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ELECTRIC VEHICLES AS A KEY FACTOR IN DECARBONIZATION AND DEVELOPMENT OF THE GLOBAL ECONOMY

ЕЛЕКТРОМОБІЛІ ЯК КЛЮЧОВИЙ ФАКТОР ДЕКАРБОНІЗАЦІЇ ТА РОЗВИТКУ СВІТОВОЇ ЕКОНОМІКИ

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Based on data from the Copernicus Climate Change Service, 2024 was marked by the highest atmospheric temperatures on record, with an average temperature of 15.1°C; 0.12°C higher than the previous highest annual value, which occurred in 2023. It is also indicated that, according to experts, 2024 was 0.72°C warmer than the 1991-2020 average and 1.6°C warmer than pre-industrial levels, making it the first calendar year to exceed this level by 1.5°C. Active climate change leads to hurricanes, floods, landslides, droughts, forest fires and major economic damage, which will increase in the future. It is noted that the negative consequences of human activity require immediate and active efforts by the entire global community to decarbonize the economy. The key and most important element of such decarbonization is the development of electric mobility. Information from the International Energy Agency shows a very dynamic increase in sales of electric vehicles of various types. It is shown that the world leader in this area is China, which is constantly strengthening its position. Noticeable dynamics of electric vehicle sales are observed in Europe, especially in Germany. The United States is developing the production and use of electric vehicles, but their indicators are still insufficient. High levels of provision of residents with electric vehicles are observed in Norway, Iceland, Sweden, Denmark, which are the most progressive countries in terms of environmental responsibility. It seems that in the future, the development of electric mobility on the planet will acquire an increasingly dynamic character. To establish electric mobility, correct and comprehensive management decisions are needed in the context of decarbonization management.

Keywords: electric vehicles, sales, management, decarbonization, innovation, investments, prospects, dynamics, sustainable development, International Energy Agency.

На підставі даних Copernicus Climate Change Service, 2024 відзначений найбільш високими температурами атмосферного повітря за всю історію спостережень: середня температура досягала 15,1°C; на 0,12°C вище попереднього найвищого річного значення, яке мало місце у 2023 році. Вказується також, що на думку фахівців 2024 був на 0,72°C тепліше середнього значення за 1991–2020 роки і на 1,6°C тепліше доіндустріального рівня, що зробило його першим календарним роком, який перевищив цей рівень на 1,5°C. Активні кліматичні зміни призводять до ураганів, повеней, зсувів, посух, лісових пожеж та великих економічних збитків, які в перспективі збільшуватимуться. Зазначається, що негативні наслідки діяльності людини вимагають

негайних та активних зусиль усієї світової спільноти у напрямку декарбонізації економіки. Ключовим та найважливішим елементом такої декарбонізації є розвиток електромобільності. Інформація International Energy Agency показує динамічне збільшення продажів електромобілів різних видів. Показано, що світовим лідером у цій галузі є Китай, який постійно зміцнює свої позиції. Помітна динаміка продажів електромобілів спостерігається у Європі, особливо у Німеччині. США розвивають виробництво та використання електромобілів, але їх показники поки що недостатні. Високі рівні забезпечення мешканців електромобілями спостерігаються у Норвегії, Ісландії, Швеції, Данії, які є найпрогресивнішими країнами з погляду екологічної відповідальності. Як видається, у перспективі розвиток електромобільності на планеті набуватиме все більш динамічного характеру. Міжнародне енергетичне агентство у доповіді «World Energy Outlook 2024», що електромобілі є одним із ключових факторів, що стримують майбутній попит на нафту. Агенство прогнозує, що річний продаж електромобілів зросте з 14 мільйонів у 2023 році до більш ніж 40 мільйонів у 2030 році та майже 60 мільйонів у 2035 році у прогнозі STEPS. Цей перехід на електромобілі зменшить понад 6 млн барелів на добу попиту на нафту до 2030 року та 13 млн барелів на добу у 2035 році, причому більша частина економії припадатиме на легкові автомобілі. Для затвердження електромобільності необхідні правильні та комплексні управлінські рішення у контексті менеджменту декарбонізації.

Ключові слова: електромобілі, продажі, менеджмент, декарбонізація, інновації, інвестиції, перспективи, динаміка, сталий розвиток, Міжнародне енергетичне агентство.

Formulation of the problem. Negative climate changes are becoming increasingly acute across the planet. This leads to numerous cases of financial damage in various sectors of the economy, in particular, in agriculture, transport, tourism, energy, and has a very noticeable impact on the living conditions and health of the population. For sustainable development, modern civilization must follow the path of decarbonization of the economy based on innovation and development of industries that use climate-neutral energy.

Analysis of recent research and publications. Current issues of the global economy, management, innovation, climate research, development of electric vehicles, climate-neutral production are of constant interest to many scientists. Among the authors of the research, it is necessary to note such experts as Fatih Birol, Claudia Kemfert, Tiffany Vass, Peter Levi, Adrian Rinscheid, Jules Sery, Martin Kittel, Jens Turau, Leonard Goeke, Araceli Fernandez Pales. Researchers contribute to solving urgent problems in the development of the modern world economy.

Previously unsolved parts of the overall problem. Research by experts on numerous problems of the global economy, caused, in particular, by climatic reasons, cannot cover in detail all the complex aspects of innovation management in such an important area of development as the production and sales of electric vehicles. Electric vehicles today act as a key element of the decarbonization of the economy, a very important condition for its development. In this regard, it is relevant to study the optimal directions of electric mobility management in the context of the prospects for sustainable development of the global economy.

Presentation of the main research material. The highly authoritative international organization Copernicus Climate Change Service in its final report “Global Climate Highlights 2024”, which was released in January 2025, informs about unique climate changes over the past year [1]: “2024 was the warmest year in a multi-dataset record of global temperature going back to 1850. 2024 had a global average temperature of 15.10°C; 0.12°C higher than the previous highest annual value in 2023. 2024 was 0.72°C warmer than the 1991–2020 average, and 1.60°C warmer than the pre-industrial level, making it the first calendar year to exceed 1.5 above that level. The last ten years have been the warmest ten years on record. Each month from January to June 2024 was warmer than the corresponding month in any previous year. August 2024 equaled the record warmth of August 2023 and the remaining months from July to December were each the second warmest for the time of year, after the corresponding months in 2023”. Negative climate change leads to hurricanes, floods, droughts in the summer, melting glaciers, landslides, and the advance of deserts. Droughts are already now, especially noticeable in 2024, leading to significant losses in agricultural crops. Further, this process will probably increase rapidly. The problem of food shortages for the rapidly growing population of the planet will only worsen. Economic losses from climate change will increase. This requires urgent and effective measures by all of humanity in the direction of decarbonization of the economy. The most important, key direction of decarbonization is the development of electric mobility.

The International Energy Agency in its report “World Energy Outlook 2024” emphasizes the

importance of development production of electric vehicles (EV) [2]:

”EVs are one of the key factors tempering future oil demand. Annual electric car sales rise from 14 million today to over 40 million in 2030 and nearly 60 million in 2035 in the STEPS. This shift to EVs displaces over 6 mb/d of oil demand by 2030 and 13 mb/d in 2035, with most of the savings deriving from passenger cars. However, the amount of oil displaced depends heavily on how quickly EV sales continue to increase. Electric car sales were up by around 25% year-on-year in the first half of 2024, with China accounting for about 80% of this increase. Some regions like Asia show robust growth, and North America has seen a rise of nearly 13%.

Table 1

Sales of EV, thousands

Countries	Type	2012	2015	2018	2019	2020	2021	2022	2023
World	BEV	59	330	1400	1500	2000	4700	7300	9500
	PHEV	61	220	660	580	980	1900	2900	4300
China	BEV	-	150	820	830	920	2700	4400	5400
	PHEV	-	61	270	230	220	550	1500	2700
Europe	BEV	19	89	210	370	760	1200	1600	2200
	PHEV	9	100	190	210	640	1100	1100	1100
USA	BEV	15	71	240	240	230	470	800	1100
	PHEV	39	43	120	85	64	160	190	290
Germany	BEV	2	12	36	63	190	360	470	520
	PHEV	-	11	31	45	200	330	360	180
France	BEV	5,7	18	33	45	110	170	210	310
	PHEV	-	5,8	15	19	75	140	130	160
Italy	BEV	0,46	1,5	5	11	33	67	49	66
	PHEV	-	0,74	4,7	6,5	27	71	65	70
Japan	BEV	13	10	27	21	15	22	59	88
	PHEV	11	14	23	18	15	23	38	52
Korea	BEV	0,51	3,1	55	33	31	72	120	120
	PHEV	-	-	4,4	2,7	8,7	19	11	12
	FCEV	-	-	0,91	4,2	5	9,2	10	4,3
Norway	BEV	3,9	26	46	60	77	110	140	100
	PHEV	-	7,9	27	19	29	38	16	10
Sweden	BEV	0,27	3	7,1	16	28	57	96	110
	PHEV	0,66	5,7	22	25	66	78	67	61
Israel	BEV	0,6	-	0,13	0,85	1,5	11	27	49
	PHEV	-	-	3,6	3,9	5,4	13	16	16
Spain	BEV	0,43	1,3	6	10	18	24	33	57
	PHEV	-	0,78	5,6	7,4	24	43	49	65
Australia	BEV	0,17	0,76	1,8	6,3	5,2	17	33	87
	PHEV	-	1	1,8	2,9	1,7	3,4	5,9	11
Netherlands	BEV	0,79	3,4	24	61	72	61	72	110
	PHEV	4,3	39	3,6	5,2	15	31	34	46
United Kingdom	BEV	1,6	10	16	38	110	190	270	310
	PHEV	0,97	19	46	37	68	120	100	140
India	BEV	0,19	0,45	0,92	0,68	3,1	12	49	82

Source: [3]

But sales are rising more slowly in other parts of the world for various reasons. For example, some EV subsidies in the European Union have been phased out, and more stringent CO_2 emissions standards are not due to take effect until 2025. A wide range of factors will affect the future rate of EV uptake, including policy support, fuel and emissions standards, the extent to which more affordable EV models become available, the rollout of charging infrastructure, consumer preferences and company strategies [2]".

The development of production and use of electric vehicles worldwide can be considered the most important trend of the modern global economy. Let us analyze the dynamics of sales of electric vehicles of different types, namely: battery electric vehicle (BEV), plug-in hybrid electric vehicle (PHEV), fuel cell electric vehicle (FCEV), according to the International Energy Agency (IEA) [3], which are presented in Table 1.

In 2015, the global production of electric vehicles had already reached significant proportions and it became clear that electromobility would eventually establish itself on the planet, which served as an important impetus for investments in active innovation in this area and investments in production capacities. The foundation for future growth was laid. In that year, 330 thousand BEVs and 220 thousand PHEVs were sold worldwide, which is extremely insignificant by the scale of recent years. Even in 2015, China's global position was already dominant: sales amounted to 150 thousand BEVs and 61 thousand PHEVs. Europe was inferior to Chinese sales, respectively – 89 thousand and 100 thousand. The US had an even lower sales level than Europe, namely: 71 thousand BEVs and 43 thousand PHEVs. Germany had low figures – 12 thousand BEVs and 11 thousand PHEVs. In the following years, sales of electric vehicles of various types grew rapidly. In 2018, global sales exceeded 2 million vehicles overall, with a noticeable dominance of BEVs – 1,400 thousand, while PHEVs were sold only 660 thousand. In 2020, global sales approached 3 million electric vehicles, including 2 million BEVs and 980 thousand PHEVs. In this year, the growth in BEV sales compared to 2015 was (Figure 1): for the whole world – 6.1 times, China 6.13 times, Europe – 8.5 times, the USA – 3.2 times, Germany – 15.8 times, Great Britain – 11 times, France – 6 times, Norway – 3 times.

The growth parameters for PHEV sales this year compared to 2015 were generally somewhat smaller (Figure 2): for the whole world – 4.4 times, China 3.6 times, Europe – 6.4 times, the USA – 1.5 times, Germany – 18.2 times,

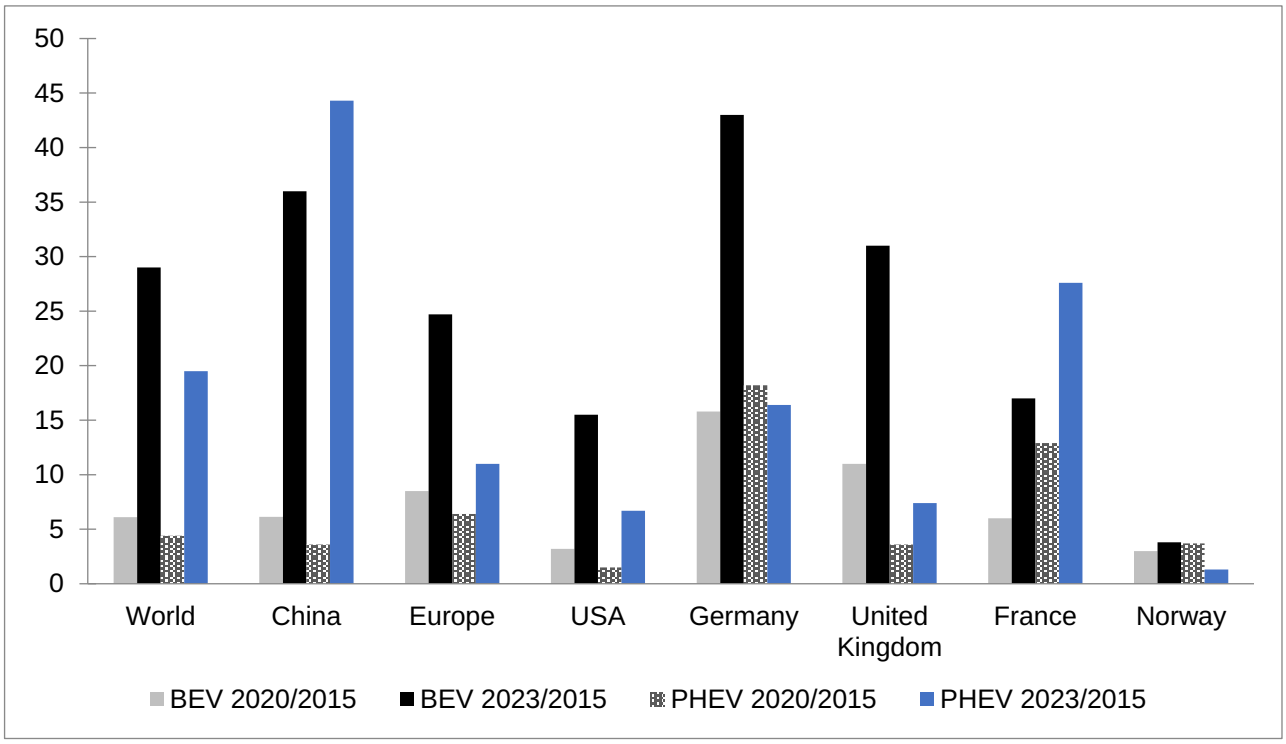

Figure 1. Dynamics of the ratio of BEV and PHEV sales in the world and in individual countries

Source: calculated based on data [3]

Great Britain – 3.6 times, France – 12.9 times, Norway – 3.7 times. Very important changes occurred in the subsequent period. Already in 2021, global BEV sales increased to 4,700 thousand, that is, 2.35 times in one year, and PHEV – to 1,900 thousand or 1.93 times. Growth in China in 2021 exceeded growth rates for the world as a whole: for BEV – up to 2,700 thousand or 2.93 times, for PHEV – up to 550 thousand or 2.5 times. In 2022 and 2023, further increase in sales of electric vehicles continued quite intensively. A comparison of sales for the period 2023 and 2015 will be clear (Fig. 1). BEV sales growth was: for the whole world – 29 times, China 36 times, Europe – 24.7 times, the USA – 15.5 times, Germany – 43 times, the UK – 31 times, France – 17 times, Norway – 3.8 times. The parameters of PHEV sales growth this year compared to 2015 were as follows: for the whole world – 19.5 times, China 44.3 times, Europe – 11 times, the USA – 6.7 times, Germany – 16.4 times, the UK – 7.4 times, France – 27.6 times, Norway – 1.3 times. It is obvious that in the development of electric vehicles there is a tendency for a noticeably more intensive growth in the number of BEVs and a smaller growth in the number of PHEVs, for some countries – even a decrease in PHEVs. It is highly probable that the future of the global automobile industry is connected with BEV electric vehicles, they are justified from the economic and environmental points of view. Sales of electric vehicles have also developed in other countries, but less intensively than in the mentioned ones (Table 1). It can be stated that the distribution of electric vehicles is happening all over the world, for example, also in the Netherlands, Italy, Japan, Spain, Israel, Australia, Korea. With the population of India comparable to China, the development of electric mobility in this country is very insignificant, but such development probably has reserves in the future.

Let's consider the change in the ratio of electric vehicle sales (total BEV and PHEV figures) in a number of the most important countries in the world and the total figure for Europe (Figure 2). In 2015, global electric vehicle sales exceeded European figures by 2.9 times, but the situation changed slightly in favor of Europe in 2020 – this ratio decreased to 2.13. In 2023, the situation changed quite significantly: the level of electric vehicle sales in the world already exceeded European figures by 4.18 times, which clearly demonstrates a significant loss of European positions in this most important area of the modern global economy in a very short period of time. In 2015, China's electric vehicle sales figures were only slightly higher than those of Europe as a whole (ratio 1.1), in 2020 they were even 19% lower, but in 2023 the situation changed dramatically: sales in China were 2.45 times higher than European figures. This situation was influenced by the following factors: growth in sales in Europe from 2020 to 2023 by 1,900 thousand electric vehicles, which is quite significant, but much more intensive growth in China – by 6,960 thousand electric vehicles, which can be considered a phenomenal phenomenon.

The dynamics of electric vehicle sales in the US relative to Europe was characterized by the following: in 2015, the American figure was 0.6 of the European one, in 2020 it significantly decreased to 0.23 against the background of active sales growth in Europe and weak growth in the US, but in 2023 the situation improved and the sales ratio was 0.42, while sales grew significantly in both markets.

A volatile situation was also observed in Germany. The ratio of sales in the country to Europe in 2015 was 0.12, in 2020 it increased significantly to 0.28, but in 2023 it decreased to 0.21, which reflects the problems of electric mobility development in the country: the progressive dynamics are maintained, but the processes of production and demand for electric vehicles are characterized by instability, which is typical for the entire German economy.

Great Britain and France are inferior to Germany in sales of electric vehicles, but their sales are quite noticeable and quite stable. Sales in Sweden and Norway are also generally stable; their markets are probably in a state of certain saturation and stabilization. Let's analyze the share of electric vehicles in total car sales. According to the International Energy Agency [3] (Table 2), if in 2012 this share was 0.2%, in 2020 – 4.2%, then in 2023 it increased to 18%. China occupies a very serious position in this indicator: in 2012, the share of electric vehicle sales in this country was 0.1%, in 2020 – 5.7%, and in 2023 it reached 38%. Quite noticeable sales figures in 2023 are in Europe – 21%, in the USA – only 9.5%, in Germany and the UK such figures are quite significant – 24%, in France even a little more – 25%, the Netherlands significantly exceed these figures – 44%.

The Scandinavian countries showed unique sales shares in 2023: Norway – 93%, Sweden – 60%, Finland – 54%, Denmark – 46%, Iceland is second only to Norway and has a share of

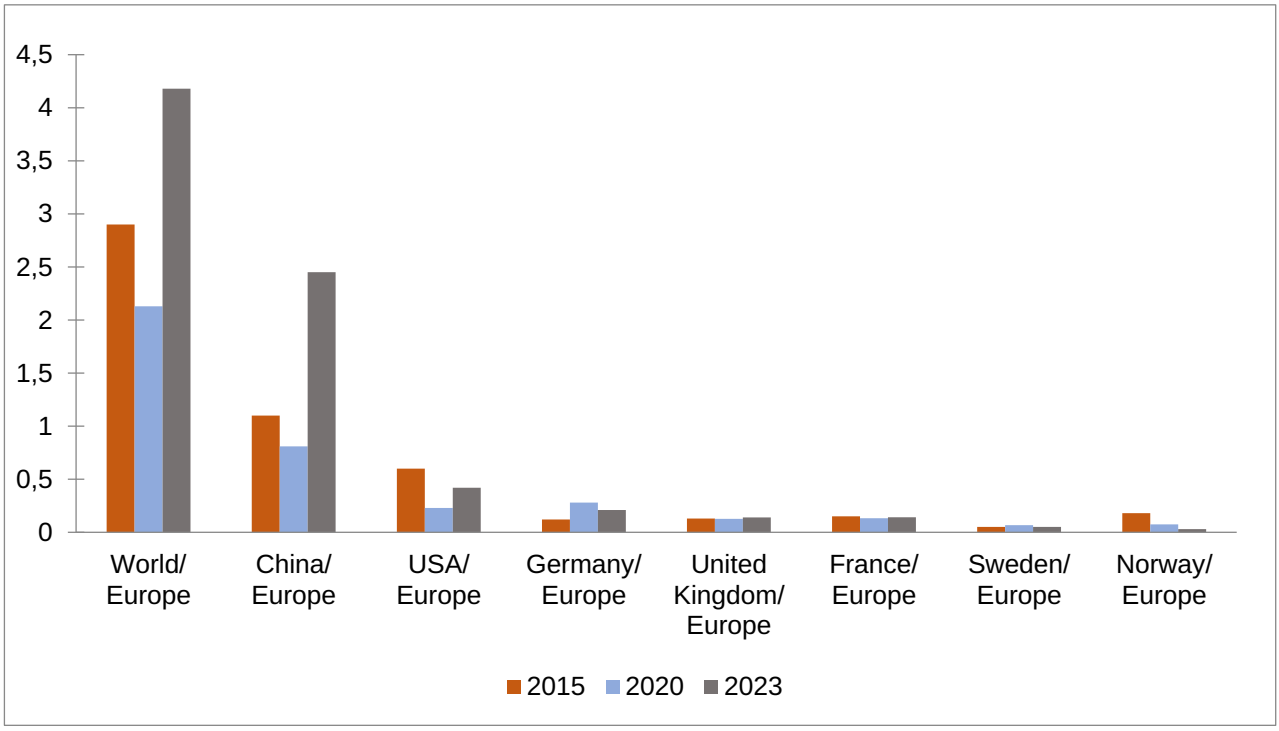

Figure 2. Dynamics of the ratio of sales of electric vehicles

Source: calculated based on data [3]

electric vehicles of 71%. Low rates are observed in Japan – 3.6%, slightly higher rates in Italy – 9.2% and Korea 7.9. In other countries of the world, the analyzed indicators are significantly lower. In general, as statistics show (Table 2), the trend of increasing the share of electric vehicles in sales is irreversible, and in recent years, this applies to the most developed countries of the world, it has been rapid.

Let's consider the dynamics of the number of electric vehicles of different types in the cumulative total in the world and some leading countries, according to the International Energy Agency [3]. In 2012, there were only 120 thousand BEVs in the world, in 2015 – already 730 thousand, in 2020 – 6.8 million, in 2023 – 28 million. Thus, the number of BEVs in 2023 increased by 233 times compared to 2012, 38 times compared to 2015, 4 times compared to 2020. PHEV figures are several times lower

In 2015, there were 520 thousand PHEVs in the world (1.4 times less than BEVs), in 2020 – 3.4 million (2 times less than BEVs), in 2023 – 12 million (4 times less than BEVs). The analysis shows that the number of PHEVs in 2023 increased 23 times compared to 2015, 3.5 times compared to 2020.

The number of FCEVs is many times smaller and amounted to 26 thousand in 2020, and 66 thousand in 2023. Probably, this direction of electric vehicles will not receive significant development.

Among individual countries of the world, the largest number of electric vehicles in 2023 is in China: 16 million BEVs (57% of the world's number), 5.8 million PHEVs (48% of the world's number). Other countries are significantly inferior to China. Thus, in the USA in 2023 there were only 3.5 million BEVs, Europe as a whole – 6.7 million BEVs, Germany – 1.5 million BEVs, France and the UK – about 980 thousand BEVs each. For comparison, in 2023, there were only 290 thousand BEVs in Japan, and 420 thousand BEVs in Korea. An analysis of the share of electric vehicles of all types (BEV, PHEV, FCEV) showed that in the total car fleet in 2023, they occupy a share of 3.2% worldwide, 7.6% in China, 3.8% in Europe, 2.1% in the USA, 5.4% in Germany, 4.1% in France, 5% in the UK, and only 0.8% in Japan. The role of electric vehicles in 2023 is very noticeable in countries such as Norway – 29%, Iceland – 18%, Sweden – 11%, Finland – 8.1%, and the Netherlands – 8.3%. The share of electric vehicles in developed countries is generally increasing significantly, which allows us to predict their dominance in the future.

It is of interest to analyze the distribution of electric vehicles among residents of a number of

Table 2

EV sales share, cars, World, %

Countries	2012	2015	2018	2019	2020	2021	2022	2023
World	0,2	0,7	2,4	2,6	4,2	8,9	14	18
China	0,1	1	4,7	5	5,7	16	29	38
Europe	0,2	1,2	2,3	3,3	10	17	20	21
USA	0,4	0,7	2,3	2,1	2,3	4,7	7,4	9,5
Germany	0,1	0,7	2	3	14	26	31	24
France	0,3	1,2	2	2,7	11	17	20	25
Italy	-	0,1	0,5	0,9	4,3	9,5	8,6	9,2
Japan	0,4	0,5	1,1	0,9	0,8	1,2	2,8	3,6
Korea	-	0,2	3,8	2,3	2,4	5,8	8,5	7,9
Norway	3	22	49	56	75	86	89	93
Sweden	0,3	2,4	7,6	11	32	43	54	60
Finland	0,2	0,6	5	7	18	31	38	54
Iceland	0,3	4	20	26	52	70	69	71
Denmark	0,3	2,3	2	4	16	35	39	46
Netherlands	1	9,5	6	15	25	29	35	44
United Kingdom	0,1	1,1	2,6	3,3	11	19	23	24

Source: [3]

economically developed countries of the world. For the study, countries with a fairly high level of electric vehicle distribution were selected, which significantly exceeds the average level of electric vehicle distribution in the world. As an indicator of the distribution of electric vehicles in a particular country, a parameter representing the number of citizens per electric vehicle can be used. This indicator does not quite accurately reflect the real distribution of electric vehicles among residents using this transport, since it includes all residents, many of whom have nothing to do with cars. But this indicator is easy to calculate and can be used for analysis, at least as a first approximation. The calculation was performed using data on the number of electric vehicles as of the end of 2023, according to information [3], and data on the population [4], and is presented in Figure 3.

The most widespread use of electric vehicles in the world is in Norway (Figure 3), where there is one electric vehicle for every 6 residents of the country. This high figure is explained by the government's policy of stimulating the purchase of electric vehicles through various benefits, the responsible attitude of citizens to the issues of preserving nature and climate, and the high level of income in the country. It should be emphasized that such a high level of distribution of electric vehicles in Norway occurs despite the fact that the country does not produce electric vehicles. The development of electric mobility is also facilitated by a significant increase in public charging stations (Figure 4).

The second country in terms of distribution is Iceland (9 residents per electric car), which also does not produce electric cars, but is distinguished by a high level of environmental responsibility of the authorities and all citizens and measures to stimulate electric mobility.

Such Scandinavian countries as Denmark and Sweden occupy high positions (19 residents per electric car) and are distinguished by very high environmental responsibility, the development of production of climate-neutral types of energy. At the same time, Sweden has historically been known for a long time as a country where cars were produced and now has all the capabilities for the production of electric cars. The Netherlands also occupy a prominent place in the distribution of electric cars (26 residents per electric car), although they are not among the countries with a traditionally developed automotive industry. The countries considered earlier did not belong to countries with a large population and therefore it was not very difficult to achieve a relatively high parameter of provision of residents with electric cars numerically.

A special place is occupied by such important European countries as Germany, Great Britain

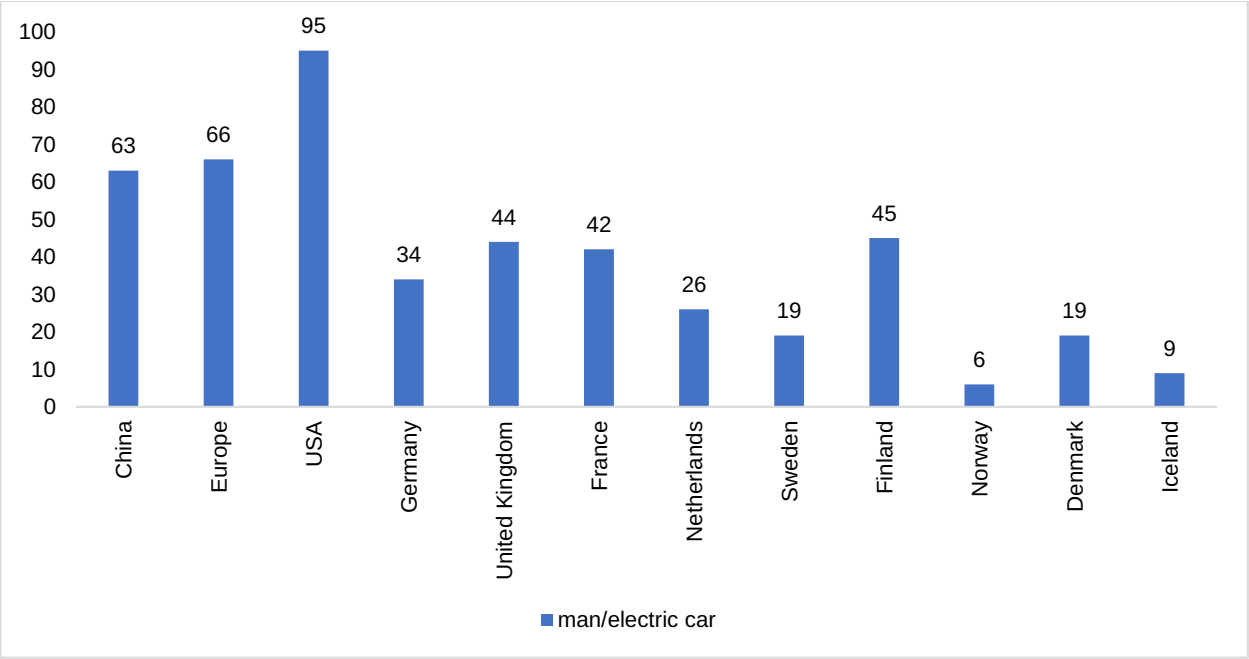

Figure. 3. Number of inhabitants per electric vehicle by country 2023

Source: calculated based on data [3; 4]

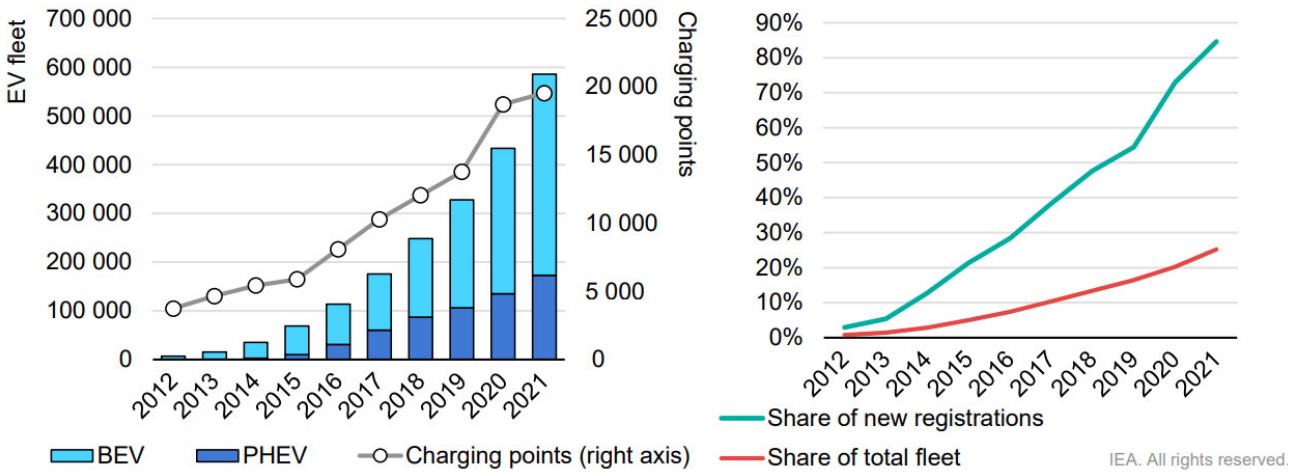

Figure 4. Electric cars and charging stations in Norway

Source: [5]

and France. They have leading positions in the European economy and are very important in the world economy, a fairly large population and a traditionally developed automotive industry of global significance. This is especially true for Germany, the most economically developed country in Europe. Germany is also currently the place where a large number of electric cars are produced. The country ranks relatively high in the prevalence of electric cars among the most economically developed countries in the world (34 inhabitants per electric car), followed by France (42 inhabitants) and the United Kingdom (44 inhabitants), which is approximately 6–7 times lower than the figure for Norway. There is an obvious electric car paradox – the prevalence of electric cars in a number of countries that do not produce these cars is higher than in countries that do. This phenomenon is complex, but is probably largely explained by the high degree of environmental responsibility of the population and authorities of these countries.

The average prevalence of electric vehicles in Europe is 66 residents per car, which is 11 times lower than Norway, more than three times lower

than Sweden and Denmark, and approximately two times lower than Germany. In China, a country that clearly ranks first in the production and export of electric vehicles in the world, there is one electric vehicle per 63 residents, which is explained by its large population. The United States is significantly inferior in the prevalence of electric vehicles to all leading economic countries in the world, although it is the most economically developed country on the planet, with great scientific and technical potential, and a traditional highly developed automobile industry. Other countries in the world still have low prevalence rates of electric vehicles, many times lower than those of leading countries.

The growth in the production of electric vehicles leads to an increase in the production of their most important element – rechargeable batteries. In this regard, the International Energy Agency indicates the following [6]: “Increasing EV sales continue to drive up global battery demand, with the fastest growth in 2023 in the United States and Europe. The growth in EV sales is pushing up demand for batteries, continuing the upward trend of recent years. Demand for EV batteries reached more than 750 GWh in 2023, up 40% relative to 2022, though the annual growth rate slowed slightly compared to in 2021 2022. Electric cars account for 95% of this growth. Globally, 95% of the growth in battery demand related to EVs was a result of higher EV sales, while about 5% came from larger average battery size due to the increasing share of SUVs within electric car sales” [6].

Dr. Fatih Birol, Executive Director of the International Energy Agency, one of the world's most respected experts in the field of energy and the global economy, notes the important dynamics and prospects for the development of electric mobility [7]: “The continued momentum behind electric cars is clear in our data, although it is stronger in some markets than others,” said Fatih Birol. “Rather than tapering off, the global EV revolution appears to be gearing up for a new phase of growth. The wave of investment in battery manufacturing suggests the EV supply chain is advancing to meet automakers’ ambitious plans for expansion. As a result, the share of EVs on the roads is expected to continue to climb rapidly. Based on today’s policy settings alone, almost one in three cars on the roads in China by 2030 is set to be electric, and almost one in five in both the United States and European Union. This shift will have major ramifications for both the auto industry and the energy sector [7]”.

Comprehensive program to accelerate the development of electric mobility.

Taking into account the analysis of modern trends in the production and sales of electric vehicles, it seems advisable to take the following measures.

1. Formation and development of environmental thinking of the population and environmental responsibility based on complete, comprehensive, accurate information about the state of the environment, the negative impact of human economic activity, possible ways to improve the situation, understanding that one of the key areas of decarbonization is the most active development of electric mobility. The general public should have complete information, not only about the environmental, but also about the very significant economic benefits of operating electric vehicles.

2. The development of electric mobility should be carried out in a complex and close relationship with the development of primary energy production in climate-neutral ways using wind, solar, hydropower, the use of nuclear energy, including small modular reactors. Small modular reactors have many important advantages and can be quickly put into operation [8].

3. Elimination of the paradox of development of electric mobility in Europe and the USA, through joint innovative projects of the leading economic countries of the world on creation of mass electric vehicles with relatively low cost, comparable to cars with internal combustion engines and active investments in production and sale of electric vehicles.

4. The most dynamic development of innovative and investment efforts of the leading countries of the world in joint actions on development of batteries for electric vehicles, which would be distinguished by significantly higher capacity and lower cost than existing ones. At present, this is most likely the key factor restraining development of electric mobility.

5. Development of the widest network of charging stations for fast charging of batteries of electric vehicles.

6. Implementation of the comprehensive program of development of construction of private individual houses, which will have chargers for charging electric vehicles, which is advisable to carry out at night, when total energy consumption is minimal. Also, these houses will have wind turbines and solar panels for generation of electricity. With a certain capacity of wind, solar turbines and corresponding wind

force, intensity of sunlight and their duration, such houses can provide their own needs and charge cars of residents of such houses. The complexity of the task of providing comfortable housing, accessibility of transport, its charging with electricity and provision of energy, at least its partial provision, will contribute to improving the quality of life, economic activity, development of electric mobility and production of climate-neutral energy and fulfillment of decarbonization tasks.

7. Creation of financial and other benefits for manufacturers and buyers of cars.

8. Emphasis on a complete transition in the future to the use of electric vehicles and the abandonment of traditional cars with internal combustion engines that use gasoline and diesel fuel.

Conclusions. Thus, the study established the following. According to the authoritative international organization – Copernicus Climate Change Service, 2024 was marked by the highest atmospheric temperatures in recorded history: the average temperature reached 15.1°C; 0.12°C higher than the previous highest annual value, which occurred in 2023. In addition, experts say that 2024 was 0.72°C warmer than the 1991–2020 average and 1.6 °C warmer than the pre-industrial level, making it the first calendar year to exceed this level by 1.5°C. Climate change leads to hurricanes, floods, landslides, droughts, forest fires and great economic damage, which, and this can be said with all certainty, will increase in the future. The negative consequences of human activity require immediate, consistent and very active efforts of the entire global community towards decarbonization of the economy. The key and most important element of such decarbonization is the development of electric mobility. Information from the International Energy Agency shows a very dynamic increase in sales of electric vehicles. The clear world leader in this area is China, which is constantly strengthening its position. Noticeable dynamics of sales of electric vehicles is observed in Europe, especially in Germany. The United States is developing the production and use of electric vehicles, but their figures are not yet high enough, which is a paradox. High levels of provision of residents with electric vehicles are observed in Norway, Iceland, Sweden, Denmark, which can be called the most progressive countries in terms of environmental responsibility and economic efficiency. It seems that in the future, the development of electric mobility on the planet will acquire an increasingly dynamic and comprehensive nature.

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