Article citation info:
Kęska A, Dziubek M, Michalik D. Market positioning of internal combustion engines and battery electric motors. Combustion Engines. 2023;195(4):136-143. https://doi.org/10.19206/CE-169803

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Market positioning of internal combustion engines and battery electric motors

ARTICLE INFO

Received: 30 May 2023
Revised: 18 July 2023
Accepted: 19 July 2023
Available online: 8 August 2023

To examine the current market situation of combustion and battery electric engines in vehicles and to determine the type of strategy for the development of the automotive market, a SWOT analysis was carried out. Internal strengths and weaknesses as well as external opportunities and threats on the market of internal combustion and electric vehicles were assessed. The most important areas of their operation have been designated. A weighting system and a rating scale were selected. The results of the analysis showed that combustion vehicles belong to a conservative market area which promotes the designs that have been thriving for years and maximizes their advantages. Battery electric vehicles belong to an aggressive market area, with the strategy based on a quick response to consumer needs, allowing for the maximization of profits while maintaining innovation. The future of the transport sector will be determined by the focus on the promotion of ecological transport elements.

Key words: *ICEV, BEV, types of vehicle markets, SWOT analysis*

1. Introduction

In February 2023, the governments of many European Union countries announced plans to ban the sale of new vehicles with internal combustion engines from 2030 and plans to sell hybrid electric vehicles (HEV and PHEV) with ICE only until 2035. It was planned that after 2035 only battery electric vehicles (BEVs), equipped with fuel cells and powered by hydrogen, would be allowed for sale. In March, seven EU countries, including Poland, opposed forced electrification. As a consequence, the EU authorities decided to allow the production and sale of ICE vehicles after 2035, provided that the vehicles are powered by environmentally neutral e-fuels or biofuels. However, this does not solve the problem, because the production of ecological fuels is highly energy-intensive and thus uneconomical [25].

99.7% of global transport is powered by ICE and 95% of global transport energy comes from petroleum fuels [8]. Since 2018, there has been a noticeable increase in considerations about the future of internal combustion and electric vehicles in the scientific community. Some argue that ICEs are largely responsible for environmental pollution and consider moving to fully electric mobility (zero emission vehicles – ZEV) a matter of time [4, 19]. On the other hand, some defend the sustainability of ICEs in the market, claiming that their development is the fastest way to reduce the carbon footprint of cars [9, 21]. However, the vast majority of researchers emphasize that a policy focusing solely on BEV vehicles will not be successful because it is not possible from the current technology, material resources and environmental performance point of view. Transport sustainability can only be ensured by improving ICEV efficiency and emissions, as these will drive transport significantly in the medium time perspective [9, 13]. Battery motors can realistically only power light commercial vehicles, cars and vans, which account for around 45% of global transport energy use [8]. The size and weight of the batteries needed for heavy transport, heavy sea freight and aviation would be too large to make full electrification practical, desirable or even possible [8]. A lot of hope is put in a circular economy where battery materials will be recycled. However, recovering critical metals from lithium-ion batteries is extremely difficult and energy-intensive due to their complexity and weight, and therefore these batteries are very unlikely to be recyclable even in the near future [6]. Only partial electrification, as in the case of self-charging hybrid electric vehicles (HEVs) with much smaller batteries and the energy coming from ICEVs but used more efficiently, offers readily available technology that allows for significant reductions in fuel consumption and thus CO2 emissions of petrol engines by about 25%, without the need to create new infrastructure [3]. In fact, HEVs offer a more practical prospect of lowering greenhouse gas emissions than BEVs [1, 18]. In order to avoid ecological and economic catastrophes, batteries must not become the only source of energy in transport. All available technologies, including ICEVs, BEVs, fuel cell vehicles (FCVs) [20], self-charging hybrids, and alternative fuels, should be utilized and continuously advanced to improve the sustainability of transport [18]. For a fair assessment of electrification, a full life cycle analysis of vehicles is needed [16], as the production of electric energy, not vehicle manufacturing, is the main cause of air pollution [5].

However, the development of combustion and electric engines is influenced not only by the knowledge and experience of researchers. It depends on a group of external factors, including legal, social, economic, environmental and logistic conditions. In order to study the current market situation of internal combustion engines and electric motors in motor vehicles, a SWOT analysis (an acronym for Strengths, Weaknesses, Opportunities, Threats) was conducted. The most important areas of operation of combustion and electric vehicles were determined, and a weighting system and a rating scale were developed. The current knowledge was used to determine the type of market strategy for both groups of vehicles.

2. Principles of the analysis

In the SWOT analysis, internal strengths and weaknesses as well as external opportunities and threats in a given market are assessed. Internal analysis is used to identify resources, capabilities, core competencies and competitive advantages. External analysis, on the other hand, identifies market opportunities and threats by analyzing the competitor's resources, the industry and the general environment. When conducting the analysis, the collected information should be divided into four groups (elements of the analysis) [22].

Strengths – the first internal element of the SWOT analysis describing the strengths of a given type of market. Advantage in given aspects covers the areas in which the market functions satisfactorily. The analysis should be conducted considering the microenvironment and macroenvironment. A properly implemented SWOT analysis considers the factors which shape a given market and features that correlate with different aspects of the development.

Weaknesses – the second internal element of the SWOT analysis describing the weaknesses of the operation. The study of weaknesses consists of identifying areas that are economically, technically and socially unsatisfactory. As in the case of strengths, the weaknesses should be analyzed considering the micro- and macro-environment. All activities, regardless of their size and profitability, have weaknesses.

Opportunities – the first external element of the SWOT analysis, which includes all favourable situations in the environment from which a given market can benefit. Diversification, the use of new technologies, market trends and development opportunities are identified as typical opportunities for this analysis.

Threats – the last element of the SWOT analysis covering all external threats to which a given segment is exposed. Regardless of the size of the market, all areas are exposed to threats. Threat examples can include lowering of prices on international markets or deteriorating relations with key customers. The stages of the SWOT analysis are presented in Fig. 1.

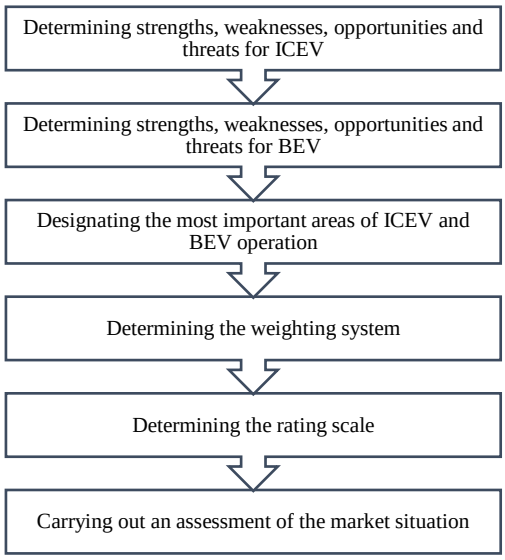

Fig. 1. Stages of SWOT analysis implementation

3. SWOT analysis

The first stage of the SWOT analysis was to identify the factors that may affect the development of the ICEV and BEV market (Table 1 and 2). They were divided respectively into strengths and weaknesses of a given market, presenting opportunities or threats to the development of a given market.

Table 1. SWOT analysis – ICEV

STRENGTHS	WEAKNESSES
1. Relatively low production cost. 2. Many years of experience in the production of ICE. 3. Availability of many types of ICE. 4. Developing industry. 5. The most common type of engines in the world. 6. Developed infrastructure. 7. Long-term improved design of the vehicle for ICE. 8. Common knowledge of engine construction. 9. Being rooted in culture, e.g. racing, rallies. 10. Easy availability of fuel. 11. Short period of filling the fuel tank. 12. Long engine life. 13. Possibility to create hybrid vehicles. 14. Lower initial purchase cost compared to BEV. 15. Known and proven ways of recycling. 16. Component availability.	1. The use phase causes environmental degradation by emitting harmful pollutants. 2. The need to install additional equipment to reduce pollution. 3. The design of the ICE requires many fluids inside the engine for efficient operation. 4. The ICE design needs servicing. 5. Maximum engine efficiency is 37%. 6. Possibility of obtaining energy mainly from hydrocarbons – crude oil. 7. A significant number of moving parts in the ICE. 8. High costs of fuels used. 9. Generating high noise levels. 10. Large size and weight of the ICE. 11. It is one of the factors causing smog in urban areas.
OPPORTUNITIES	THREATS
1. Technological progress. 2. Modernization of existing ICE units. 3. Unwillingness of vehicle users to change the existing paradigms (abandonment of the engines used so far). 4. Improving biofuel technology. 5. The possibility of using synthetic oils. 6. Probability of rejection of EV engines in favour of ICE. 7. Better driving characteristics. 8. Alternative ICE, e.g. hydrogen engines. 9. Versatility of ICE in light, heavy and specialist vehicles. 10. Consumer habits.	1. Limited oil deposits. 2. Political conditions aiming at zero greenhouse gas emissions. 3. The development of alternative forms of propulsion. 4. Users may stop using these devices for environmental reasons 5. Rising oil prices. 6. Growing restrictions in access to city centres. 7. Increase in production costs related to compliance with environmental standards. 8. Assumptions of sustainable mobility.

The analysis for combustion engines shows the advantage of strengths over weaknesses and opportunities over threats. The practical advantages of using internal combustion engines in vehicles are primarily the short time needed for refueling and the developed infrastructure. During longer journeys, the driver does not need to set the exact route. Petrol stations are widely available. Combustion engines are the most popular type of vehicle propelling devices. Currently, there are over 1.1 billion vehicles equipped with internal combustion engines [15]. This contributes to creating an environment ready for transformation. An important aspect in the scope of ICE is the product life cycle. Combustion cars have much more modern and extensive forms of recycling. Many parts are reused. In addition, the number of disposal points available is high. From the user's point of view, the operating time is an important element. Combustion engines have a long service life. Its average period is from 300 to 350 thousand kilometers.

The disadvantages of ICEVs are the high emission of pollutants during operation. The level of generating harmful substances causes non-compliance with the plans developed by the European Union in the field of zero-emission economy. This factor is decisive and has a strong impact on other areas of ICEV development. Due to the need to adapt to legal requirements, activities aimed at developing low-emission technologies are a necessary element. Nevertheless, currently used filters can negatively affect the drive unit, thus shortening its life. Adapting to EU standards requires improving individual components. All the indicated factors correlate with the high cost of purchasing ICEV. Combustion engines have a low maximum efficiency of 37%. As a result, more than half of the energy is wasted and not used for work purposes. Another aspect is the process of obtaining energy exclusively from fossil fuels. This feature prevents the production of its "pure" counterpart. Rising oil prices are transferred to end users who, in order to use vehicles, have to pay higher and higher prices for petrol and diesel fuel.

The developing automotive industry is considered the main opportunity for ICEV. The possibilities of its development correlate with the high probability of minimizing pollutant emissions for the discussed category of devices. Reducing the level of generated harmful substances will allow the use of internal combustion vehicles without a significant impact on the environment. Another important feature is the attitude of consumers towards switching to alternative forms of propulsion. User reluctance may be a decisive factor in the dominance of the ICEV market. Profit maximization is a basic element of the functioning of production enterprises. The demand in the analyzed segment can be monetized by entities with a leading position. Another factor identified in the area of opportunities is the possibility of developing alternative internal combustion engines. The use of internal combustion engines is also a very important aspect. Specialty machines and tractor units would require a radical change. The distance covered by the BEV currently prevents the installation of such solutions in trucks.

Among the potential threats to the development of ICEV may be primarily restrictions related to the availability of crude oil. Non-renewable resources are characterized by limited availability. At the current rate of oil use, it can be expected that the deposits will be exhausted in about 50 years [17]. This will result in the resignation from the solutions used so far. In addition, the European Union plans that by the end of 2050 the member states will achieve zero emissions [23].

Table 2. SWOT analysis – BEV

STRENGTHS	WEAKNESSES
1. High engine efficiency up to 85%. 2. During operation, the engine does not emit harmful pollutants. 3. Lack of engine fluids, e.g. engine oils. 4. Less frequent failures of the drive unit. 5. Less failure-sensitive gearbox. 6. Amenities in cities, such as parking lots, bus lanes. 7. Co-financing for the purchase. 8. Possibility of charging the BEV by using a household socket. 9. Rapid technological development. 10. Ability to obtain energy from many sources. 11. Energy is produced externally and the vehicle only stores and converts it into work. 12. It does not emit noise while driving. 13. Low cost of using and servicing the vehicle. 14. Power available throughout the rev range. 15. BEVs raise public awareness on environmental protection. 16. In urban conditions, it allows the recovery of a significant part of energy through recuperation.	1. High purchase cost. 2. Use of rare earth elements such as lithium or cobalt. 3. Long charging time. 4. Poorly developed charging station infrastructure. 5. The need to plan long routes due to "black spots" on the map. 6. Lack of proper recycling and reuse technology. 7. Weaker driveability. 8. The production stage emits significant amounts of harmful substances. 9. Usage gradually reduces the maximum capacity of the battery. 10. Sensitivity to cold. 11. The battery condition should be kept between 20 - 80% of the battery. 12. High production cost.
OPPORTUNITIES	THREATS
1. Dynamic development of the BEV market. 2. Increasing demand for electric cars. 3. Political orientation regarding the concept of sustainable mobility. 4. Implementation of new technologies. 5. Social pro-ecological awareness. 6. Minimization of purchase costs. 7. Manufacturers' declarations on the transition/development of EV technology. 8. The growing trend for electric vehicles. 9. Depleting oil resources.	1. Limited resources of rare earth elements. 2. Alternative forms of drive. 3. Difficulties in driving heavy and specialized vehicles (tractors or giant trucks). 4. ICE development. 5. Poorly developing infrastructure, in particular in low and medium developed countries. 6. Environmental performance depends on the energy supply structure of a given country.

The introduction of a ban on the use of internal combustion engines is one of the possible steps of the implemented policy. The ecological awareness of the society is also improving. From year to year, more and more people declare their willingness to change the form of propulsion to a more ecological one. Problems with accessibility to city centers are currently being observed. The cities of Hamburg and Stuttgart prohibit diesel vehicles [2].

The analysis carried out for electric vehicles allows to identify the dominance of the advantages of BEV vehicles over their disadvantages. Opportunities and threats, however, are on a similar level. The lack of pollutant emissions during vehicle operation is the most important strength of this category of vehicles in the context of environmental performance. This element is conditioned by the design of the car. Zero-emission vehicles are environmentally friendly when they operate. Another argument is the high efficiency of the electric engine compared to its combustion equivalent. In BEV vehicles, the engine efficiency can be as high as 85%. This translates into the level of efficiency of using the stored energy. The development of electromobility is supported by the activities of some countries regarding the co-financing of the purchase of electric vehicles. This contributes to minimizing the real costs of purchasing an electric vehicle. In Poland, the value of the subsidy may be up to EUR 4000. For comparison, in Western countries, i.e. Italy and France, the subsidy amount is EUR 6000 [12]. An important aspect is also the introduction of tax reliefs on the acquisition of BEVs. For example, some units are completely exempt from excise duty, and for the purchase of a BEV, the company can introduce almost twice as much into the business costs as compared to the purchase of a combustion vehicle. Another important factor is the versatility of the utilized energy. BEVs can draw energy entirely from renewable sources. The last important aspect is the low cost of using and servicing the vehicle. BEVs are characterized by lower repair prices than standard ICE vehicles. In addition, the price of electricity is lower than that of the liquid fuels. Assuming that the BEV will be charged at home with energy produced by installed solar panels, the energy needed to power the device may be cost-free.

Battery charging time is a significant weakness of the electric vehicles. The limited length of the power supply period is a discouraging factor for a potential group of buyers. In addition, when traveling long distances, the BEV user must take into account the charging period of the used car in the route planning process. The low level of expansion of the charging infrastructure limits the technical capabilities of electric cars. Many of the currently available points offer the users free charging. Expanding the charging infrastructure may be significantly more difficult in Eastern countries. In these regions, the availability of the number of charging points is significantly lower than in Western countries, for example Germany. Another negative feature of electric vehicles is the need to use rare earth resources. This raises questions about the actual environmental performance of BEVs. During the production of the battery, necessary for the operation of the vehicle, a significant amount of pollutants is emitted, causing degradation of the natural environment. The areas of recycling and disposal are also a barrier due to the lack of technologies enabling the recovery of elements. We should also remember about lithium greases used in BEV and HEV, for which alternative solutions should also be sought.

The dynamic development of the BEV market is the most important factor regarding possible opportunities. In recent years, the market has seen an increase of interest in BEV and a focus on expanding the existing infrastructure. These factors are an important component that contributes to achieving the goals of the Green Deal. The next chance is the legal regulations that favour the development of the electric car market. The phenomenon of globalization contributes to the increase of ecological awareness of the society. In this aspect, BEVs have an advantage over the competition being zero-emission vehicles. Over the years, one can also observe a change in the directions of activities of the leaders of the automotive industry. They focus on developing solutions based solely on electric motors. In addition, due to further EU concepts, there is a high probability of a forced departure from internal combustion engines. Depleting oil reserves are the main reason for the electrification of the automotive industry.

Depleting lithium and cobalt resources are the most important threats to the BEV market. The process of obtaining rare earth elements is characterized by complexity. Additionally, the amount of extraction of lithium and cobalt deposits is relatively low compared to other elements. Technical limitations of electric vehicles are among the factors threatening the development of BEVs. The need for high power, as in the case of trucks, can limit the use of electric engines. Increasing power is associated with the need to store more energy. Infrastructure is also a problematic area. The limited number and difficult accessibility of charging stations discourage potential consumers. In addition, in countries where energy is mainly obtained from fossil fuels, the environmental performance of vehicles with an electric engine decreases significantly.

The next stage of the analysis included the selection of the most important factors from among the strengths and weaknesses as well as opportunities and threats for ICEV and BEV. All factors were selected based on the most important areas related to infrastructure, technical aspects and environmental conditions. Then, the values of the weights (in the form of decimal fractions) were determined along with the determination of the level of importance of strengths and weaknesses as well as opportunities and threats in the development of the combustion and battery electric vehicle market (Table 3). The sum of the weights of the five selected factors for each element of the SWOT analysis must equal 1. In addition, a five-point rating scale was determined (Table 4), thanks to which it was possible to determine the impact of a given factor on the development of a given market [14]. A higher rating for strengths and opportunities is related to the positive impact of a given factor on the development of the combustion or electric engine vehicle market. A low rating for weaknesses and threats indicates a negative impact on the market. Tables 5–8 list the analyzed factors and calculated a weighted score for each of them.

Table 3. The SWOT analysis weight system

Weight	The level of importance of the factor in the development of a given market
0.1	Low
0.2	Medium
0.3	High

Table 4. The SWOT analysis rating scale

Rating	The strength of the factor's impact on the development of a given market
1	Very low
2	Low
3	Medium
4	High
5	Very high

Table 5. Weighted rating of strengths and weaknesses – ICEV

Strengths	Weight	Rating	Weighted rating	Weaknesses	Weight	Rating	Weighted rating
Well-developed infrastructure	0.3	4	1.2	The operation of the vehicle causes the emission of harmful pollutants	0.3	5	1.5
Long engine life	0.1	4	0.4	The need to install additional equipment to reduce pollution	0.3	4	1.2
The prevalence and availability of fuel	0.2	5	1	Maximum engine efficiency is 37%	0.1	1	0.1
The most common type of engine in the world	0.3	3	0.9	Possibility of obtaining energy mainly from hydrocarbons	0.1	2	0.2
Known and proven ways to recycle internal combustion vehicles	0.1	4	0.4	High costs of fuels used	0.2	2	0.4
Sum	1	–	3.9	Sum	1	–	3.4

Table 6. Weighted rating of opportunities and threats – ICEV

Opportunities	Weight	Rating	Weighted rating	Threats	Weight	Rating	Weighted rating
Unwillingness of vehicle users to change the existing paradigms (abandonment of the engines used so far)	0.3	3	0.9	Limited oil resources	0.2	4	0.8
Technological progress	0.3	4	1.2	Political conditions aiming at zero green-house gas emissions	0.3	5	1.5
Alternative combustion engines, e.g. hydrogen	0.1	3	0.3	Users may stop using electric vehicles for environmental reasons	0.1	3	0.3
Versatility of combustion engine applications in light, heavy and specialist vehicles	0.1	2	0.2	Increasing restrictions on access to city centers	0.1	3	0.3
Modernization of existing ICEVs	0.2	3	0.6	Increase in production costs related to compliance with environmental standards	0.3	3	0.9
Sum	1	–	3.2	Sum	1	–	3.8

Table 7. Weighted rating of strengths and weaknesses – BEV

Strengths	Weight	Rating	Weighted rating	Weaknesses	Weight	Rating	Weighted rating
No emission of harmful pollutants during operation	0.3	5	1.5	The use of rare earth elements, for exampl lithium or cobalt	0.2	3	0.6
Financial allowance for purchase	0.3	4	1.2	Long charging time	0.3	5	1.2
Ability to obtain energy from many sources	0.1	3	0.3	Poorly developed charging station infra-structure	0.3	4	0.8
Low cost of using and servicing the vehicle	0.2	1	0.2	Lack of proper recycling and reuse tech-nology	0.1	2	0.2
High engine efficiency up to 85%	0.1	2	0.2	The production stage emits significant amounts of harmful substances	0.1	2	0.4
Sum	1	–	3.4	Sum	1	–	3.2

Table 8. Weighted rating of opportunities and threats – BEV

Opportunities	Weight	Rating	Weighted rating	Threats	Weight	Rating	Weighted rating
Dynamic development of the BEV market	0.2	4	0.8	Limited resources of rare earth elements	0.4	3	0.6
Political conditions focused on ecology	0.3	5	1.5	Difficulties in driving heavy and special-ized vehicles (tractors and trucks)	0.2	2	0.4
Social pro-ecological awareness	0.2	3	0.6	ICE development	0.1	2	0.2
Manufacturers' declarations on transition/development of BEV technology	0.2	4	0.8	Poorly developed infrastructure, in particular in low and medium developed countries	0.2	3	0.6
Decreasing oil deposits	0.1	3	0.3	Environmental performance depends on the energy structure of a given country	0.3	5	1.5
Sum	1	–	4	Sum	1	–	3.3

4. SWOT analysis results

The analysis of the main factors influencing the market situation provided four different results for each of the discussed markets (Fig. 2 and 3). On this basis, a strategy upon the development of the ICEV and BEV markets is based was selected. The SWOT analysis distinguishes four development strategies: aggressive, conservative, competitive and defensive. If, after analyzing the results, strengths and opportunities prevail, we can be tempted to choose an aggressive strategy. It should focus on the advantages of the market and use them through strong expansion. If it turns out that strengths are the most important, but at the same time there are a lot of threats in the environment, we should choose a conservative strategy. In this case, the market will try to overcome threats using its strongest internal features. On the other hand, when we see the dominant share of weakness on the market, and at the same time there are clear opportunities outside, a competitive strategy may turn out to be the best. This means that a given market should focus on eliminating internal weaknesses in such a way as to make better use of the opportunities of the environment in the future. The last strategy - defensive - will be the best choice if we have the dominant share of weakness, and at the same time there are a lot of threats in the environment in which the market operates. When choosing it, the market focuses mainly on activities that will ensure the possibility of survival.

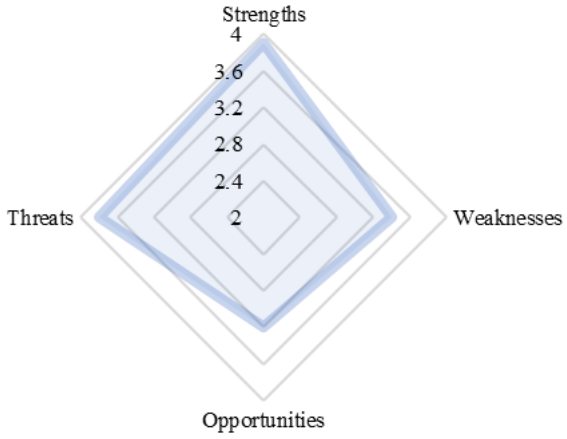

Fig. 2. ICEV market rating

The activity of entities using the construction of vehicles equipped with internal combustion engines is related to the established position in the automotive industry and the advantage of this type of equipment (high efficiency, low production costs). In the case of BEV, the current market depends mainly on the potential opportunities to be seized. The market assessment of ICEV is diversified depending on the considered factor. The advantages that characterize the market today show a high value of 3.9 points. What is important, however, is the threat level, which is as high as 4 points. Such a high value may indicate problems for ICEV in the future. The prospects for change are relatively low at 3.2 points. The average value of defects is 3.4 points. The ICEV market currently holds the leading position. However, the progressive threats it may face contribute to significant changes in the production and operation of ICEV.

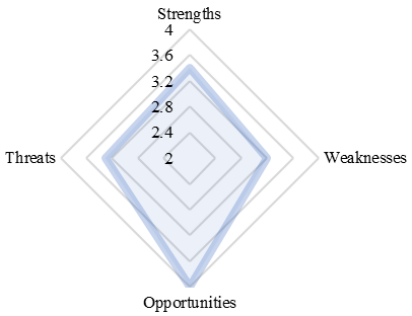

Fig. 3. BEV market rating

In the case of electric cars, the market is shaped by seized opportunities. The value of potential opportunities is as high as 4 points. The global trend for pro-ecological activities favours zero-emission vehicles. The concept of BEV creation was developed in response to the high level of environmental pollution caused by internal combustion engines. The number of risks and disadvantages are relatively low. They are respectively 3.2 and 3.3 points. Dangers and defects mainly focus on problems related to the infrastructure and the loading process. Improving technology means that in the perspective of several years these values may decrease. The advantages of an electric vehicle on a point scale are 3.4 points. The current market and stages of BEV evolution allow predictions related to the dynamization of the growth of their advantages.

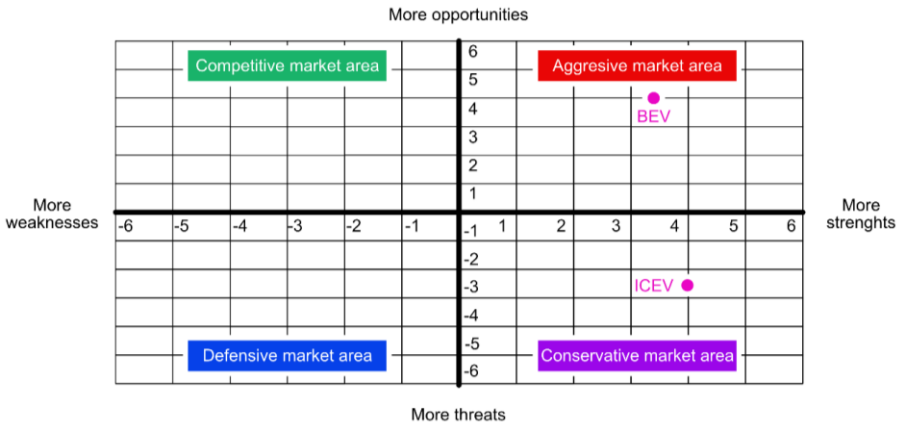

Fig. 4. Market positioning of ICEVs and BEVs

The choice of strategy is conditioned by the relationships between advantages and disadvantages as well as opportunities and threats. Figure 4 shows the types of strategies currently followed by the ICEV and BEV markets.

The market of internal combustion engine vehicles is conservative. The activities of this market are focused on generating profit from a long-term, thriving structure. The market does not show radical changes, it is stable. This effect is visible in the form of relatively stable stock quotations of concerns such as General Motors or Mercedes Benz Group AG. Capital preservation is more important here than growth or market returns. Market threats are eliminated by maximizing the use of internal strengths.

The aggressive market area that characterizes the electric vehicle market means that it is dominated by its opportunities. In addition, internal strengths are supported. It is a strategy of strong expansion and development. The marketing strategy is based on a quick response to consumer needs, which allows for maximizing profits while maintaining innovation. An aggressive strategy includes activities such as: capturing opportunities, striving to strengthen the market position and concentration of resources on competitive products. Examples of aggressive behavior of the electric vehicle market can be observed by intensifying media interest, e.g. launching the first electric car into space [10], creating stylistically unique structures (Tesla cybertruck) [7] or creating BEVs as ecological vehicles [11].

5. Conclusions

The conducted SWOT analysis allowed to identify the strengths and weaknesses of internal combustion and electric engines. The designated market areas show the current situation of ICEVs and BEVs. Electric vehicles are characterized by a rapid growth of development based on pro-ecological aspects. Conventional drives, on the other hand, use existing and prospering structures to maximize their advantages.

It is certain that in the next decade the automotive industry will develop more than in the previous century. Adapting to the current era of electromobility requires the introduction of zero-emission cars on the roads. However, caution should be exercised when identifying a single solution (BEV) as the best way to achieve the principles of sustainable development [24]. Energy policy certainly needs to be based on much greater realism, fairness and appreciation of broader global development, economic and environmental needs. It is essential to continue the research and development of all technologies that provide the world with energy, including the combustion of fossil fuels, in particular in internal combustion engines.

Nomenclature

BEV	battery electric vehicle
HEV	hybrid electric vehicle
ICE	internal combustion engine
ICEV	internal combustion engine vehicle
PHEV	plug-in hybrid electric vehicle
SWOT	strengths, weaknesses, opportunities, threats

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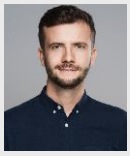

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