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The outlook for the development of the electric car market in Poland until 2025 compared to the Norwegian market

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ABSTRACT

The article presents an outlook for the development of electric cars in Poland until 2025. To that end, the situation in Poland will be compared to the situation in Norway. In many scientific papers, little attention was paid to the possibility of developing this technology in Poland because researchers focused mainly on technical issues. In order to determine the current and future situation, two tools will be used: Weight Attractiveness Scores and Three-tiers of Noncustomers. The analyses show that Polish policy is heading in the right direction. However, it is still not enough to become a leader, or a significant member, in implementing this technology, like Norway. Electric cars in Poland will grow at a very rapid pace, however, the dissemination of this product on Polish roads until 2025 is unlikely.

Keywords: electric vehicle, the electric car market in Poland, assessment, development, the electric car market in Norway.

1. Introduction

Polluted environment and the threat of a shortage of resources of conventional energy sources trigger the need to look for a more eco-friendly source for driving car engines. A popular solution is an electric car, which is considered by many to be the future of motorisation, but it also has a large group of sceptical people. An electric car (a battery electric vehicle – BEV) is a motor vehicle meeting the traffic rules, which can drive only on the accumulated electricity by connecting to an external power source [Ustawa o elektromobilności i paliwach alternatywnych, 2018]. BEVs are becoming more and more visible on roads, especially in Norway, which is one of the leaders in the development of this technology. Similar ambitions in the last two years have been expressed in Poland. The Polish government plans a significant increase in the number of available stations, which contributes to the acceleration of the development of BEVs in Poland. However, on the other hand, a high purchase price and a different attitude of Poles, in comparison to the Norwegians, regarding ecology can be a brake on development. Many contradictions in the final assessments and a small number of articles about this issue have led to the review of the possibility of developing electric cars in Poland until 2025. The current situation and decisions taken by the Polish government will be compared with the policy implemented in Norway, because this country is a role model for the development of this technology. The year 2025 was chosen as the time horizon, since it is the right time to implement and develop planned investments, which may contribute to the universalisation of BEVs, and this is the time when the electric car market in Poland can be credibly evaluated.

The primary purpose of the article is to identify and evaluate the potential of the battery electric car market development in Poland until 2025. Two tools will be used to assess the potential: modified Weight Attractiveness Scores and Three-tiers of Noncustomers.

In the first part of the work, a review of the literature will be presented, in which the potential for development of BEVs in the country and around the world will be included together with the factors which have an impact on car buyers' decisions. In the further part of the article, the tools and conclusions from the conducted analysis will be used.

2. Literature review

2.1. Forecasts and assessments of the electric car market around the world and in Poland

Analyses carried out by Polish experts regarding electric cars focus mainly on technical issues, and the subject of development prospects for the market in Poland is not discussed. Probably, it is related to the lack of policy in Poland in the past supporting the purchase of such cars. This causes the market share of these cars being less than 0.1% [European Automobile Manufacturers Association, 2017] and in 2017, only 475 electric cars were sold [EAFO, 2018a]. This is an increase by almost 245% compared to 2016.

A large number of studies have been devoted to electric cars around the world and in some countries. According to the IEA [2017, p. 50], 467,000 BEVs were registered all over the world in 2016. The increase in registration in 2016 compared to 2015 was 43%. IEA [2017, p. 20] predicts that by 2030 electric cars will have been fully competitive with internal combustion cars. According to BP [2018, p. 36], the number of electric cars around the world should reach about 150 million in 2040. Experts from Bloomberg New Energy Finance [Morsy, 2018] predict that the number of newly registered electric cars in 2025 will amount to approximately 7.5 million, in 2030 approximately 25 million, and in 2040 almost 55 million. A nearly 50% share in all newly purchased vehicles would contribute to this.

Let us now have a look at the situation of electric cars in Europe. In 2008, the German government assumed that the number of electric cars would reach one million vehicles by 2020 [Gis and Menes, 2015]. On the other hand, Gis and Menes [2015, p. 3] think that it is impossible unless the cost of producing electric cars will drop and their performance will increase. A scenario assuming an increase in oil prices and increasing financial support by the government predicts only 189,000 vehicles on German roads [Propfe, Kreyenberg, Wind and Schmid, 2013, pp. 5206–5208]. Nonetheless, an increase in registration by over 850% was recorded in Germany between 2012 and 2017 (accordingly: 2,555 and 24,438 BEVs), and between 2016 and 2017 approximately 117% [EAFO, 2018b]. This proves that the market is growing fast. However, the market share in 2017 was only 0.71% [EAFO, 2018b]. The leader in the development of electric cars in Norway, in which in 2017 the share of these vehicles in the whole number of newly registered cars was over 20.82% (33 025 cars) [EAFO, 2018c]. Moreover, the increase in registration in 2017 compared to 2016 was 36% (compared to 2012, when it was 673%) [EAFO, 2018c]. This is a result of significant state support, a well-developed accompanying infrastructure and high ecological awareness of Norwegians. Forecasts for the whole of Europe are promising. If the other countries follow the path taken by Norway, electric cars could become a serious competitor for ICE cars [Berkeley et al., 2017, pp. 330–331]. The research prepared by BCG [Mosquet et al., 2018] shows that in 2025, 13% of all newly registered cars are said to be electric cars, while in 2030 this value is to rise up to 22% (about 5 million).

Perspectives on the US market, which always sets trends in terms of motoring, look promising. Becker, Sidhu and Tenderich [Becker et al., 2009, p. 26] believe that electric cars are going to restructure the car industry in the US for the next two decades, but they predict that the market will grow at a rapid pace. They state that many incentives will encourage consumers to switch an ICE car to a BEV one. For instance, more extended distance travel on one charge, good opinions issued by electric car owners, an increase in oil prices and growing public awareness of health and environmental protection. According to the BCG report [Mosquet et al., 2018], in the USA, the sale of electric cars should reach more than 1,300,000 per year in 2025. Lee and Lovellette [2011, pp. 30–32] connect the development of the electric car market with oil prices and state support. They point out that the efficiency achieved by cars is also important. However, electric cars are no longer inferior to combustion cars.

2.2. Factors which have an impact on car buyers' decisions

The main criteria for the consumer who is going to buy a car are the price of the car, maximum range, performance, reliability, durability and environmental impact [Lieven, Muhlmeier, Henkel and Waller, 2011, p. 237]. The high purchase price of a car is the most significant barrier to the development of electric cars [Power, 2010, p. 15]. A similar conclusion was re-

ached by Axsen and Kurani [2013, p. 541], who researched car buyers' decisions. They have unequivocally shown that consumers do not want to spend considerably more on an electric vehicle than a conventional one (Internal Combustion Engines - ICE). Deloitte research [2011, p. 10] depicted that a consumer is willing to pay only $2,000 more (about 5,000-8,000 PLN). However, another study shows that a consumer is willing to pay an additional $6,000 - $16,000 (about 20,000 – 55,000 PLN) [Hidrue, Parsons, Kempton and Gardner, 2011, pp. 690–702]. This could be a little bit confusing. Nevertheless, in the second research, consumers set their expectations for some parameters above current standards, e.g. the range of travel larger than currently is possible. For this reason, another study will be presented, which shows that nearly 30% of respondents are willing to pay up to $5,000 [Larson, Viáfara, Parsons and Elias, 2014, p. 311]. To sum up, consumers want to spend up to 20,000 PLN more on an electric car than on a car with an internal combustion engine. The high price of batteries causes higher BEVs prices. However, the report "Global trends in renewable energy investment 2016" seems to be optimistic [Frankfurt School, UNEP, Bloomberg New Energy Finance, 2016, p. 36], which shows that the average price of batteries for electric cars has dropped from $1,000/kWh down to $350/kWh. This change can cause significantly lower costs of purchase and use of electric cars shortly. However, during the process of buying a car the consumer considers the total cost of use. In ICE, the necessary expenditure is the purchase of fuel, the prices of which are very fluctuating and vulnerable. Forecasts of the Energy Information Agency are not favourable for conventional cars, because until 2030 the price per barrel of oil, in the least optimistic scenario, may total almost $200. Moreover, in the most likely to happen scenario a barrel might cost about $140 [Becker, Sidhu and Tenderich, 2009, pp. 5–7]. This information can have an enormous impact on consumers' decisions as regards choosing a car [Becker et al., 2009, p. 7]. However, according to Innogy Polska, the total cost of obtaining and using an electric car within five years is higher by 19,100 PLN than a car with a diesel engine [2017, p. 32]. This depicts that currently buying a car with an electric motor is not an economically rational decision. However, comparing this information with previously presented surveys concerning willingness the consumer to pay extra for an electric car, the conclusion was reached that these two prices are similar to each other. It allows forecasting that people interested in environmental protection will be able to buy an electric car. Nonetheless, in our market, in some cases, there are more considerable disparities. Considering the example of the popular Volkswagen Golf on Polish roads, we will have to pay almost 100,000 PLN more for the basic BEV version [Volkswagen AG, 2018a]. Such a significant price may discourage the majority of people interested in buying an eco-friendly car. Moreover, this is not the only one case.

The maximum range on single charging of the BEV depends on the capacity of batteries installed in cars and the cars' demand for energy. ICE cars can travel a distance of two times longer on a single tank than electric cars [Raca, 2014]. However, Rob van Haaren's study [2011, p. 6] depicts that the average distance covered by the most popular cars in the United States of America is about 400 km on a single tank. Comparing this number to the 300 km covered by a BEV (e.g. VW e-Golf [Volkswagen AG, 2018b]), the results obtained show that there is no significant difference. However, the cars used in the study had large engine capacity. Moreover, the author [Haaren, 2011, pp. 29–31] analysed daily distances covered by drivers, which shows that almost 70% of drivers in the USA travel up to 40 km a day. Because of that, it appears that the argument of an overly short range of electric cars [Hacker, Harthan, Matthes and Zimmer, 2009, p. 34; Szyjko, 2013, p. 4] is exaggerated. Nonetheless, there is another critical factor which is crucial to travelling by electric car. Namely, an accompanying infrastructure which is necessary for the development of a BEV. Hacker and other authors [2009, p. 42] think that the infrastructure is insufficient to meet the basic needs of electric car users. They note that it is indispensable to build open-access spots for charging cars. In Poland, an act has recently been signed based on which 6,000 electric charging points with standard power and 400 high-power charging points are going to be created until 2020. These spots are going to be built in 32 agglomerations and densely populated areas [Business Insider Polska, 2017; Ministerstwo Inwestycji i Rozwoju, 2017; Ustawa o elektromobilności i paliwach alternatywnych, 2018]. However, according to Lee and Lovelette [2011, p. 23], the private sector is not interested in building such stations because it could not be profitable. A similar situation was at the beginning of the development of combustion cars, since entrepreneurs did not see building a petrol station as a viable business. This causes a necessity for the involvement of the government in the construction of the infrastructure

for electric cars. Nowadays, in Poland, there are 582 charging points [EAFO, 2018a].

In addition to the availability of charging points, the speed of charging is crucial as well; slow chargers can provide energy for several hours to overcome 100 km, which makes this solution ineffective [Hacker et al., 2009, p. 42]. Nonetheless, according to Polakowski [2011, p. 33], the charging time has decreased in recent years. The fast chargers CHAdeMO can charge a medium-sized battery up to 80% in approximately 30 minutes [Barycki, 2017].

One of the main advantages of electric cars is the lack of direct emissions to the environment [Hacker et al., 2009, p. 91]. However, Chłopek [2012, pp. 106–107] has noticed that eco-friendliness of electric cars occurs only in a Tank-to-Wheel cycle, i.e. from the tank to the drive wheels. In the situation when we additionally take into account the Well-to-Tank cycle (from the source of the energy carrier to the energy tank), eco-friendliness changes. It is connected with the fact that in order to produce electricity fossil fuels are used predominantly (in particular in Poland). Moreover, Szyjko [2013, pp. 3–4] has noticed a problem related to the production and utilisation of batteries, which relatively often require changing as battery life plummets after 200,000 km. However, a significant number of producers allow free disposal. In the assessment, we should take into account the entire cycle, i.e. Well-to-Wheel. According to Szyjko [2013, p. 3], assuming the average European emissions of pollution, electric cars emit less harmful substances into the atmosphere than conventional cars. An internal combustion engine car would have to burn three or four litres of fuel per 100 km in order to be at the same level as the electric one. Moreover, if the share of renewable energy sources increases, the situation will be even more favourable for electric cars. An additional factor affecting the improvement of the situation is very low noise emissions by a BEV, which, as Łebkowski [2016, p. 159] highlights, is a considerable problem in Polish society. The results of his research show that electric cars cause noise reduction form 2 to 5 times [2016, p. 158].

In order to be fully competitive, electric cars must achieve similar performance, failure-free operation and provide equipment at the same level [Lee and Lovellette, 2011, pp. 18–23]. In this respect, it is noted that these conditions have already been met because the failure-free operation is ensured by a small number of moving parts in electric motors and the simplicity of the car's construction. High efficiency has also been achieved, e.g.Tesla Roadster reaches a speed of 96.5 km/h in 1.9 s [Tesla Motors Inc, 2018].

To sum up, the statement of Gyimesi and Viswanathan [2011, p. 6] has confirmed that the main incentives for buying an electric car are environmental advantages, technological innovation and no cost associated with the purchase of petrol. Whereas, the main barriers in development BEVs are: the cost of acquisition, the availability of charging infrastructure and the range on single charging. However, the statement about the range on one charge is dubious because, as was mentioned, vehicles should be able to withstand a typical day of driving by an average user on a single charge. Nonetheless, there is a conviction among people and researchers, e.g. Power [2010, pp. 6, 14], that electric cars cover only a very short distance.

Governments can also encourage consumers to buy BEVs by implementing friendly policy for electric cars. At the other end of the spectrum, Kochhan and Horner [2015, p. 20] claim that the most crucial activity increasing the attractiveness of the electric car market is to focus on improving the infrastructure and technical level of the car. Moreover, tax breaks are a short-term solution, and in the long-term, they will not improve the prospects for the sector's development. This opinion seems quite controversial, especially taking into account that a large number of experts note that state support is a crucial activity. A similar position is held in the report prepared by the International Energy Agency [2017, pp. 15–16], in which the authors claim that subsidies, tax breaks and free parking in city centres are crucial factors which can contribute to development, and in many cases have already caused the development of the electric car market. Lee and Lovellette [2011, p. 25] note that the government support in building an infrastructure for charging cars is also crucial.

3. Methodological research

In order to carry out the assessment of the potential of electric cars in Poland the author has applied modified Weighted Industry Attractiveness Scores and a tool from Blue Ocean Strategy – Three-tiers of Noncustomers.

Weighted Industry Attractiveness Scores was presented by A.A. Thompson, A.J. Strickland, J.E. Gamble and M.A. Peteraf [2012, pp. 313–331]. The authors used the tool to evaluate the attractiveness of the industry, but in this case, the idea of this tool will be utilised for an entirely different purpose and with changed components. This enables identifying the cur-

rent situation and possibilities for growth. Moreover, this will give the opportunity to compare the situation of electric cars to conventional cars. Additionally, the situation in Poland will be compared to the situation in Norway, because the Norwegians are one of the leaders in the deployment of technology for electric cars around the world. Modified Weighted Industry Attractiveness Scores seem to be the best option, especially in evaluating the potential of growth and attractiveness to customers. In traditional Weighted Industry Attractiveness Scores several factors are used, e.g. the market size, intensity of competition, industry profitability, etc. However, in this case, these elements are not useful. As was mentioned, factors which are suitable for evaluating the potential of the electric car market will be used. Nevertheless, first of all, the idea of this tool will be discussed. Each of the factors has a weight, which shows how important a specific factor is for car buyers. Next, each factor is rated on a scale of 1 to 10 (where 10 is the best and 1 is the worst) to show the situation in a particular sector. The next step is to multiply the relevant weight by an applicable rate. The last step is to sum each score. Markets with a score below 5 will probably have problems with thriving [Thompson Jr. et al., 2012, pp. 315–316].

The second tool, which is going to be used, is Three-tiers of Noncustomers invented by W. Chan Kim and Renee Mauborgne. This tool depicts opportunities and ways to unlock the noncustomers. Firstly, the most important thing is to define the three tiers. The first tier of noncustomers is closest to the current market. They are buyers who are looking for something better and accept the current offer of the market in minimum level. Whereas the second tier of noncustomers are people, who refuse or do not use the current offer, because of, e.g. financial aspects. The third tier of noncustomers is the furthest from the market. They have never been considered as the market's clients [Kim and Mauborgne, 2015, pp. 160–176].

4. Weighted Industry Attractiveness

The factors, which are used to assess the growth potential are similar to the criteria which were used by Lieven and other authors of the article entitled "Who will buy electric cars? An empirical study in Germany". However, more factors will be employed – station availability and the impact on the environment, divided into two aspects (Well-to-Tank and Tank-to--Wheel). In the author's opinion, these 7 factors, presented in the table below, are the most critical criteria in the decision-making process of buying cars, and thus, with these criteria it is possible to figure out the attractiveness and predict the possible development of electric cars. The weight, which is registered in table 1 arises from the article of Lieven and other authors, which has been widely described in chapter 1. The price of electric cars in Poland is considerably higher than that of conventional cars. Therefore, BEVs in Poland have obtained 3 points, and ICEs have received 6 points. A completely different situation is in Norway, where the price of an electric car is more profitable than that of a conventional one. In the Well-to--Tank stage, a much smaller value of BEVs was also attributed to the fact that in Poland, only 11.8% of energy is generated from renewable sources [Główny Urząd Statystyczny, 2017, p. 3], whereas in Norway, 96% of electricity is produced by hydroelectric power plants. There are 6803 gas stations in Poland [Polska Agencja Prasowa, 2017], while there are only 582 electric chargers (172 fast charging and 410 regular charging spots) [EAFO, 2018a]. The result is that this factor cannot create value for the customer, which translates into only 2 points for BEVs, whereas conventional cars received 9 points. On the other hand, in Norway, there are almost 1,600 fast charging spots and 7,100 places for normal charging [Lorentzen, Haugneland, Bu and Hauge, 2017]. Other factors do not require additional explanation because they are related to the operation of cars that are not dependent on the country and are discussed in the first chapter of the article.

This tool depicts expressly that electric cars in Poland will have great problems to develop because in the overall score the winner is a conventional car with sufficient advantages. According to Thompson Jr. et al. [2012, pp. 315–315], electric cars in Poland will have difficulty flourishing because of the score below 5 points. However, why is the situation in Norway completely different? The main reason is government support. The generosity of the Norwegian government has been developed for 20 years. The main incentives for buying electric cars are:

- Exemption from the VAT on purchase and leasing,
- No purchase/import taxes,
- Free spaces in public parking,
- BEVs can use bus and collective traffic lanes,
- Exemption from fees on toll roads and free car ferries,
- 50% reduced company car tax (the amount depends on the company's income) [Figenbaum, 2017, pp. 15–16; Holtsmark and Skonhoft, 2014, pp. 161–162].

Thus, the electric car market in Norway has obtained such a high mark, even better than the ICEV market. These results have been reflected in the current situation – 141,951 battery electric vehicles were on roads in 2017 [elbil.no, 2017; Haugneland, Lorentzen, Bu and Hauge, 2017, pp. 1–2]. Moreover, Norway's advantage in individual factors was achieved by significant government support. These examples show how important government support is for the development of this technology. The only Well-to-Tank stage is connected with long-term policy, and it is tough to change quickly. However, even with a lower mark of that factor, the electric car market in Norway has excellent results, which is competitive with the result of the conventional car market.

Table 1: Assessment of market attractiveness and growth potential

Criteria		Poland				Norway			
		Electric cars		Conventional cars		Electric cars		Conventional cars	
Factors	Weight	Points	Score	Points	Score	Points	Score	Points	Score
Price	0.2	3	0.6	6	1.2	8	1.6	7	1.4
Range (distance)	0.175	5	0.875	7	1.225	5	0.875	7	1.225
Performance	0.15	6	0.9	7	1.05	6	0.9	7	1.05
Well-to-Tank – the impact on the environment	0.075	2	0.15	7	0.525	9	0.675	7	0.525
Durable and reliable	0.15	8	1.2	8	1.2	8	1.2	8	1.2
Tank-to-Wheel – the impact on the environment	0.075	10	0.75	3	0.225	10	0.75	3	0.225
Station availability	0.175	2	0.35	9	1.575	8	1.4	9	1.575
Overall score	1	-	4.825	-	7	-	7.4	-	7.2

Source: own study.

Until 2018, Poland had no plan to support electric cars. However, optimism may increase due to actions taken by the Polish government aimed at building a developed accompanying infrastructure by 2020. This allows it to move freely around the country. An additional incentive is to exempt electric cars from excise tax and higher amortisation charges for the consumption of electric vehicles for companies. BEVs will also receive additional privileges in cities, such as free parking in paid zones and the possibility of using bus lanes until 2025 [Business Insider Polska, 2017; Ministerstwo Inwestycji i Rozwoju, 2017].

By comparing the situation in Poland with the situation in Norway, a conclusion was reached that Poland has much to do to make the attractiveness of an electric car at a satisfactory level. The analyses clearly show that electric cars in Poland are not at the same level as internal combustion engine cars. However, this situation is possible to change. Namely, the Norwegians have significantly managed to promote electric cars. Some conclusions have been drawn that the role of the state in the success of this technology is significant. The Norwegian government has created an excellent climate for the development of electric cars by offering numerous facilities and tax breaks. This caused the electric car in Norway to be comparable, and even better, than an internal combustion engine. This is because the conclusions from the previously mentioned works have been confirmed, i.e. the high price and the lack of accompanying infrastructure are effective barriers to the development of electric cars. The government has the most significant impact on these issues, and the example of Norway depicts that the impact may have awe-inspiring effects. Of course, Poland has taken some actions to encourage people to buy electric cars. However, it still seems insufficient. Electric cars will remain much more expensive than the ICE ones, and the price is the primary motive when choosing the type of a car. Poland must significantly reduce the final cost of purchasing BEVs so that it is comparable to internal combustion engine cars. Only this solution will result in substantial sales results, as is the case in Norway. Moreover, the government's plan to reach more than 6,000 recharging points does not have to be fulfilled, because nowadays this investment may seem unattractive for entrepreneurs, given such low demand for these services. Therefore,

we have reached a paradox because one of the reasons for the low volume of car registration is the low number of charging points (supply). It underlines the significance of the influence of the state on the development of electric cars.

5. Three-tiers of Noncustomers

Three noncustomer tiers in the electric car market in Poland will be defined. The first tier is people who are going to change BEVs to Hybrid electric vehicles or Plug-in hybrid electric vehicles, because of the lack of charging spots or the short range of BEVs. This corresponds to the analysis carried out in the second part of this chapter - a significant problem for Polish residents who would like to purchase an electric car is the issue of free movement, in particular over longer distances. Although electric cars are developing in terms of the distance travelled, there is still lack of adequate accompanying infrastructure. The second tier consists of people who cannot afford to buy electric cars due to the price, and for this reason, they use conventional cars. The second tier reflects the conclusions of the previously used tool, namely the price of an electric car is decidedly overly high for an average inhabitant of Poland. The difference is even more noticeable if compared to the situation in Norway. The third tier contains customers who relied on public transportation and people who are fascinated by conventional cars.

Development of charging spots has made it possible to unlock the first tier, and the range of electric cars is continuously enhanced by electric car manufacturers. To unlock the second barrier it is necessary to create incentives for buyers, e.g. exemption from the VAT on the purchase. The main task should be alignment of the prices of electric cars and conventional cars. Fans of conventional cars may be encouraged to purchase BEVs by producers, who could increase the efficiency of an electric car, so that they become even more competitive compared to conventional cars. The second part of the third tier are people who for the most part choose urban transport, because of moving faster in crowded cities and also due to significant problems with finding parking space. To unlock this group of people, local governments should increase the number of parking spaces only for electric cars and free them from the charges for such parking.

Through the use of Three-tiers of Noncustomers, it is confirmed that the main barriers now are: price and availability of charging points. However, through the presented solutions it is possible to overcome unfavourable factors. Furthermore, some activities (e.g. free parking in city centres) have already been implemented. Moreover, this tool depicts how vital the Polish government is in developing this technology. In each of the tiers, the government can significantly improve the situation and encourage people, even those very distant from the electric car market, to buy such a car.

6. Discussion

Sales of electric cars should increase at a rapid pace, but until 2025 there will not be a revolution on Polish roads. This technology will continue to develop, and after 2020 the pace should accelerate because of an increase in the number of charging points. However, the discretionary income in Poland is too low to buy more expensive BEVs, and the support of the Polish government seems to be not enough. Nonetheless, it has to be underlined that there is a turn toward eco-friendly technology in Poland. Even without the support of the government, the price of electric cars will decrease in the future, so this technology will become popular in the long-term, but this change will only be a slow substitution.

Electric cars are a product which can significantly contribute to reducing the ecological problems of the developed world. In particular, when there is a shift towards renewable energy. It is a technology that requires further improvements and significant development of the accompanying infrastructure, but it is undoubtedly a perspective. Development in Poland should accelerate in particular after 2020. However, the dissemination of this product on Polish roads by 2025 is unlikely. This will be caused in particular by the price of electric cars compared to ICE cars. However, a lot depends on the Polish government, as the Norwegian example shows.

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