

## TWO DECADES OF HYBRID ELECTRIC VEHICLE MARKET

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Reviewed positively: 22.03.2022

### Information about quoting an article:

Menes M. (2021). Two decades of hybrid electric vehicle market. Journal of civil engineering and transport. 3(1), 29-37, ISSN 2658-1698, e-ISSN 2658-2120, DOI: [10.24136/tren.2021.003](https://doi.org/10.24136/tren.2021.003)

**Abstract** – The article presents a cross-sectional view of the development of the HEV car market over the last two decades. Hybrid cars are currently the widest group of cars equipped with alternative to classic drive systems. They are also the most numerous group among electric vehicles. The historical meanders of HEV development were described, as well as the current level of development of this market and the real prospects for the popularization of HEV cars. The level of world production of this category of motor vehicles in the twenty-year period 2001-2020 was also characterized. The article attempts to estimate the real size of the world's HEV fleet. The level of sales of this category of vehicles by individual countries and their changing percentage share in the passenger car market were also presented. Sales of electric hybrids even in the crisis year 2020 increased from 3.2 million to approx. 4 million vehicles, despite a decrease in sales of new passenger cars from 64 to 54 million units. The above fact also proves the market attractiveness of this type of vehicles and the constantly growing interest in them.

**Key words** – directions of automotive development, greenhouse gases, hybrid electric vehicles, HEV

**JEL Classification** – O31, O32

### INTRODUCTION

Electricity as a source of propulsion for road vehicles is nowadays one of the prospective directions of development of the global automotive industry.

There are a number of different solutions in this matter, the most important of which are: hybrid electric cars (HEV), plug-in battery electric cars (BEV), hybrid electric cars with external power (PHEV), and electric cars powered by hydrogen electric energy (fuel cell electric vehicle - FCEV).

The first solution, both in the time sequence and in the current scale of development, is electric hybrid cars equipped with a traditional internal combustion engine (both gasoline and diesel) and supporting electric motors powered by electricity from batteries charged while driving. The first prototype of an electric hybrid was built in 1899 by Ferdinand Porsche [1].

The research problem discussed in this article is the analysis of 20 years of development of the HEV market. The hypothesis was the assumption that

the HEV car market would continue to develop regardless of the crisis in other segments of the automotive market. A critical analysis of the literature on the subject was adopted as the research method, supported by own calculations and multi-criteria assessment of the described changes in the automotive market.

Magnitude of the global car fleet, estimated in 2019 at 1.5 billion vehicles (95% of which were passenger cars), and above all, the increasing dynamics of its growth (in 1970 this fleet numbered 250 million vehicles, in 1986 already 500 million vehicles and billion in 2010) [2], puts on the agenda, on the one hand, issue of the exhaustibility of liquid fuels used by the automotive industry, and on the other hand, the issue of greenhouse gases and other pollutants generated by internal combustion engines.

### 1. CLIMATE CHANGE AND THE POSSIBILITIES TO COUNTER IT

The progress observed in the development of internal combustion engines, despite the enormous

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financial outlays incurred, is not able to fully meet the indicated challenges. Hence, the continuation of work to improve the design of internal combustion engines is accompanied by work on the development of alternative sources of propulsion, including their combination with traditional internal combustion engines.

The depletion of physically and economically available energy carriers and, above all, the existential need to reduce greenhouse gas emissions force the need for a fundamental transformation of the global energy economy. One of the strategic directions of the necessary transformation is the development of electrification of individual transport, carried out in various forms.

Counteracting further global warming has become not only an absolute priority for the European Union, and the electrification of transport has been widely recognized as one of the indispensable factors for the necessary transformation.

Limiting global warming to below 2°C requires a reduction of CO<sub>2</sub> emissions by 85% from today's level till 2050, while with continued increasing consumption of conventional fuels, an increase in the current scale of CO<sub>2</sub> emissions can be expected. Limiting global warming to below 2°C applies to the period 1860-2050, and by the 2015 the average temperature of the environment increased by 1.6°C, which means that only 0.4°C remained to the desired climate warming ceiling by the 2050.

The implementation of the above objective, adopted at the World Climate Conference in Paris in December 2015, and approved by 195 countries, requires reduction of cumulative carbon dioxide emissions from energy production and use by the 2100 by 900 Gt. This is the amount that the world will emit before the 2050, with continued current development trends, assuming a tripling of the world GDP and population increase from 7.6 to 9.8 billion people. (No changes in the global energy system, with the assumed trends in the development of the world economy, would result in a global warming in the order of 4°C).

In order to achieve the assumed objective of reducing carbon dioxide emissions, it is necessary to decarbonise transport as far as possible.

In addition, wide spreading of the electrification of transport would allow to eliminate local emissions of such toxins as: sulphur oxides, nitrogen oxides, or solid particles that participate in the creation of smog, being responsible, according to the estimates for 3 million deaths already per year [3].

In the option assumed by the International Energy Agency of continuation of the current

development trends, CO<sub>2</sub> emission will increase by 35% by the 2050, with a large share of transport (20% at present), while the implementation of the scenario of limiting climate warming below 2°C is necessary to reduce CO<sub>2</sub> emission by 40%. The implementation of the above objective requires to have 160 million low-emission vehicles on the world's roads as early as 2030, including 80 million hybrid vehicles and 80 million zero-emission vehicles - BEV and FCEV. All technologies based on electricity will develop synergistically, finding their application in various areas defined by the required ranges and gross weight of the transport means.

BEVs are primarily low-weight and short-range vehicles characterized by admittedly the efficiency of using electricity from renewable sources of 60%, with 25-30% efficiency in the case of traditional combustion engines, but also with a low energy density of 0.6 MJ/kg.

In the light of forecast assumptions, global haulage in the years 2012 - 2050 will double. If the current development trends continued, CO<sub>2</sub> emission from transport, amounting to approx. 35 Gt CO<sub>2</sub> in 2012 (20% of total industrial emissions) would double [4] and would significantly contribute to a 60% increase in total greenhouse gas emissions, which would result in a global warming by 6°C [5].

The elimination of fossil fuels as energy resources requires a fundamental increase in the share of energy from renewable sources. The decreasing costs of obtaining energy from wind and sun should lead, depending on the country, to an increase in their share in the electricity balance by 30 to 60%, or even 70% (e.g. in Portugal). This should be accompanied by a progressive electrification of various types of economic activity. In 2050, the energy balance of Europe, forecast by the International Energy Agency, amounting to 3,378 TWh, renewable energy should account for 68% of all energy consumed, of which solar should account for 7%, wind power should account for 33%, hydropower 4% plus 26% nuclear energy [6].

Limiting global warming to below 2°C requires an increase in the share of electricity from renewable sources from 23% in 2015 to 68% in 2050. According to German studies, in the future 80-90% of electricity consumed in the country will come from renewable sources [7].

### 2. HYBRID ELECTRIC VEHICLE MARKET – CURRENT STATE AND DEVELOPMENT FORECASTS

The increase in the production scale of BEVs and HEVs as well as technological progress should contribute to a further reduction of production

costs and an increase in the competitiveness of the vehicles in question.

Maintaining various financial systems operating in many countries, as well as non-financial support for the acquisition and operation of low and zero-emission vehicles, with the expected increase in the operating costs of cars equipped with classic combustion engines, should result in real and increasing sales of BEV and HEV cars.

The European Commission has clearly confirmed that the development of electrification of transport is one of the key elements in achieving the goal of reducing the EU's CO<sub>2</sub> emissions by 50-55% as early as 2030.

Already today, cars powered by electricity are becoming a real component of the automotive market, both in individual countries and on a global scale.

Most experts assume that by the 2050 HEVs will become an extremely important element of the global fleet of vehicles. Complementary to battery electric vehicles and FCEVs, will constitute gross of passenger vehicles produced. On the other hand, decarbonisation of heavy transport is to be ensured by hydrogen vehicles, the number of which will increase to 30% in the group of trucks (5 million units) and up to 25% in the group of buses (15 million units) [8].

A number of authors have been paying attention for years to extremely dangerous and harmful, especially highly concentrated in urban agglomerations, toxins such as sulfur oxides, nitrogen oxides or solid particles [9].

A number of authors from Europe, the USA and Asia describe the HEV market by examining its trends. The vast majority of them emphasize the very serious ecological benefits resulting from the introduction of new types of propulsion to passenger cars, including just like HEV [10].

Many authors claim that HEV, BEV and FCEV cars are not competitors, but complement each other and fill market gaps. Each of these types of cars will develop at different rates in different regions of the globe, depending on local social and economic conditions [11].

The sixties and seventies of the last century brought a renaissance of interest in electric hybrid vehicles. Actions taken during the Middle East War and the 1973 oil crisis were soon halted by the return to abundant supplies of cheap oil.

Contemporary, electric hybrid cars appeared in the late 1990s. The company that launched in 1997 and has the greatest track record in the production of hybrid electric cars is Toyota (introducing the Coaster Hybrid EV in August 1997 and the hybrid Prius in December). In 1999, another Japanese

concern, Honda, joined the group of electric hybrid manufacturers. In the early 2000s, Ford electric hybrids (Fusion Hybrid, Escape Hybrid, Mercury Hybrid, Milan Hybrid, Mercury Mariner Hybrid) appeared, and in 2007 Nissan and General Motors electric hybrids (Cadillac, Esclade, Chevy, Jukon, Sierra, Saturn) appeared.

In the period of 20 years (2002-2020), a total of over 25.6 million passenger electric hybrid cars were sold worldwide. In addition to the countries listed in Table 1, cars of this type, in the numbers from several to several dozen thousand, are found in several other countries, such as: Mexico (23.9 thousand), Argentina (3.3 thousand), Paraguay (5.0 thousand), Panama (2.0 thousand), Costa Rica (1.4 thousand) - all items illustrating the registration status at the end of 2019[12], or India, Indonesia, Thailand.

Most, over 14.7 million HEVs, were sold in Asia, mainly in Japan (over 12.5 million vehicles), then in North America (over 6.1 million vehicles), including mostly in the USA nearly 5, 9 million vehicles.

In Europe, over 4.7 million passenger electric hybrids were sold in the period of 20 years, including nearly 4.5 million in the European Union countries. The largest sales of HEVs concerned: Germany (855 thousand), Great Britain (855 thousand), France (717 thousand), Italy (610 thousand), Spain (487 thousand) and the Netherlands (nearly 268 thousand units).

In 2020 alone, approx. 4 million electric hybrid cars were sold worldwide (over 2.1 million in Asia, over 1.3 million in Europe, most of which - 1,293,000 in EU countries and over 0.5 million in the countries of North America and South America, including 0.48 million in the USA).

The first million of passenger electric hybrids were sold in 6 years (2001-2006), when annual sales increased from 42,000 cars sold in 2001 in the USA and Japan to 390,000 cars in 2006, when there were sold: 88.6 thousand HEV in Japan, 258,000 in the USA and 33.7 thous. in Europe.

By 2010, a total of over 3.5 million electric hybrids were sold worldwide, including 1.9 million in the USA and 3 million in Japan. Electric passenger hybrids began to appear in small numbers in the most motorised European countries (Great Britain over 80,000 vehicles, Netherlands 50,000 vehicles, Germany 45,000 vehicles, France 44,000 vehicles), as well as in China 8,000 vehicles and Canada 70 thousand vehicles. The progressive quantitative and qualitative development of the market offer of hybrid cars: Toyota Prius, Lexus RX, Lexus LS, Honda Insight, Toyota Camry was accompanied by their numerical expansion.

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Table 1. Sales of electric hybrid cars (HEV) in the world's most motorized countries in 2001-2020, in thousands of units

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total	
Austria					0.1	0.4	0.8	1.3	1.0	1.0	1.0	2.0	3.0	2.0	2.4	3.5	6.6	7.1	14.3	26.0	72.5	
Belgium				0.1	0.5	1.0	1.3	1.9	1.9	4.0	7.0	5.0	6.0	8.0	6.9	9.5	12.6	15.3	17.2	15.8	114.0	
Denmark							0.1	0.2	0.1	0.2	0.2	0.3	1.0	1.1	2.5	6.8	7.1	8.8	9.7	47.9		
France			0.1	0.5	2.1	6.3	7.3	9.1	9.4	9.4	13.0	28.0	47.0	41.0	56.0	51.0	69.7	91.8	6.8	168.8	717.2	
Finland				0.1	0.0	0.1	0.2	0.8	0.7	1.2	1.1	1.4	9.2	7.8	2.8	4.7	8.5	10.7	15.5	18.7	83.5	
Spain				0.4	0.1	0.1	0.2	0.2	12.0	7.0	10.0	10.0	10.0	12.0	18.4	30.9	55.5	75.8	108.7	137.4	487.7	
Holland			1.0	1.0	1.0	2.0	1.0	11.8	16.1	16.0	15.0	23.0	24.0	14.0	15.0	1.0	17.7	23.0	28.8	46.5	267.9	
Ireland				0.3	0.3	0.5	1.1	1.2	0.3	0.7	0.5	6.8	1.0	1.0	1.5	2.6	4.4	6.9	10.1	10.9	50.0	
Germany				3.3	3.3	6.9	6.3	6.5	8.4	9.0	13.0	22.0	25.0	21.0	22.5	34.2	55.2	98.8	193.9	327.4	856.7	
Norway									0.0	0.0	3.9	6.2	9.5	9.8	10.7	17.3	20.5	16.3	17.5	12.2	123.9	
Poland									0.3	0.5	3.9	6.2	9.5	9.8	10.7	17.3	20.5	16.3	17.5	12.2	123.9	
Sweden	0.3	0.2	0.1	0.7	1.9	2.8	3.3	4.0	2.6	4.0	3.0	3.0	5.0	7.0	8.7	13.8	19.6	20.8	22.0	29.0	151.8	
Switzerland			0.3	0.2	0.6	1.4	2.3	3.0	3.4	1.9	4.9	6.1	6.7	7.0	6.0	6.1	7.7	8.4	11.3	22.0	32.1	131.4
Great Britain				2.6	4.9	9.4	15.9	15.4	14.6	22.0	23.0	25.0	29.0	37.0	44.0	51.8	72.5	94.8	174.1	219.6	855.6	
Italy			0.2	0.1	1.4	0.7	1.9	4.6	2.4	7.8	4.0	5.0	7.0	15.0	21.0	37.2	63.4	82.0	109.9	221.9	610.7	
UE	0.3	0.4	1.5	10.4	14.9	3.4	42.1	54.8	75.2	79.3	91.8	134.5	177.0	175.4	211.5	267.8	410.0	558.6	853.0	1293.7	4482.9	
UE + EFTA	0.3	0.7	1.5	11.0	16.3	33.7	45.1	56.2	77.1	83.3	101.8	146.4	193.5	191.2	228.3	292.8	438.9	586.2	892.5	1338.8	4737.8	
Australia												1.9		11.9	42.1	12.1	11.0	11.0	31.2	60.4	151.6	
China						0.0	2.0	0.1	2.1	0.6	2.6	2.0	8.4	24.3	10.0	80.0	140.0	210.0	285.0	385.0	1152.1	
Japan	22.0	19.0	40.0	39.0	60.8	88.6	88.4	108.5	348.9	481.2	451.3	887.8	921.0	1016.8	937.6	1275.6	1385.3	1431.9	1472.3	1452.0	12528.0	
South Korea												37.0	28.0	28.8	37.0	59.0	80.0	91.0	103.6	210.0	674.4	
Malaysia										0.3	8.4	15.0	19.0	12.0	7.0		12.0	20.7	13.0		107.4	
New Zealand											1.2	1.5	1.3	1.0	1.1	1.4	1.7	2.1	5.9	8.7	25.9	
Turkey															0.1	0.9	4.4	3.9	11.0	22.7	43.0	
<b>Total Asia</b>	22.0	19.0	40.0	39.0	60.8	90.6	88.5	110.6	349.5	484.1	462.9	951.6	993.6	1070.5	1014.9	1430.0	1574.4	1770.6	1922.0	2138.8	14682.4	
Canada				2.9	3.1	7.2	12.5	19.9	13.8	10.0	10.1	20.9	20.7	19.8	15.3	21.7	22.8	25.3	35.9	30.0	291.9	
USA	20.3	36.0	47.6	84.2	209.7	258.6	352.7	312.4	290.3	274.2	268.7	434.5	495.7	452.1	384.4	346.9	362.9	349.2	400.7	480.0	5870.4	
<b>Total North Amer.</b>	42.6	71.6	84.8	128.4	212.8	265.8	365.2	332.3	304.1	284.2	278.8	455.4	516.4	471.9	399.7	368.6	385.7	374.5	436.6	510.0	6162.3	
<b>Total world</b>	42.6	55.7	89.1	137.1	289.9	390.1	498.8	501.1	730.7	851.6	843.5	1553.6	1703.5	1733.6	1633.9	2091.4	2399.0	2731.3	3251.1	3987.6	25582.5	

Source:

European countries: 2002-2003:[13] 2004-2009:[14] 2010-2017:[15] 2018-2019:[16] 2020:[18]  
 China: 2005-2013:[19] 2014-2017:[20] 2018-2020:[21]  
 Australia: 2012:[22] 2014-2018:[23] 2019-2020:[24]  
 Japan: 2001-2004:[25] 2005-2016:[26] 2017-2019:[27]  
 South Korea: 2013-2017:[28] 2018:[29] 2019:[30] 2020:[31]  
 Malaysia: 2010-2012:[32] 2013-2015:[33] 2017-2020:[34]  
 New Zealand: 2011-2020:[35]  
 Turkey: 2011-2019:[36]  
 Canada: 2011-2019:[37]  
 USA: 2000-2019:[38] 2020:[39]

**Table 2. Share of personal hybrids in the world passenger car market and in the passenger car markets of Japan, China, the USA and EU and EFTA countries in 2010-2020, in %**

Item/Year	World	Japan	USA	China	EU + EFTA
2010	1,3	1,4	4,8	0	0,6
2011	1,3	12,8	4,4	0	0,7
2012	2,5	19,4	6	0	1,2
2013	3	20,1	6,5	0	1,6
2014	3,1	21,6	5,9	0	1,5
2015	2,6	22,2	5	0	1,6
2016	3,1	30,7	5	0	1,9
2017	3,5	31,5	6	0,6	2,8
2018	4	32,6	6,6	0,9	3,7
2019	5,1	34,2	9,6	1,4	5,6
2020	7	38,1	11	1,8	11,2

Source: own study based on Table 1 data and on the basis of passenger car sales data of OICA

**Table 3. National markets of selected countries and the EU and EFTA in the global HEV market in 2010-2020, in %**

Item/Year	Japan	USA	China	EU + EFTA	Other countries included in the analysis
2010	56,5	32,1	0	9,8	1,6
2011	53,5	31,8	0	12	2,7
2012	56,9	28	0	9,4	5,7
2013	54,4	29	0	11,4	5,6
2014	58,6	26	0	11,3	4,1
2015	57,4	23,5	0,6	14	4,5
2016	60,4	16,6	3,8	14	5,2
2017	57,7	15,1	5,8	18,3	3,8
2018	52,4	12,8	7,6	21,4	5,8
2019	45,5	12,3	8,7	27,4	6,3
2020	38,5	9,9	10,5	35,5	5,9

Source: own study based on Table 1 data and on the basis of passenger car sales data of OICA

By the 2015, the number of HEVs sold, reaching over 1.5 million vehicles annually, exceeded a total of 11 million vehicles, including 5.5 million in Japan and 4 million in the USA. Electric hybrid cars, in apart from practically all European countries, also appeared, among the others in Australia, South Korea, Malaysia, New Zealand, Mexico.

By 2020, a total of over 25.6 million passenger electric hybrids were sold worldwide, with annual sales in 2016-2018 ranging from 2.1 to 2.7 million vehicles and in 2019-2020 exceeding 3.2 million vehicles and 4 million vehicles respectively), which represented 5% and 7%, respectively, of the global sales of new passenger cars.

In total, the share of HEV in the global passenger car fleet, even taking into account that some of the electric hybrids, especially among the 3.5 million purchased in 2001-2010, have already been withdrawn

from traffic, has reached the level of 2%. In the years 2015-2020, HEVs increased their dominance in Japan, where, with annual sales of 1.5 million vehicles, the number sold in the period 2001-2020 exceeded 12.5 million vehicles. The share of electric hybrids in passenger car sales in Japan increased in 2010-2020 from over 11% to 38%.

In the US, with the stabilisation of the annual sales of new hybrids in recent years at the level of approx. 350,000-400,000 vehicles, their total amount exceeded 5.8 million vehicles. The share of electric hybrids in the sales of new passenger cars increased in 2010-2020 from approx. 5% to 11%.

Total sales of electric hybrids in China exceeded 1 million vehicles, and in South Korea 0.6 million vehicles. The share of electric hybrids in new car sales in China remains low (up from 0.6% to 1.8% in 2017-2020).

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As of 2017, the European market has moved up to the second position in terms of HEV sales volume. The total number of electric hybrids sold in the years 2001-2007 in the EU and EFTA countries exceeded 4.7 million vehicles, of which about 4.5 million vehicles in the EU countries.

Annual HEV sales in the EU and EFTA countries increased from 228 thousand in 2015 to over 890 thousand vehicles in 2019 and over 1.3 million vehicles in 2020 (including less than 330 thousand vehicles in Germany and approx. 220 thousand in Italy and the United Kingdom).

In Poland, in the years 2001-2020, a total of approx. 167 thousand electric hybrids (7th position in Europe) were sold, most of which in the last three years, 23 thousand, 42 thousand and 62 thousand, respectively.

The share of electric hybrids in sales of new passenger cars in the EU and EFTA countries increased in the years 201-2020 from 0.6% to 11.25%.

In 2010-2020, the share of the Japanese electric hybrid market in the global market for such vehicles decreased from 56.5% to 38.5%, the share of the American market decreased from 32% to approx. 0%, respectively.

At the same time, in 2010-2020, the share of the global electric hybrid market of the Chinese market increased from 0% to over 10%, the EU and EFTA markets increased from approx. 10% to 35.5% and the markets of other countries covered by the analysis from 1.6% to approx. 6% (Table 3).

Toyota remains the leader among manufacturers of electric hybrid cars, which currently sells over 40 models of such cars in over 90 countries. In January 2020, the concern celebrated the production of 15 million HEV [40].

According to the latest available statistics, the share of Toyota brands in HEV sales was, for example, 60.5% in Europe in 2019 [41], and 59.5% in the USA in 2017 [42]. Major manufacturers of electric hybrids are, apart from Honda, Hyundai-Kia (with 11.7% share in Europe and 14.8% share in USA), as well as Ford, Nissan and General Motors.

Individual concerns focus their activities on

selected markets. For example, Honda on Asian markets, especially Japanese, Ford on the American market, where it has a share of almost 18%, while on the European market it has a share of less than 1%.

Sales of electric hybrids, even in the crisis year 2020, in which only 54 million new passenger cars were bought worldwide, with 64 million new passenger cars purchased in 2019 (a decrease by over 15%), have increased from 3.2 million vehicles to approx. 4 million vehicles. This was due to the independence of this type of cars from the charging network required by plug-in electric vehicles, as well as the constant improvement of their energy efficiency (each subsequent generation of Toyota electric hybrids, which already account for 23% of the number of cars sold by this firm, brings 10% savings in specific fuel consumption). Table 4 shows a significant increase in HEV sales compared to increase in sales of other low-emission vehicles.

According to information from Toyota Motor Corporation, which in January 2015 celebrated the sale of the 10 millionth electric hybrid, and in January 2020, the 15 millionth, the operation of these vehicles resulted, over 23 years period, in savings in CO<sub>2</sub> emissions of 120 million tons, compared to the use of cars with combustion engines, which they replaced.

The above factors underlie the further assumed development of the electric hybrid market. In the forecast made before the outbreak of the COVID 19 pandemic, it was assumed that the share of electric hybrids in global sales of passenger cars will increase to 7% in 2020 (which has already been confirmed) and to 20% in 2025 and 39% in 2030.

According to the forecast made during the COVID 19 pandemic, in 2027 the annual sales of this type of vehicles should exceed 6.5 million cars.

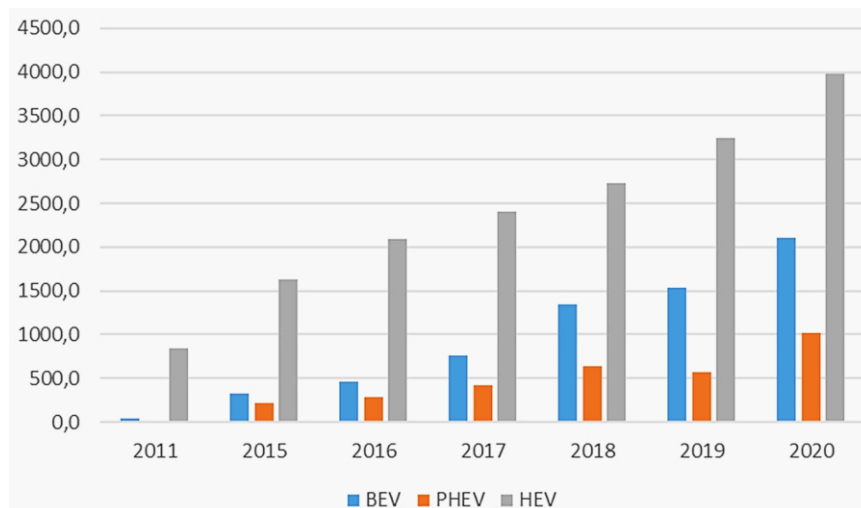
According to another source, the value of the global HEV market, estimated at US \$ 256 billion in 2020, is supposed to increase to US \$ 2 trillion by the 2026.

Interesting comparative data on the sale and registration status of BEV, PHEV and HEV cars is presented in Table 4 and Figure 1.

**Table 4. Sales of HEV, PHEV and BEV in the world in 2011-2020, in thousands of units and total park of registered cars HEV, PHEV and BEV in 2020**

Year	New registrations							Park
	2011	2015	2016	2017	2018	2019	2020	2020
Total world BEV	39,2	324,1	464,7	756,5	1344,3	1533,7	2104,6	6895,5
Total world PHEV	9,3	222,5	285,9	416,0	636,7	568,3	1014,9	3391,8
Total world HEV	843,5	1632,9	2091,4	2399,0	2731,3	3251,1	3987,6	25582,5

Source: own study based on Table 1 data and on the basis of passenger car sales data of OICA



**Fig. 1. Comparison of sales of BEV, PHEV and HEV vehicles in the world in 2011-2020, in thousands of units**  
[Source: own study based on Table 4]

### CONCLUSIONS

The observed progress in the development of internal combustion engines, despite the enormous financial outlays incurred, is not able to fully meet the challenges related to ecology. Everything indicates that regardless of the depth and duration of the pandemic crisis, the electric hybrid segment will be the fastest growing segment not only among electric cars, and its share in the registered vehicle park will continue to grow in the coming years. Most experts assume that by the 2050 HEVs will become an extremely important element of the global fleet of vehicles. Complementary to battery electric vehicles and FCEVs, will constitute gross of passenger vehicles produced.

### DWIE DEKADY RYNKU HYBRYDOWYCH SAMOCHODÓW ELEKTRYCZNYCH

W artykule przedstawiono przekrojowy obraz rozwoju rynku samochodów HEV na przestrzeni ostatnich dwóch dekad. Samochody hybrydowe to obecnie najszerza grupa samochodów wyposażonych w alternatywne dla klasycznych układów napędowych rozwiązania. Stanowią też najliczniejszą grupę wśród pojazdów elektrycznych. Opisano historyczne meandry rozwoju HEV, obecny poziom rozwoju tego rynku oraz realne perspektywy spopularyzowania samochodów HEV. Scharakteryzowano również poziom światowej produkcji tej kategorii pojazdów samochodowych w dwudziestolecie 2001-2020. W artykule podjęto próbę oszacowania rzeczywistej wielkości światowej floty HEV. Przedstawiono również poziom sprzedaży tej kategorii pojazdów przez poszczególne kraje oraz

zmieniający się ich udział procentowy w rynku samochodów osobowych. Sprzedaż hybryd elektrycznych nawet w kryzysowym roku 2020 wzrosła z 3,2 mln do ok. 4 mln pojazdów, pomimo spadku sprzedaży nowych aut osobowych z 64 do 54 mln sztuk. Powyższy fakt świadczy również o atrakcyjności rynkowej tego typu pojazdów i stale rosnącym zainteresowaniu nimi.

**Słowa kluczowe:** gazy cieplarniane, hybrydowe samochody elektryczne, HEV, kierunki rozwoju motoryzacji

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