users and distributors (Janoušek, 2014). The central elements of the whole concept are electric vehicles, supplemented by charging infrastructure, information technology and legislation.

In the upcoming years, electromobility, especially in conjunction with the development of smart electric networks, it is expected to provide new jobs and at the same time

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contribute to the protection of the earth's climate and reduction of fossil fuel consumption through greater use of renewables.

1 Methodology

The aim of this paper is to analyze and evaluate the global and European electric vehicle market and using the PESTLE analysis to identify the key factors that affect the development of electromobility and the number of electric vehicles.

In order to achieve the set goal, the paper uses classical scientific methods such as analysis, synthesis, description and comparison. We have worked with data and survey results reported in studies by international consulting companies and research agencies IEA, Statista, Roland Berger&fka and KPMG. For logical justification of the conclusions was used the method of deduction.

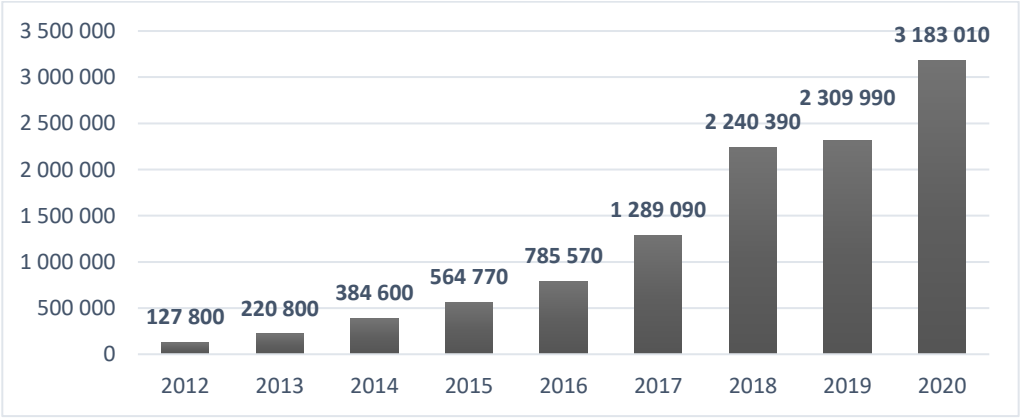
2 Results and Discussion

2.1 Current state of the electric car market

The electric car market is a young and fast-growing segment of the automotive industry. Even at the beginning of the millennium, electric cars represented a completely negligible part of the global market with approximately tens of pieces.

A significant rise in the global electric car market can be observed in 2010, when the total number of electric cars sold more than doubled compared to 2009 and amounted to approximately 16,500 units. An even more significant increase in sales occurred in 2011, when the number of electric cars reached just over 55,000, which meant more than a threefold increase compared to the previous year (IEA, 2017).

Graph 1 Electric car sales worldwide (BEV, PHEV)



Source: KORDS, M. 2021. Absatz von Elektroautos weltweit bis 2020. Available from: https://de.statista.com/statistik/daten/studie/406683/umfrage/anzahl-der-verkaeufe-von-elektroautos-weltweit-prognose/.

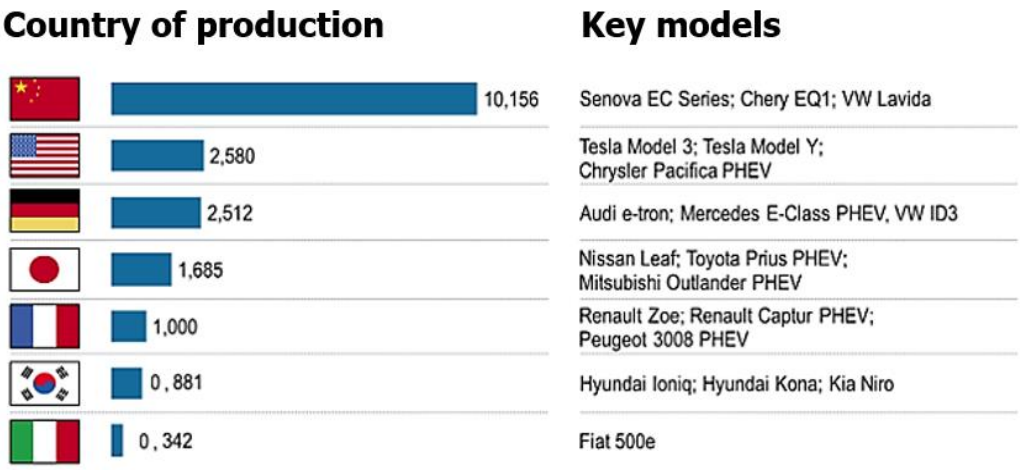
In the following years, the number of electric cars sold, as illustrated in Graph 1, approximately doubled on year-to-year basis. In 2017 more than a million electric vehicles were sold worldwide for the first time, in 2020 sales rose to 3.183 million electric cars (Kords, 2021).

Since the beginnings of the electric car industry, the United States has played a major role in the development and number of electric cars. Until 2010, they clearly dominated the entire market. Since the "electric car boom" began in 2010, other countries have begun to join. In 2010, it was mainly Japan and Norway, where electric cars are very popular. The dynamically developing electric car market in China surpassed the United States in 2015 and China became a leader in electric car sales. Statistics declare more than 1.3 million e-cars sold in 2020, making China the clear market leader. According to a study carried out by the International Energy Agency, electric car sales are currently concentrated in ten countries - China, the United States, Germany, Norway, the United Kingdom, Japan, Canada, France, the Netherlands and Sweden (IEA, 2021).

The Chinese market is currently the largest electric car market in the world. China not only sells but also produces more electric cars than in all the other countries in the world combined. The most populous country in the world is expected to maintain this significant lead it has gained in electromobility. According to experts from the consulting firm Roland Berger&fka in their most recent study the E-mobility index 2019, China was ranked first among the seven most important countries. China is followed by the USA and Germany.

Graph 2 The most important countries in the global electric car market

PRODUCTION (prognosis for 2017 - 2022, in millions)



Source: Study E- mobility index 2019. Roland Berger&fka, Munich, November 2019, p. 7. Available from: https://www.fka.de/images/publikationen/2019/E-Mobility_Index_2019.pdf.

China is currently the world leader in production, sales and number of registered electric vehicles. The interest of Chinese citizens in electric cars is not only documented

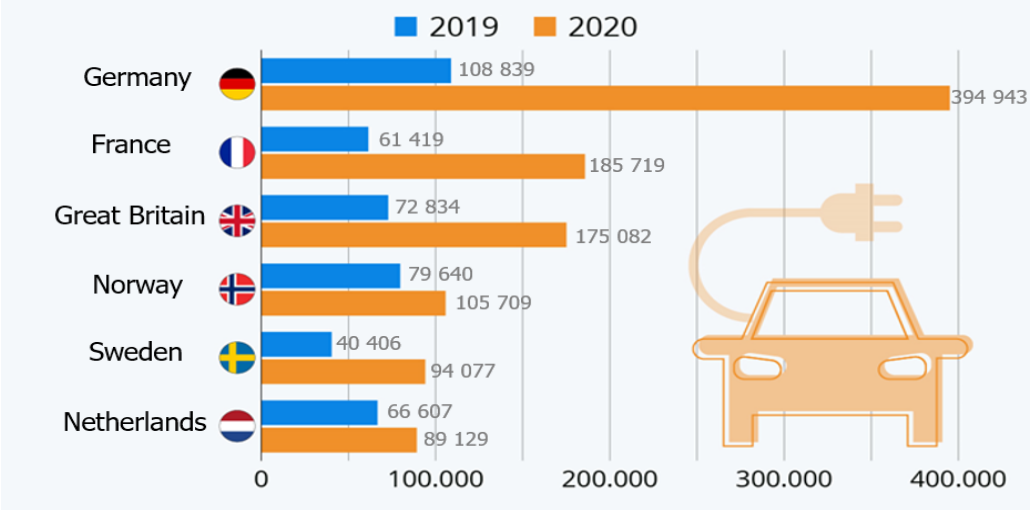
by the highest number of new electric car registrations, but also for example by the fact that they have a great choice of vehicles. Chinese customers can choose from more than 75 different models, which is incomparably more than customers in the United States or Europe (Hertzke - Müller - Schenk, 2017).

The United States has played a key role in the development of the electric car market. Initially, they dominated the entire market in terms of production, development and registration of electric cars. Since 2005, i.e. since the statistics are available, the United States has been the market leader in electric cars, but in 2015, China came to the lead. According to an analysis by the company Navigant Research, the number of electric vehicles in the United States should reach 1.1 million by 2024 (Žuffa, 2018). Sales are dominated by Tesla. The best-selling model is the Tesla Model 3, followed by the Model X and the Model S. The Bolt EV model from company Chevrolet (Wagner, 2020) is also successful in sales.

The European electric car market has started to develop more since 2009. Since this year, the number of electric cars on European roads has been growing constantly. While in 2013 more than 55,000 electric cars were newly registered in European countries, in 2015 it was almost 150,000 electric cars and in November 2021, 1 million electric vehicles were registered for the first time (Hennsler, 2021).

Graph 3 shows the European markets according to the highest number of new registrations in 2019 and 2020. Germany is currently the leader in electromobility in Europe with 394,943 newly registered electric vehicles. In 2020, the second highest number of registrations was reported in France. Specifically, there were 185,719 newly registered electric vehicles. The United Kingdom ranks third in the number of new registrations with 175,082 vehicles, followed by Norway with 105,709 registered electric cars. Sweden closes the top five with 94,077 newly registered electric cars.

Graph 3 Electric car sales in Europe in 2019 and 2020 (newly registered BEV, PHEV)



Source: Suhr, F. Europäischer Elektroautomarkt nimmt Fahrt auf. 16.02. 2021. Available from: https://de.statista.com/infografik/24193/anzahl-der-neuzulassungen-von-elektroautos-in-europaeischen-laendern/

As for the best-selling models on the European market, the best-selling electric model in Europe is, according to current statistics, Renault Zoe, followed by the second best-selling Tesla Model 3, which is also the best-selling electric car on a global scale. The third best-selling electric vehicle in Europe in 2020 is the Volkswagen ID.3. (Suhr, 2021).

Regarding the popularity of electric cars in European countries, Norway is clearly in the first place, with 81 electric cars per 1,000 inhabitants. Iceland, Sweden, Germany and the United Kingdom follow with a big gap (Janson, 2021).

Slovakia is directly affected by electromobility. However, the number of electric cars on the roads in the Slovak Republic is very small compared to classic cars. The development of sales of electric vehicles in Slovakia was supported by a subsidy scheme that came into practice in November 2016. As is illustrated in Table 1, interest in alternative battery drives has increased significantly over the next two years. We can clearly see from the table that in 2019 no subsidy was available in the Slovak Republic. While in 2017 and 2018 the trend of newly registered cars in the category of electric cars (BEV) was rising with 209 and 293 vehicles respectively, the year 2019 saw a drop in sales to 165 registered electric cars per year. Compared to the neighboring countries, we were the only market where sales of electric cars declined in 2019. After the reintroduction of subsidies, 9,014 electrified models were registered in 2020, and 918 pure electric cars were sold, which represented 1.2 percent of all registered cars.

Table 1 Sales of electric vehicles in the Slovak Republic

	2015	**2016**	**2017**	**2018**	**2019**	**2020**
BEV	52	59	209	293	165	918
PHEV+HEV	131	363	1936	2434		8096
PHEV					202	863

Source: own processing from data: Ročenka ELEKTROMOBILITA. 2020. p. 17. Available from: https://www.pcrevue.sk/library/PDF%20ARCHIV/Elektromobilita%202020+inz.pdf, Ročenka ELEKTROMOBILITA. 2021. p. 37. Available from: file:///C:/Users/mmatu/AppData/Local/Temp/ELEKTROMOBILITA%202021v1.pdf.

In 2021, electric cars in Slovakia accounted for only 1.5 percent of new passenger car sales, which is very small compared to about eight percent on the European market. According to the Association of the Automotive Industry, the Slovak Republic, together with countries such as Poland, Bulgaria and Malta, is one of the few countries where there is currently no support for their purchase (Turza, 2022).

2.2 Selected factors of electromobility development

The importance of electromobility has been growing on a worldwide scale for a long time now. In the coming years it is expected that the field of electromobility will experience great development, which is supported in all developed countries of the world. Using the PESTLE analysis will be further identified the most important factors that affect the development of electromobility and the number of electric vehicles.

Political factors

Government subsidies for the purchase of electric cars and subsidy programs have a significant impact on the interest in buying electric cars. The competitiveness of the electric car industry is not yet at a level that can fully compete with the market for cars with conventional internal combustion engines. For this reason, governments provide subsidies and other benefits for the purchase and subsequent operation of an electric vehicle.

As already mentioned, in recent years China has been the leader of electric cars. The Chinese government is trying to contribute to the improvement of urban air quality by subsidizing the electric car market. The total amount of subsidies is at the level of 23% of the purchase price of the vehicle. Only vehicles manufactured by Chinese manufacturers are subsidized, which means that only Chinese vehicles are among the best-selling models on the market. Subsidies are granted not only to regular users but also to the manufacturers themselves who produce or plan to produce electric cars.

The United States has one of the largest and most developed electric vehicle markets. The United States government provides various types of financial and non-financial benefits to support the roll-out of electric vehicles. Since 2010, tax breaks for the purchase of an electric vehicle have been provided in the range of $ 2,500 to $ 7,500, depending on the size and carrying capacity of the vehicle. More than half of the states in the USA uses tax breaks, tax exclusions and tax credits to encourage the purchase of electric vehicles. In addition to financial support, some states allow drivers of electric cars to use reserved road lanes or vehicles are exempt from registration fees. In selected states, electric cars are exempt from parking fees or have a toll discount (Žuffa, 2018).

EU countries governments support the purchase of electric vehicles through subsidies to the citizens. Subsidies for electric cars in Europe are the highest in Norway. Electric vehicles are exempt from VAT, do not pay road tax, are exempt from tolls, have a 50% discount on ferry transport, can use lanes reserved for public transport, do not pay fees for parking and entrances to city centers and are also exempt from the registration tax. Taxation of these vehicles is zero, while vehicles producing increased emissions are taxed at a higher percentage. When buying an electric car in Germany, the buyer receives a subsidy of 4,000 euros and does not pay road tax for the electric car for the first ten years. In larger cities, electric cars also benefit from the fact that they have free parking, reserved parking spaces and can use lanes for public transport. In France, when buying a purely electric car, the customer receives an environmental bonus of up to 6,000 euros and 4,000 euros as scrapping fees for old diesel models. In some cities and regions, electric car owners do not pay property tax or road tax. When buying a vehicle in Great Britain, a subsidy of up to £ 3,500 is provided for the purchase of an

electric car or hybrid with electric drive, and they also do not pay registration tax or other fees (Srpová, 2019).

To the growth in sales of electric vehicles in Slovakia also contributed a state subsidy, as the first specific project in the form of direct support for the purchase of electric vehicles, which the Ministry of Economy of the Slovak Republic began to provide in 2016. The last support in 2020 enabled citizens, companies and cities to get a bonus of up to 8,000 euros per electric car and 5,000 euros per plug-in hybrid vehicle when buying an electric car, up to a maximum purchase price of 50,000 euros with VAT. The development of electromobility is also supported by a reduced registration tax, zero road tax, accelerated depreciation of electric vehicles, the introduction of color-distinguished registration plates for electric cars and plug-in hybrids, free parking, driving in reserved lanes or permission to enter low-emission zones.

Economic factors

The economic factors that affect the development of electromobility include in particular the price of electric vehicles, the price of electricity, the price of petrol and diesel and the costs of operating and maintaining an electric vehicle.

Currently, the biggest disadvantage of electric cars compared to vehicles with internal combustion engines is the high purchase price. An electric car can be up to one-half more expensive than a comparable internal combustion car. The reason for high prices is mainly low production and expensive batteries. The development of an electric car is a very expensive process and these costs are logically reflected in the price of the vehicle. At present, there are also still very few manufacturers of batteries for electric vehicles, and moreover, their production is quite low and does not allow them to optimize production costs. For this reason, the prices of batteries are so high that they significantly increase the overall production price of electric cars.

On the other hand, electric cars paradoxically have lower operating and service costs. The operating costs of an electric car depend on its electricity consumption, electricity prices and service costs. This similar as in the case of internal combustion engines. However, electric cars have the advantage that the price for electricity per 100 km is significantly lower than the price of petrol or diesel. The same is true for service visits, because the drive unit of an electric car is structurally simpler and less stressed. The maintenance costs of an electric car are very low and account for about half the cost of a vehicle with an internal combustion engine. This is due to the fact that electric cars have fewer moving parts in the engine. Electric cars also do not need oil, spark plugs, pumps, catalytic converters and do not require emission checks. The electric motor therefore lasts several years even without any maintenance.

Social factors

The decisive social factors include the population's approach to the environment and trends in the field of automobiles. According to Bláhovec (2018), current trends in the field of automobilism are new materials and electromobility. According to the consulting company KPMG (2020), the key trends are connectivity, digitalization and electromobility. Another possible trend is, for example, vehicle sharing, so-called carsharing.

Technological factors

Vehicle mileage range, battery quality and charging time are among the main technological factors in the development of electromobility. Current electric cars have a real range of approx. 250 km. Tesla and Jaguar luxury cars offer a range of around 500 km. Due to the length of charging and the number of charging stations, mileage range is an important factor that determines purchasing decisions. The electric car is currently an ideal vehicle for the city. It is quiet and does not produce emissions. On the other hand, thanks to the new generation of electric cars and the ever-expanding network of charging stations, it is no longer the case today that electric cars are only suitable for the city. Electric cars with a range of over 400 km can already be considered a full-fledged replacement for a vehicle with an internal combustion engine. The range of the vehicle is also related to the quality of the batteries, because the better the battery, the longer the range.

Charging time depends on the selected charging method. The basic type of charging is home AC charging. This is, of course, slower, but it can also be charged from a standard 230 V socket or using a home wallbox. The fastest way to recharge the batteries is to use fast charging stations, where charging takes 30 to 50 minutes depending on the vehicle (PC REVUE, 2020). Charging stations are one of the most important factors for the charging speed of electric cars. Therefore, their performance is constantly increasing.

Legislative factors

The main force of today's transition to electromobility is the pressure of regulators. The European Union is constantly tightening the amount of harmful carbon dioxide emissions allowed. Currently, an emission limit of 95 grams of CO 2 per kilometer is set. The intermediate target was set at 2025, when CO_2 emissions from passenger cars and commercial vehicles will have to fall by 15 percent compared to 2021. The final target for 2030 sets a reduction in CO_2 emissions from passenger cars of 37.5 percent compared to 2021.

According to Deloitte, the share of electric cars will have to reach 10 percent in 2025 in order to meet the limits. By the end of the decade, every fifth car sold in the EU will have to be an electric car. To these limits must be added the restrictions of individual states and cities. Ireland, the Netherlands and Slovenia plan to ban the sale of internal combustion vehicles in Europe from 2030. France and the United Kingdom have announced this measure for 2040. The most ambitious in this regard is Norway, which plans to ban the sale of combustion cars starting from 2025 (Kvašňák, 2019).

Ecological factors

Air pollution is one of the main global problems. For those who think about protecting the environment rather than saving costs, it is good to know that electric cars do not produce emissions during operation. However, this fact is a bit debatable, because it also depends on what source the energy that the vehicle is supplied with comes from and how ecological its production was.

The use of electric cars will solve several environmental problems, but at the same time it will create a new one in the form of used batteries. Today, it is clear that used batteries from electric cars can be recycled in several ways.

The first option is to disassemble the battery and reuse its functional parts. In a similar way, batteries can be used in households as a backup source. For example, used Nissan Leaf car batteries are applied as a source of energy to street lighting, for caravans, apartments and houses, often in combination with solar panels (Niedermeier, 2019).

A new method of recycling was also discovered by Professor Zheng Chen, who published a method in the journal Advanced Energy Materials, where a certain type of battery can be used to produce a new functional battery with the same capacity and performance (Zecha, 2020).

Conclusion

The automotive industry is undergoing a fundamental transformation caused not only by a new regulatory framework towards emissions and technological innovation, but also by new trends in areas such as shared economy, urbanization and the new way of working.

Today, vehicles with conventional internal combustion engines are considered to be one of the most significant polluters of the environment. This statement is one of the main reasons why alternative drives, which do not show negative externalities during the operation of the car, are beginning to come to the foreground. The support of the environmental approach in the automotive industry is represented by the concept of electromobility, or more precisely production of ecological cars.

Electromobility is a trend today that is moving from marginal technology for enthusiasts to the mainstream. The reason mainly is the activities of regulators, which significantly tighten the requirements for emissions of new vehicles manufactured by car manufacturers. As well as support schemes for the purchase of electric cars and at the same time restrictions on entry to cities, or the sale of vehicles with internal combustion engines.

China is currently the world leader in the production, sale and number of registered electric vehicles. The largest markets in Europe are Germany, France, the United Kingdom and Norway. The largest electric vehicle markets are also the most generously subsidized markets. This leads to the conclusion that electric cars currently still need support to be competitive compared to classical vehicles with conventional internal combustion engines.

Despite the overall decline in car registrations during the COVID-19 pandemic, the importance of electromobility in the world has been growing for a long time. According to the BNEF analysis, the electric vehicle segment was expected to grow by 8.1% in China and 5% in Europe in 2021 due to financial incentives and infrastructure spending (Stock, 2021).

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