European Research Studies Journal
Volume XXV, Issue 2, 2022

pp. 210-222

Determinants of Growth of the Electric Car Market – Investigating on the Truck Market

Submitted 18/03/22, 1st revision 19/04/22, 2nd revision 22/05/22, accepted 05/06/22

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Abstract:

Purpose: *The market for electric vehicles is growing steadily. Planned growth and market share of this type of vehicles are expected to change the face of global roads diametrically in the near future. Manufacturers as well as governments of individual countries are introducing new solutions and directions of development in order to support electromobility, strive for decarbonization and make transport, which is responsible for a large part of air pollution and other external costs, as environmentally neutral as possible. Therefore, it seems important to indicate the determinants, trends and barriers observed in the electric vehicle market, with particular emphasis on the truck market. The aim of the article is to present trends and barriers in the development of the market for electric vehicles and charging infrastructure for this type of vehicles.*
Design/Methodology/Approach: *In the paper was used the method of critical analysis of scientific literature and quantitative methods. The following were used for this purpose materials and reports from available public databases, statistical offices and official websites of European organizations and companies dealing with electromobility and sustainable development based on alternative energy sources.*
Findings: *The most important findings include: forecasts of the development of the electric freight vehicle market, identification of a catalogue of barriers and benefits and their interrelationships, and identification of opportunities to eliminate barriers to development through identification and awareness of the role of individual stakeholders.*
Practical Implications: *The practical implications relate to showing companies what are the positive aspects of introducing electric vehicles into an organisation's fleet.*
Originality/value: *The novelty and originality of the considerations is the inclusion of the same categories of barriers and development trends in the context of the development of the electric car market. As well as considering these categories from two perspectives. Some of the barriers may very quickly turn into benefits, but also benefits may quickly lose their potential if the barriers are not eliminated.*

Keywords: *Electromobility, estimation, electric truck market.*

JEL classification: *Q11, Q13, C44.*
Paper Type: *Research study.*

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1. Introduction

The electric car market is growing in volume, in virtually every vehicle category. The need for changes in climate policies pursued by countries, including an emphasis on zero-emission vehicles and support for climate neutrality in the transport sphere, is leading to the development of the market for vehicles powered by alternative fuels. The increase in air pollution, environmental hazards and external costs caused by transport, as well as legal regulations (efficiency and emission standards), including a strong emphasis on supporting electromobility, as well as strong competition and rapid technology development contribute to the fact that both manufacturers and users (in this case, mostly companies) are interested in energy-efficient, fuel-efficient and environmentally friendly vehicles. The consequence is that the market for electric trucks is growing ever faster.

According to estimates (https://www.marketsandmarkets.com), the market for electric trucks will reach almost 70,000 units in 2021 (Light, medium and heavy-duty trucks in Asia Pacific, North America and Europe region). And by 2030, almost 1.5 million trucks are expected to be on the world's roads. This market was valued at USD 422.5 million in 2019 and is projected to reach USD 1893.1 million in 2027 (Report: Global Opportunity Analysis and Industry Forecast, 2020-2027). Estimates also indicate that the compound annual growth rate (CAGR) in terms of the number of vehicles will increase by 39.7% from 2021 to 2030, and in terms of market value, by 25.8% from 2020 to 2027.

The great interest in this type of solution and the implementation of an increasing number of electric trucks is related to the development of the logistics market, virtually all over the world. High demand for this type of fleet is demonstrated not only by companies from North America, but also from Europe. The European market is the fastest growing market, especially considering the logistics sector. The Covid-19 pandemic has contributed to a change in the global logistics market, including the rapid development of the e-commerce market and thus the increased demand for light trucks. In terms of the use of electric vehicles, this has to do with last mile deliveries, especially in cities. The number of vehicles, routes and journeys due to restrictions on stationary trade has increased dramatically between 2020 and 2021.

In addition, taking into account regulations, development trends of economies in the context of climate protection, it seems reasonable to state that in the near future, it will be electric delivery vehicles (especially lightweight vehicles) that will supply city dwellers with goods ordered via e-commerce. Leading delivery vehicle manufacturers are paying more and more attention to this market, with companies adopting new product development strategies, but also collaborations and partnerships to gain as much as possible from the newly created and growing market. With the increasing demand for low-carbon transport, electric trucks are forecast to grow in popularity over the coming decade.

At the same time, it should be pointed out that electric vehicles can solve the interrelated problems of air pollution, depletion of non-renewable energy sources, rising oil prices, increasing oil imports and demands for 'green' development (Lane, 2021).

The research in this paper addresses the following questions: what factors are influencing the development and growth of electric trucks in Europe. What barriers to this development can be distinguished and whether charging systems affect the growth of interest in this type of vehicle as part of the fleet and whether the trends indicated will change the picture of the current market for the fleet of light electric vehicles.

2. Literature Review

The electric truck market is very diverse. In its area, we can talk about the division of vehicles by propulsion (battery truck, hybrid electric truck, plug-in hybrid electric truck and fuel cell electric truck) vehicle type (light electric truck, medium electric truck and heavy electric truck) and the range the vehicle can reach (0-150 miles, 151-300 miles and 300 miles+). Electric trucks differ from traditional trucks in the way they are powered. They are commercial vehicles, powered by a battery pack and are used to transport cargo and freight. Due to the design of electric motors they have lower vehicle maintenance costs, high reliability with very limited noise emissions. These elements are definitely advantages of using electric vehicles for freight transport.

The use of this type of vehicle has many advantages. Market and economic trends support their use, and technological advances contribute not only to increasing the range of vehicles on a single charge, but also to reducing the cost of their purchase (lowering battery prices) as well as their operation. In 10 years, the price of an EV battery has decreased from around USD 1100 per kWh to around USD 100-137 per kWh depending on the country (The Electric Vehicle Outlook – report: Ed., Bloomberg NEF's). Such significant changes in costs are related, inter alia, to reduced costs of battery production, lower prices for materials used in production.

It is predicted that battery prices will fall to around USD 40-60 per kWh by 2030, which will clearly contribute to lower prices for electric trucks. It is indicated that actually the price will be comparable to traditional cargo carrying vehicles. It is projected that it will take about 3-5 years to achieve a return on investment in electric vehicles; and taking into account legal conditions and tax policy developments, it is assumed that electric delivery trucks will become more economical in terms of total cost of ownership in the future than vehicles with, for example, diesel engines, which currently dominate the fleets of transport companies (Kleiner *et al.*, 2015).

The determinants of the development of the electric truck market can be considered

under several categories: (1) economic, (2) social, (3) environmental. The determinants have been divided and distinguished in the context of satisfying the principles of sustainable development, as this aspect, among others, is a factor and impulse for introducing changes, including the promotion of electromobility and a change of propulsion in the road transport of goods and passengers. To this can also be added (4) technological and (5) political-administrative-legal trends.

In the literature, it is very difficult to find research studies that analyse the EU infrastructure in terms of factors influencing the choice and purchase of electric HGVs by companies and identify solutions that could play a key role in popularising this type of solution in HGVs (Tsakalidis *et al.,* 2021). The observable development trends of economies aimed at reducing the negative impact on the environment, including the transport sector, mean that innovative technologies are beginning to play an important role. An element supporting the indicated processes of transition to low-emission economies and environmentally neutral vehicles is the change of means of transport to more ecological (Ripple *et al.,* 2021). One solution to this is to use electric vehicles for freight transport (Morgan, 2020).

In general and theoretical terms, this is an ideal solution, and technological progress in this area also brings many promising solutions. However, we should consider whether this will actually happen and whether electric vehicles for the transport of goods will soon be on the roads of the world on a mass scale. Economic trends, but also the concern for the natural environment contributes to the fact that the implementation of assumptions of sectoral policies simultaneously supports the development of electromobility, and in this scope - the development of the electric vehicle market.

As mentioned earlier, the market for heavy goods vehicles is broadly defined and understood. Also, both the performance and efficiency of the various segments of this market depend on the type of vehicle. Large, heavy goods vehicles have different requirements from trucks and light vehicles in general. With regard to the latter, it should be pointed out that the majority of such vehicles are sold in China, and that the market for medium and heavy-duty electric trucks itself is small, with higher requirements for charging power (Osieczko *et al.*, 2021).

The social aspect is extremely important in implementing and achieving decarbonisation. In this respect, the needs of society, including the need for clean air and increased quality of life in cities, imply the need for participation and involvement in electromobility implementation processes. In this regard, it is possible to focus on transport, which, especially in cities, is a nuisance for its inhabitants, but which is also used by inhabitants. Given that 24% of greenhouse gas emissions come from transport activities, of which road transport accounts for as much as 72% and is constantly growing, stakeholders need to become more involved and make efforts for the ecological transformation of transport (Anenberg *et al.*, 2019).

In social terms, supporting trends in electromobility and the introduction of electric vehicles means accepting and supporting solutions. In this respect, achieving the social objectives of reducing the external costs of transport, noise, pollution, accidents and improving quality of life can be achieved precisely by increasing the use of electric vehicles as a strategic solution for achieving the objectives of decarbonisation, environmental sustainability, commercialisation and technological innovation in the transport sector (Cao *et al.*, 2021).

The social aspect must be pursued by all stakeholders: governments, societies, vehicle suppliers and the companies that use them. Seeing common goals, development trends will quickly materialise and barriers will be removed. The consumer and his or her intentions play an extremely important role in the implementation of electromobility, including purchasing decisions for electric vehicles, not only for households but also for businesses. The consumer's environmental awareness, opinions from the environment, observation of economic trends, and acceptance of new technologies have a strong, positive impact on the purchase of electric vehicles and support for such initiatives (Tu and Yang, 2019).

As regards technological factors, it should be pointed out that developments in this field have an impact on economic, environmental and social aspects. Newer and newer solutions, more advanced technologies, allowing better performance per battery charge, the possibility of recycling batteries and accumulators (which was very problematic and had a negative impact on the environment in the earlier stages of development), as well as the reduction of initial (purchase-related) and subsequent costs influence economic aspects by eliminating certain barriers that were identified. The use of energy from renewable sources in the transport sector, will make a significant contribution to reducing exhaust emissions (Inkinen, Hämäläinen, 2020).

One hundred percent electric or plug-in hybrid vehicles offer the possibility of reducing the use of conventional fuels in terms of transport. This clearly contributes to improving the environment and reducing emissions of greenhouse gases and other harmful substances (Plötz *et al.*, 2019; Chandler *et al.*, 2016). Changing the ways in which heavy-duty vehicles are powered from conventional to electric or hybrid fuels has attracted interest, with different backgrounds and reasons ranging from improving local air quality, reducing exhaust emissions or diversifying energy sources (Osieczko *et al.*, 2021), to changing company perceptions and their implementation of sustainability strategies.

There is no doubt that the use of electricity is crucial for the decarbonisation of the transport sector (Moultak *et al.*, 2017). The beneficial environmental effects in terms of greenhouse gas emissions and whole vehicle life cycle are widely presented in the literature (Pollák *et al.*, 2021; Hawkins *et al.*, 2012; Hawkins *et al.*, 2013; Nordelöf *et al.*, 2014; Grea and Lehmann, 2015; Ortar and Ryghaug, 2019). When referring to environmental effects, it is not only possible to consider emissions of pollutants but also to consider additional elements (noise re-education, technical and technological

aspects and others) (Connolly, 2017; Wietschel *et al.*, 2017). Unfortunately, the lack of well-developed technical and supporting infrastructure (charging stations) may affect the further development of the market.

The environmental protection context influences the creation of sectoral policies which will support the development of electromobility. We can talk about climate policy, transport policy or economic policy in general, which include trends related to electromobility in their provisions. On their basis legal conditions and regulations are created, which must meet the needs of the electric vehicle market, but also model it in a certain way. Certainly, the determinants constituting the criterion for making decisions about investing in an electric fleet in enterprises are less based on initial costs connected with the purchase of the vehicle itself.

Stable legal regulations, tax facilitations and facilities, subsidies and state policy in this area supporting enterprises in their drive towards electromobility will play a greater role and will be more important. The last important element will be access to repair facilities, workshops and staff capable of repairing minor or major faults that will undoubtedly occur, and in the context of commercial use of the vehicle, their rapid repair plays an important role. Innovative technologies will play an important role in this respect, and their application may contribute to a change in the fleet structure towards a more environmentally friendly one, i.e., electric trucks (Sovacool *et al.*, 2019; Kester *et al.*, 2020).

In the European context, reference must be made to the legal conditions. They refer both to CO2 emissions, meeting technical requirements and the development of electric vehicle charging infrastructure. There are relevant EU directives that refer to decarbonisation of economy, support of electromobility or support of electric vehicle market development, also in the part of the market that supports cargo transport (e.g., European Commission, 2014; European Commission, 2019a; European Commission, 2019b). The development trends in the European Union clearly indicate that the decarbonisation of transport must take place and that the objectives of sustainable development in transport must be met, inter alia, through the development of the electric vehicle sector, including for freight transport.

Overall, it can be said that the trends and directions identified for electromobility support the development of the electric car sector. Simultaneous cooperation and vision of making decarbonisation a reality can only support the development of this market.

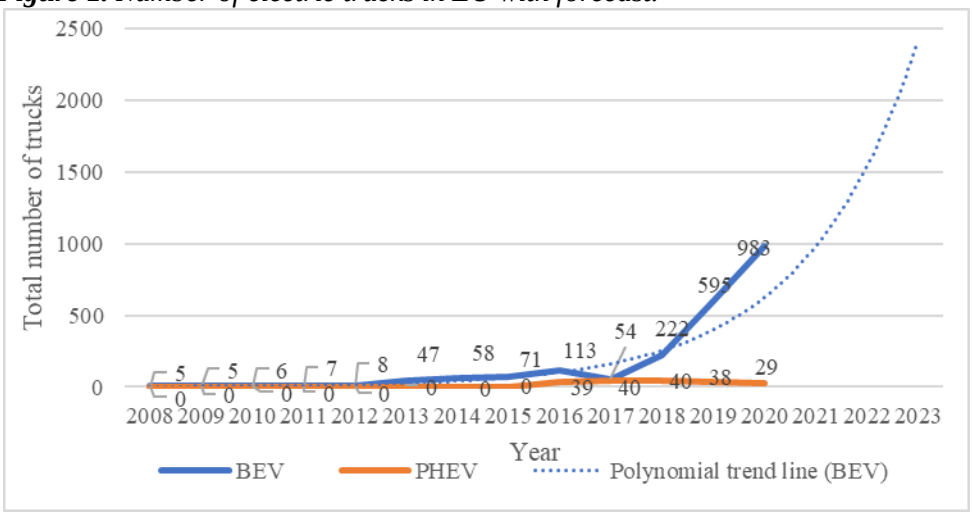
3. Materials and Methods

Quantitative analysis were used materials and reports from available public databases, statistical offices and official websites of European organizations and companies dealing with electromobility and sustainable development based on alternative energy sources.

4. Research Results and Discussion

There are 6.2 million registered trucks in the EU, of which 0.04 percent are zero-emissions (that's only about 2,500 trucks, of which approximately 1,000 are BEV - Battery Electric Vehicle and PHEV - Plug-in Hybrid Electric Vehicle - ACEA report, 2021). Trucks are responsible for 22 percent of CO_2 emissions from road transport, and this share will increase as the passenger car fleet is replaced by electric cars - unless the implementation of e-truck use is properly supported. In 2020 in EU 96.5% of all newly-registered trucks run on diesel, 2.9% are fuelled by alternative fuels, while only 0.4% of trucks sold are electrically-chargeable vehicles (ACEA, 2021). Diesel's share, however, is down from 97.5% in 2019 and 98.5% in 2018. The trend is clear though still slow.

Figure 1. *Number of electric trucks in EU with forecast.*



Source: *Author's calculations based on EAFO, 2021.*

If the forecast from the data, the number of electric trucks will increase to 2500 in 2023 and almost 7 thousand in 2025. If we take only the data from the last 5 years for the forecast, it is almost 20 thousand. If we stick to the number of cars for the number of planned chargers dedicated to trucks (for passenger cars there are about 4 to 7 cars per charger), it should be 40 thousand in 2025. But in its recently published mobility strategy, the European Commission set a goal of having around 80,000 zero-emission trucks on the road by 2030. However, truck manufacturers believe that this estimate is an underestimate and they need to sell 200,000 electric trucks by 2030 (which still only accounts for about 3.23% of all trucks) to avoid penalties for excessive CO_2 emissions.

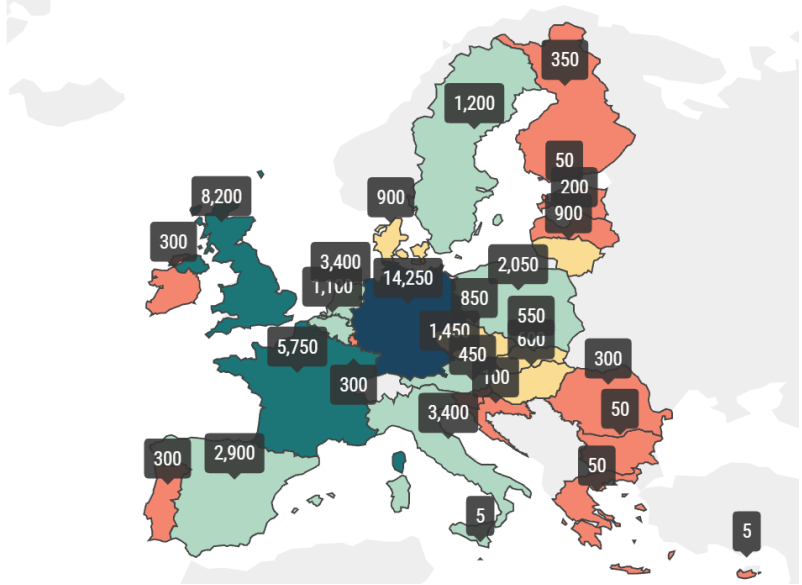
Even taking into account this number (200,000 electric trucks), it becomes a big logistic challenge to prepare the infrastructure for charging trucks. Many countries have not even started preparing for this undertaking, explaining that for the time

being there is no demand for this type. Truck manufacturers are interested in the offer. Infrastructure managers, on the other hand, have not yet paid attention to this topic.

The infrastructure that is necessary to charge electric trucks is almost completely absent today. Because of their higher power and energy demand, heavy-duty vehicles simply cannot use existing infrastructure for cars. On the figure 2 one can see number battery electric medium- and heavy-duty vehicles that should be in operation in Europe by 2030. The AFID (Alternative Fuels Infrastructure Directive) should specifically set an EU-wide target of 10,000-15,000 (higher power) public and destination charging points no later than 2025, and 40,000-50,000 charging points no later than 2030 (ACEA, 2021).

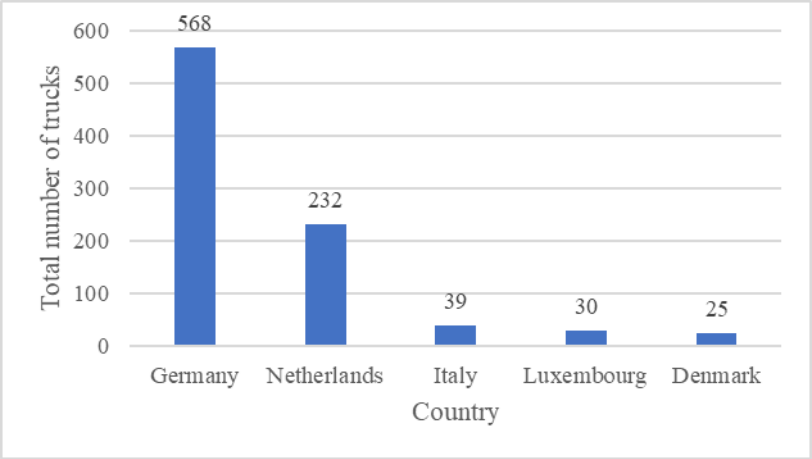
Policymakers need to take action to ensure a rapid infrastructure roll-out as part of the review of the AFID. Analysing reports and statistical data from the European Union, it is clear that the infrastructure needed for charging electric vehicles is constantly increasing, but it is still insufficient. And it does not correspond to the real demand. Moreover, most of the infrastructure development is connected with installation of chargers for passenger vehicles, whose power and charging time are not suitable for heavy-duty vehicles. According to the European Commission's estimates, in order to meet the requirements and expectations of the market, the number of chargers should reach around 3 million by 2030.

Figure 2. *The number of charging points for electric trucks required in Europe by 2030 for each country*



Source: *ACEA 2021.*

Figure 3. *Top 5 country in EU with electric trucks.*



Source: *Author's calculations based on ACEA, 2021.*

Table 1. *Top countries with new registrations of electricity trucks in EU*

country	2020	2019	2018	2017
Germany	302	238	0	0
Netherlands	39	77	0	0
Denmark	16	3	0	0
Italy	11	4	0	8
Spain	8	5	0	2
Austria	0	0	10	0

Source: *Author's calculations based on EAFO, 2021.*

Looking at the number of registered electric trucks in the EU by country, one can see that the numbers are not impressive (Figure 3). The largest number is in Germany, here sales have been increasing in the last two years (Table 1). The Netherlands also stands out. The remaining countries, however, have a negligible number of electric trucks. Here again, the main barrier is the number of chargers, or rather the lack of them, and thus the small range using such transport.

Table 2. *Total number electric light commercial vehicles with theirs market share in EU*

Year	Number of cars	Market share
2008	253	<0.1%
2009	254	<0.1%
2010	309	0.1%
2011	7669	0.1%
2012	9527	0.5%
2013	13669	0.6%
2014	19049	0.6%
2015	28610	0.6%

2016	40926	0.7%
2017	52026	0.9%
2018	76286	1.1%
2019	97363	1.2%
2020	120711	2.0%
2021	140528	2.3%

Source: *Author's calculations based on EAFO, 2021.*

The next summary shows the situation related to cars classified as light commercial vehicles. The situation in this market is developing much faster, already for many years, than in the electric truck market. The most popular models are: Renault Kangoo ZE, StreetScooter Work, Nissan e-NV200. More and more cars of this type are sold every year and the market share of electric cars is also growing steadily, although in 2021 it is still only 2.3% of the total number of new cars sold (Table 2).

5. Discussion, Limitations and Conclusions

Development trends indicate that there are many positive effects that can be seen with the introduction of electric vehicles on the market. However, in addition to trends and positive effects, barriers also need to be considered. As well as trends and barriers can generally be considered in terms of: (1) economic, (2) social and (3) environmental, (4) technical and (5) legal.

Undoubtedly, one of the most important barriers to the development of the market for electric vehicles for freight transport is the high cost of initial investment, especially given the creation and construction of the vehicles. To date, the prices of parts and, above all, batteries, are quite high and influence the final costs. The phenomenon of mass production and use of this type of vehicle does not yet exist, so this is a development barrier.

However, as indicated by forecasts or assurances from manufacturers, by 2030, the production price of electric trucks will be 50% cheaper in comparison to diesel and petrol powered trucks. The economic aspect is one of the most important barriers identified, including high costs, concern about operating costs (including battery life) or access to charging stations (technical aspect) cause the market to develop, but rather slowly, especially in the context of using electric vehicles for cargo transport. Often, legal restrictions are also an obstacle to the implementation of this type of solution, the lack of clear guidelines and plans to support the development of infrastructure, as well as the lack of qualified staff to repair and remove any faults and problems hinder the adoption of EV technology for widespread use.

In terms of technical development, the barrier is still the short distance that a vehicle can cover on a single charge and access to charging infrastructure, and in the legal context, not all countries are supporting the development of this type of solution and technology in a similar way, there are often no subsidies, tax exemptions or, for

example, organisationally easier access and parking in cities. Given the current costs of such vehicles, the legal and organisational aspect is extremely important and must be supported by the authorities if the market is to develop rapidly.

The Polish Society for Transmission and Distribution of Electricity assesses it as unlikely that trucks with large and heavy batteries will become a common solution in truck transport. Also the issue of power requirements for these prototype solutions is so problematic that so far no country in the world is able to meet these requirements for widespread implementation. It seems that it is more feasible to use fuel cells in lorries and solutions with "external" power supply e.g. from pantographs or other ecological solutions which are being researched.

Trucks cause more air pollution than light vehicles. Improvements in engine efficiency, emission control technology or a change in fuel type are needed to reduce carbon dioxide emissions. These are the challenges facing researchers to put the assumptions into practice. The success of the electric car industry as a whole will depend on whether barriers are overcome and economy-wide trends are supported by key stakeholders and their commitment, involvement and efforts to develop the electric vehicle market. The introduction of electric vehicles on the market changes the entire value chain and in fact redefines it.

In addition to the fleet itself, the entire system of vehicle charging and other activities (replacement, storage, recycling, collective charging options, at home or integrating EVs with solar energy) must be introduced. This approach offers the opportunity for further development and the creation of new value chains. So the use of new types of vehicles is not just about a different type of car on the road, but about creating new value chains. The EV market faces huge challenges, related to the introduction of stable and unambiguous government policy in this area, support for the development of charging infrastructure, provision of qualified staff, solving tax problems, system of incentives and subsidies, as well as raising public awareness and appropriate communication.

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