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SUSTAINABLE ELECTROMOBILITY DEVELOPMENT IN LITHUANIA COMPARING WITH EU COUNTRIES IN CONTEXT OF THE EUROPEAN GREEN DEAL

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Abstract. The global climate is currently warming due to human activity. The period 2011–2020 was recorded as the warmest decade. CO2 produced by human activity is the biggest contributor to global warming. Since every ton of CO2 emitted contributes to global warming, all emissions reductions can help to slow it down. Currently, the cars used by the population still do not ensure a sufficient reduction of CO2 emissions. The purpose of paper is to investigate the potential of electromobility development as a means to mitigate CO2 emissions in EU countries. The research methodology: statistical and comparable analysis of environmental and economic factors influencing the electromobility development in EU countries during last decade were performed. The conclusions of paper provide results of electromobility development, the main obstacles and needed government policies and incentives.

Keywords: climate change, CO2 emissions, electromobility, sustainable transport system.

JEL Classification: G18, G22, G24.

1. Introduction

Currently, the cars used by the population still do not ensure a sufficient reduction of CO2 emissions. Motorization rate of the European Union counts 567 passenger cars per 1,000 inhabitants on average in 2021, which grew by 18% from 2010 year (European vehicle market statistics, 2023). Simultaneously, the global climate was currently warming by 0.2 °C per decade due to human activity. The period 2011–2020 was recorded as the warmest decade. CO2 produced by human activity is the biggest contributor to global warming. In 2020 its concentration in the atmosphere was 48% higher than in the pre-industrial period. Since every ton of CO2 emitted contributes to global warming, all emissions reductions can help to slow it down. However, transport also consumes one of the largest non-renewable natural resources and is responsible for around 25% of the EU's total carbon dioxide (CO2), which is the main greenhouse gas (Cars and the Green Transition, 2023). Knowing the significant and irreversible negative impact of CO2 on human health and global ecosystems, scientists and business practitioners are analysing this problem trying to create technological innovations and find new possibilities to solve it. Beside this, aiming to become the world's first climate-neutral continent, the EC announced the European Green Deal in December 2019, the most ambitious set of measures that should provide opportunities for European citizens and businesses, to take advantage of the sustainable transition to a green economy and to achieve its obligations under the international Paris Agreement, to ensure climate neutrality by 2050. Factors such as the growth of the number of electric cars, including heavy-duty vehicles, the use of green fuels, the application of innovations in the transport sector, the planning of residential areas and, of course, the regulatory legal framework regulating standards and setting restrictions on the consumption of exhaust gases, can have the fastest effect on achieving the goal. The development of electric vehicles is an important priority goal of the European Union [EU] in order to reduce emissions, energy dependence on oil and contribute to the development of a sustainable transport system.

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The purpose of this paper is to investigate the potential of electromobility development as a means to mitigate CO2 emissions in the EU countries. The paper describes research on Lithuanian development of electromobility in comparison with the EU countries. Although the EU allocates up to 292.5 million euro per year for member countries to promote electromobility, it does not give the expected proportional return in CO2 reduction, but from the other side electromobility contributes to increasing energy efficiency and reducing air pollution. In the article the following tasks are defined: to analyse the growth of electromobility in the EU; to define the factors influencing this process; to define the relationship between CO2 emissions per capita, electromobility, economic development of country and its charging infrastructure.

2. Theoretical background of electromobility implementation

The scholars working in this field, J. V. R. de Souza et al. (2019), pointed out a much broader understanding of the concept of electromobility, arguing that it is a new ecosystem of shared value creation, the result of the interaction between the transport sector, the automotive industry, the power sector, the petrochemical and chemical industries. The result of this collaboration is an effort to improve the energy efficiency of electric cars and the possibility of using them as energy storage; sustainable use of raw materials and materials, focusing on critical minerals, value creation from waste, the use and development of smart grids, development of electromobility as a service, development of appropriate consumption-production ratio, expanding the life cycle of electric vehicles [EV] batteries, developing technology "Vehicle to Grid", creating solutions that increase scale of economy. Acknowledging the above-mentioned interdependencies, it can be concluded that when thinking about the development of the electrification of car transport, a systematic approach, implementation of technological innovations, the increasing the responsibility of companies and public awareness is necessary. Such approach will be in favor of the main goals of sustainable electromobility development, assessed in an economic, social, environmental and institutional context (Rokicki et al., 2022). Awareness of climate change has grown over the past decade and, despite the pluralism of internal combustion vehicles [ICV] in transport, the technological shift being driven is encouraging electric vehicles to reduce the carbon footprint of the transport sector. On the other hand, electromobility is highly dependent on the energy sector, as electric cars use electricity for their propulsion (Ajanovic & Haas, 2016). Thus, the national targets to reduce greenhouse gas emissions and carbon fuel use can only be implemented if both the transport and energy sectors are prepared and the deployment of electromobility has been extensively studied to identify dependencies and effective policies for this change (Machado et al., 2020). As modern electric vehicles are increasingly penetrating European markets, both old and new EU countries are setting increasingly ambitious goals for the future in the area of promoting electromobility. Among all these measures, a large part takes the expected transformation of the transport sector – it will be necessary to reduce the amount of greenhouse gas emissions by 90%, while ensuring affordable solutions for citizens (European Council, 2019). In order to systematically implement the goals, set in the Green course in 2020, January 1 Directive 2019/631 (Regulation EU 2019/631) came into force in the EU, establishing new CO2 emission indicator standards and changed guidelines for new vehicles in the EU. This directive set CO2 emission reduction targets for the years 2020, 2025 and 2030, as well as mechanisms to help market participants more intensively switch to zero or low CO2 emission vehicles. From 2020 year, when the new standards came into force, the average CO2 gas emissions generated by vehicles in Europe decreased by 12% compared to the previous year, and the number of electric vehicles tripled (EUR-Lex, 2019). Carbon dioxide emissions are the primary driver of global climate change. It is widely recognized that to avoid the worst impacts of climate change, the world needs to urgently reduce emissions. But, how this responsibility is shared between regions, countries, and individuals has been an endless point of contention in international discussions. This debate arises from the various ways in which emissions are compared: as annual emissions by country; emissions per person; historical contributions; and whether they depend on government policies and behavior of drivers to support electromobility. The latest scientific investigations are centered on the morbidity and mortality associated with heat and climate change. Further research is required in the future, particularly in the areas of transdisciplinarity and cross-sector, to investigate newly emerging issues with limited evidence-based foundations and to gain a more comprehensive understanding of climate-sensitive health outcomes. Subsequent research endeavors may contribute to the body of knowledge by investigating additional climate-related repercussions and more extensive psychosocial health consequences. Furthermore, the majority of research on the health effects of climate change has been undertaken by scholars associated with scholarly institutions situated in affluent nations. It is imperative to confront this inequity, given that the repercussions of climate change disproportionately affect countries with lower income levels and will persist in doing so.

The novelty of the present article is its comparative analysis of factors influencing the electromobility development in high-income and low-income EU countries in relationship with decrease of CO2 emissions.

3. Research methodology

In the article the methods of descriptive statistics, comparative analysis of data, synthesis and generalization analysis, as well as summarization of the scientific literature were used. Firstly, the scientific literature on CO2 mitigation issues and still unexplored areas was reviewed. In chapter 3 analysis of factors influencing the electromobility development was completed: 1) comparison of the relevance of environmental and economic factors to the electromobility development in EU countries, 2) comparison of government policies and incentives, 3) comparison of charging infrastructure development. Data analysis allowed to determine relationship between CO2 emissions per capita, the registrations of new electric vehicles by country, and GDP per capita in EU countries, development of charging infrastructure, dependance of purchase of electric cars from national income, and what policies and incentives governments are using in the EU countries. Finally, the main obstacles for electromobility development were defined and measures to overcome them proposed.

4. Analysis of factors influencing the electromobility development

4.1. Comparison of the relevance of environmental and economic factors to the electromobility development

As carbon dioxide emissions are the primary driver of global climate change it is necessary to define their places of origin and sources. There are very large inequalities in CO2 emissions, registered electric cars and national income across the EU. CO2 emissions in metric tons per capita are presented in Figure 1, which measure the average annual emissions per person for EU countries. It is calculated by dividing the total annual emissions of the country by its total population.

The source for the annual CO2 emissions data is the Global Carbon Project (2023), according to which many countries across Europe have higher than the global average (4.8 tons per person) which was in 2017. From Figure 1 we can see that the highest CO2 emission was in Luxemburg – 12,5 metric tons per capita, and the lowest in Malta – 3,1 and Sweden – 3,2.

Analysis of statistical data in Figures 2 and 3 gives comparative analysis about dependence of registered electric cars from standard of living in old and new EU countries.

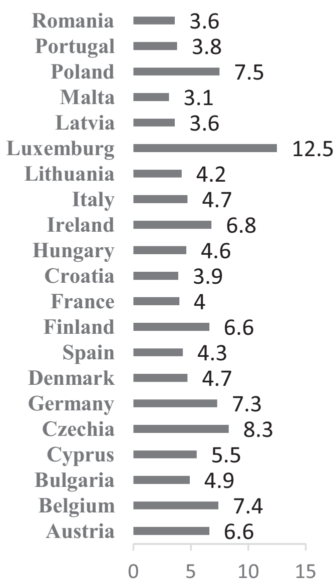

Figure 1. CO_2 emissions (metric tons per capita) in EU countries in 2020. *Source*: Eurostat

We can see that in old developed EU countries the highest number of registered electric cars was in Germany – 1090 units, in France – 606, Netherland – 318, with GDP per capita 46.150 euro in Germany, France – 38.590 euro, Netherland – 53.260 euro in 2022. From the other side, in Luxemburg in 2022 with the highest GDP per capita (119.239) only 14 electric cars were registered and CO2 emission was the highest (12.5 metric tons per capita).

Figure 2 shows that in the highest-income EU countries the inhabitants not always are making decisions to change their cars into electro vehicles, although CO2 emissions are the highest.

In Figure 3, which shows the relationship between registered electric cars and GDP per capita in new EU countries, we can see that the highest income was in Malta, but nevertheless there were no registered electric cars in 2022.

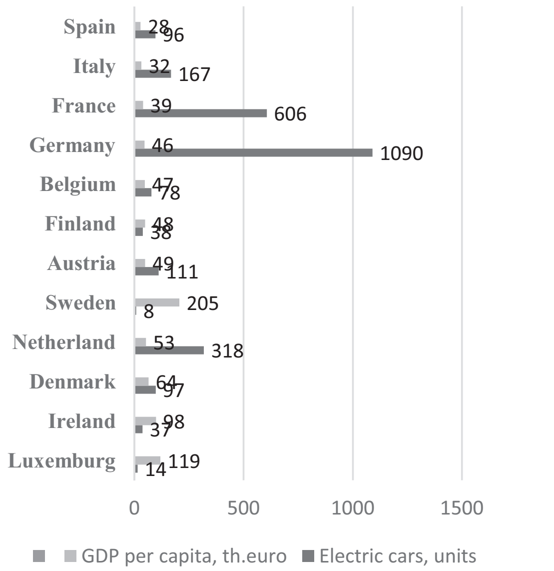

Figure 2. Relationship between registered electric cars and GDP per capita in old EU countries in 2022. *Source*: Eurostat

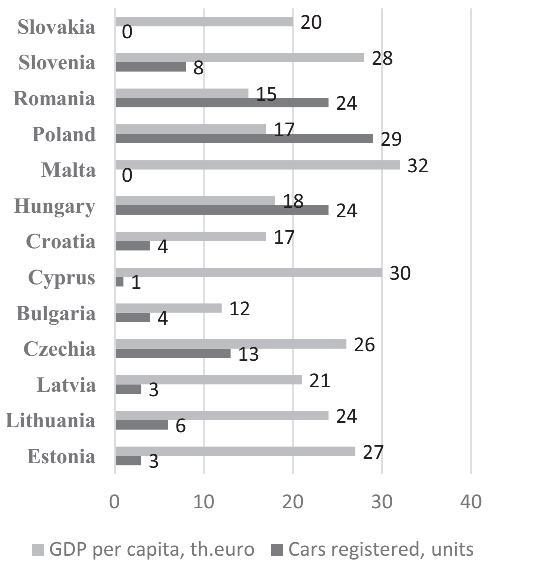

Figure 3. Relationship between registered electric cars and GDP per capita in new EU countries in 2022. *Source*: Eurostat

From the other point, in Poland, Hungary and Czechia there were registered 29, 24 and 13 electric cars, respectively, though their GDP per capita was significantly lower. While in other countries only few new electric cars were registered: in Lithuania – 6, in Estonia – 3, 1 in Cyprus and 0 in Slovakia and Malta. It must be noted that Bulgaria with the lowest GDP per capita (12.400) has registered even 4 electro cars.

4.2. Comparison of government policies and incentives

The initiatives include subsidies and tax incentives and rebates for businesses and private entities purchasing new or used electric vehicles. Encarnação et al. (2018) developed a theoretical model incorporating evolutionary game theory and Markov chains to investigate the incentive policies, involving governments, firms, and sectors that support the market transition to Electro Vehicles (EV). Their findings suggest that the public sector should be the initiator of this policy, with subsidies and taxes encouraging consumers' environmental awareness to increase demand for electric cars. The private sector could take advantage of the increase in demand, and then public sector intervention could be reduced, maintaining the level of EV adoption (Schill & Gerbaulet, 2015). Furthermore, the manner in which policies are implemented can greatly affect the EV up-taking. Researchers agree with the contribution of financial incentives to market development in the early stages of EV adoption, but conclude that non-financial incentives, including road priority, charging infrastructure density and fuel price, are better predictors of EV development.

In 2022 the share of electric cars in new car registrations compared to 2021 increased in almost all European countries. Electric cars, which include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), are gradually penetrating the EU market. There has been a steady increase in the number of new electric car registrations from 600 in 2010, to about 1,74 million in 2021, accounting for 18% of new registrations. These figures continued to grow in 2022, when almost 22% of newly registered passenger cars were electric. BEVs accounted for 12,2% of total new car registrations in 2022, while PHEVs represented 9,4% (www.eea.europa.eu). The largest share was in Norway (89%), Sweden (58%) and Iceland (56%). Germany, France and Norway together accounted for around 64% of all new registrations in the EU-27 and non-EU EEA countries. In Norway in 2022 the biggest number of new BEVs was registered, accounting for 79% of new car sales. The percentage of PHEVs was highest in Iceland and Sweden (both 23%) and Finland (20%). In four European countries (Cyprus, Poland, the Czech Republic), the percentage of registered electric cars remained below 5% of the total fleet. In Lithuania from June 2 of 2022, natural persons and legal entities are given compensations for purchased pure electric cars. It is planned for this purpose by 2026 to allocate 50 million euros. For natural persons, who had purchased electric passenger car will receive 5 thousand euros compensation. For those who purchased a used electric car – 2,5 thousand euros compensation. Legal and natural persons carrying out commercial activities are paid compensation of 4 thousand euros for the purchased new light pure electric cars(Ministry of Transport and Communications of the Republic of Lithuania, 2024).

4.3. Comparison of charging infrastructure development

Investments in electric car charging infrastructure are developing rapidly, which can be named as the biggest drawback for refusing to purchase EVs. The Netherlands consistently comes out on top. By sharing well-defined EV infrastructure deployment strategies, strong tax incentives, and an increasing number of public charging points, the leader is setting the tone for mass EV adoption. As the global EV market develops, countries need to accelerate investment in charging infrastructure to successfully transit to zero-emission vehicles. Adequate infrastructure in the form of public charging stations contribute to the development of electromobility. The situation in this regard is improving every year, we can see in 2020 that countries with relatively few vehicles, such as Portugal, Malta and Lithuania, had the highest number of electric cars per charging point: 27, 26, and 18, respectively) (https://www.mdpi.com). Probably, in this case, the development of the infrastructure did not lag behind the growth of sales of this type of car. In case of Germany in 2019 there were 6,2 electric cars at one public charging point, and in 2020 – already 13,3. Such a large increase of this indicator was due to very high sales of electric cars in 2020 (143% compared to 2019), a slight increase in public charging points – 14% (EU – Concilium). A similar situation occurred in Malta, Ireland, Denmark and Luxembourg. Only a few countries have seen a lower load on public charging stations, i.e. Greece, Cyprus, Bulgaria and Austria (9, 8, 13, 7). This was due to large investments in infrastructure.

In the European Union, the Alternative Fuels Infrastructure Directive [AFID] is the main instrument that guides the deployment of publicly accessible charging stations for electric vehicles (World Bank, 2023). EU member states must set targets for the installation of publicly available electric car chargers up to 2030, approximately 1 charger for 10 electric cars. The EU's Green Deal has raised the bar with a 2025 target to install 1 million publicly available chargers, and set out a key action plan for achieving this.

The lower running costs of electric vehicles, including reduced maintenance and lower electricity prices compared to petrol or diesel, make EVs a cost-effective option in the long run. The region must have a mature EV market to support viable charging infrastructure investments. A mature market is characterized by the availability of vehicles and increased production capabilities. Europe leads the way, especially Norway and the

Netherlands. Based on the 2020 Eurostat data, it was established that in the longer term, the development of electromobility in the EU, measured by the number of electric cars, is closely related to the economic situation in this area.

The crisis caused by the COVID-19 pandemic affected the economic situation in all EU countries, but did not slow down, and perhaps even accelerated the pace of electromobility implementation. In all EU countries, during the first year of the COVID-19 pandemic, the dynamics of putting electric cars into operation increased. Across the EU, the growth rate was 86% in 2020 and 48% in 2019. The reason was a change in social behaviour related to mobility in conditions of risk of infection. COVID-19 has become a positive catalyst for change. The development of this type of transport the prospects are very good, because the activities related to the development of the electromobility sector perfectly meet the needs related to the reduction of environmental pollution.

When it comes to the promotion and development of electromobility, it is important to emphasize the challenges faced. First of all, these are socioeconomic factors, such as the distribution of social groups of the population in different countries and their ability to purchase new or used electric cars, so the critical responsibility here falls in the hands of the authorities, which must offer the public incentives, discounts or preferential tax conditions. EVs tend to have higher upfront costs compared to conventional vehicles, and those with lower incomes may not have the financial means to make the switch. Despite subsidies and incentives, the affordability gap remains a challenge.

The issue of battery recycling is also unresolved. Battery components are very harmful to the environment, so specific procedural steps must be developed to manage end-of-life batteries and establish effective recycling methods to ensure environmental sustainability (Biresselioglu, 2018). In parallel with the promotion of electromobility, the renewal of energy networks must be carried out rapidly, which will ensure control of energy overloads and be able to balance energy jumps and shortages. While significant progress has been made in expanding charging infrastructure, there are still challenges with its availability and coverage, especially in rural areas. This could lead to "range anxiety" among EV owners and discourage potential buyers in regions with limited charging options. The resale value of used electric cars is no less important for EV owners while electric cars are known for lower running costs, their resale value has not always lived up to the expectations of early adopters. Factors such as battery condition and rapid technological advances can affect the used electric car market.

5. Electromobility development and its obstacles

In EU countries, the idea of electromobility began to gain special importance in the second decade of the 21st century: in 2011, electric cars were used in 19 EU countries, and in 2014 – even in all EU member states. In 2011, a total of 15.000 electric cars were used in the EU, and in 2020 there is 2.5 million. Of course, there are differences between countries in terms of the scale and speed of EV deployment. The quality of transport services has a significant impact on people's life quality. On average, 13,2% of each household's budget is spent on transport goods and services according Eurostat data, of 2022. Transport is also heavily dependent on oil resources and is an important source of CO2 emissions. The "Transport 2050" strategy outlined in the guidelines of the common transport space aims to introduce fundamental structural changes to transform the transport sector. All the main objectives of EU transport policy are related to the economy, competitiveness and decarbonization of transport. In order to take place for the development of electromobility, smoothly and more or less proportionally in different EU countries, it is necessary to make essential complex decisions with the help of large-scale analyses: increasing the efficiency of the entire transport system with the help of technological-economic analysis of new technologies, the impact on transport demand, costs, emissions, congestion, availability and economic impact analyses. Their manifestations include the desire to reduce the cost and prices of electric cars, to improve the quality and availability of charging infrastructure, as well as to perform functions related to the preventive impact on the environment and climate. According to EC 2020 in the appendix of the "Sustainable and smart mobility strategy" (2019) distributed in December, as many as 82 initiatives in 10 main action areas have been approved, each of which provides for specific measures setting binding indicators for each of the member countries, which will be necessary to achieve in order to systematically and smoothly transit to clean vehicles and foster a holistic approach to the processes taking place in the world. These main action areas identified in this document included such aspirations as: "by 2030 to install 3 million of public charging points", "development of zero-emission airports and ports", "doubled high-speed rail traffic", "in the next 10 years to develop additional bicycle infrastructure" (EUR-Lex, 2019).

According to Table 1, in 2021 a leader was Norway in the field of electromobility: battery electric cars consisted 64,5%, in Sweden – 19%, in Germany 13,6. France, Italy, Spain, and Austria are also in the top in terms of the number of electric cars.

In turn, Cyprus, Latvia, Croatia, Estonia and Lithuania were among countries with the fewest electric cars. In 2021, the number of electric cars increased in all EU countries and continues to increase significantly. From the data of the Ministry of Transport and Communications of the Republic of Lithuania by 1 of January, 2024, there were 15 427 pure electric cars registered in Lithuania. Every year their number increases, but so far it is only 0.67 percent of all light vehicles registered in Lithuania. In 2023, a record number of electric cars were registered in Lithuania, i.e. 4851 or 2 thousand more than

Table 1. Market share of technologies for new passenger cars in 2021 by country. *Source:* EEA

Market	Hybrid electric cars	Plug-in hybrid electric	Battery electric cars
Germany	2.7%	12.4%	13.6%
France	8.5%	8.5%	9.8%
Italy	7.0%	4.8%	4.6%
Spain	10.0%	4.9%	2.7%
Poland	12.9%	2.0%	1.6%
Belgium	5.0%	12.2%	5.8%
Netherlands	8.6%	9.6%	19.8%
Sweden	7.7%	25.7%	19.0%
Austria	3.4%	2.5%	13.6%
Czechia	3.8%	1.8%	1.3%
Denmark	4.7%	21.7%	13.3%
Norway	5.4%	21.7%	64.5%
Portugal	4.7%	10.8%	8.7%
Hungary	8.5%	2.7%	3.5%
Romania	7.7%	2.4%	5.2%
Ireland	14.1%	7.6%	8.2%
Greece	8.6%	4.4%	2.2%
Finland	14.8%	20.5%	10.3%
Slovakia	6.9%	1.6%	1.5%
Luxembourg	2.6%	10.0%	10.5%
Slovenia	4.1%	1.2%	3.8%
Croatia	3.9%	1.8%	3.2%
Lithuania	13.4%	1.3%	3.7%
Estonia	13.3%	1.0%	2.1%
Iceland	9.0%	31.0%	26.9%
Latvia	14.3%	1.0%	2.9%
Cyprus	1.5%	0.9%	0.8%

in 2022. In 2023, new electric cars were mostly bought by legal entities (65%). This was mainly due to the application to legal entities value added tax relief and coinciding with its Tesla's price cut. The goal of Lithuania is to increase the percentage of electric cars and other zero-emission cars powered by alternative fuels to 20% of the total proportion of cars by 2030 (European Parliament, 2021). However, there are a number of factors limiting the development of electrified cars, the main ones of which are the following: battery prices, on which the limit of the final price of the electric car itself basically depends, consumer anxiety about driving range and user dependence on battery charging networks (EEA, 2019). Consequently, electricity production is highly variable, and while at some point all demand can be met by wind and solar power alone, in many places every additional kWh is generated using fossil fuels (a very CO2-emitting energy source). Therefore, charging electric vehicles during those periods necessarily means that the total amount of energy generated by fossil fuels in the system must be increased by the same amount of energy required by electric vehicles, regardless of the average amount of renewables in the system (Jochem et al., 2015). Therefore, depending on the charging time of electric cars, a vehicle like the Chevrolet Volt can be associated with only 37 g CO2/km when electricity is produced only from renewable sources (much less than ordinary vehicles, or even 190 g CO2/km), when electricity is produced from fossil fuels – much more than usual vehicles (Plötz et al., 2018). But due to the charging methods of electric cars, most of the electricity load is generated in the evenings (Anderson et al., 2018). During those periods, renewable energies contribution is low and the demand for electricity is high, which means that the electricity generated to meet the demand comes mainly from fossil fuels (i.e. 190 g CO2/km). The use of electric vehicles significantly helps to reduce air pollution, which is a growing concern for public health and urban planning. Cities are doing everything possible to limit the use of vehicles powered by internal combustion engines. An excellent example of this can be the city of Vilnius in Lithuania, where in recent years the central city government has taken drastic changes to reduce pollution in the city: streets are narrowed, bicycle paths are built, and public transport is changed to electric or biofuel-powered ones. Initiatives such as the introduction of one-off pollution charges for transport are entering the city.

6. Data analysis and discussion

Analysis of growing CO2 emissions show that the average CO2 gas emissions generated by vehicles in Europe decreased by 12% compared to the previous year, and the number of electric vehicles tripled. The debate arises from the various ways in which emissions are compared: as annual emissions by country; emissions per person; historical contributions; and whether they depend on government policies and behaviour of drivers to support electromobility. Electric cars have not only changed the automotive industry, but are constantly reshaping the very structure of our modern transport ecosystem. The greatest influence on the development of electromobility has battery price, driving distance, charging time and battery technology themselves. The statistical data show that countries with high standards of living have a high carbon footprint: for example, if in Luxemburg, GDP per capita is 119 thousand euros, but CO2 emissions per capita was the highest among EU countries – 12,5 metric tons per capita in 2020. For example, in other EU countries: Ireland: 98,2 with 6,8; Netherland: 53,2 with 7,5; Denmark: 63,5 with 4,7; Austria: 49,4 with 6,6; Belgium: 47,2 with 7,4. From the other side, countries with lower GDP per capita have less CO2 emissions: Latvia with 20,7 euro GDP per capita had 3,6 metric tons per capita of CO2 emission, Lithuania: 23,6 and 4,2; Estonia: 27,2 and 5,3. However, there are very large inequalities in CO2 per capita emissions, registered electric cars and national income across the EU. For example, in Luxemburg in 2022 were registered only 14 electric cars battery-only, Ireland – 37; Germany – 1090; Netherland – 318; France – 606; Lithuania – 6; Latvia – 3; Estonia – 3. During the process of the study, it was analysed that significant progress has been made in expanding charging infrastructure, that countries with relatively few vehicles, such as Portugal, Malta and Lithuania, had the highest number of electric cars per charging point, but there are still challenges with its availability and coverage, especially in rural areas.

Despite the fact that the results of this study are novel and intriguing, there are also some limitations. The generalizability of this study is a limitation. The study analysed the situation in the EU in general, giving more detailed analysis of Lithuania.

According to R. Curtale et al. (2021), it is crucial to examine how city municipalities could organize public transportation to reduce the use of private automobiles and to prepare infrastructure for the use of electric vehicles. To this end, it is essential to determine whether the proportion of car owners and their satisfaction with public transportation can impede the implementation of infrastructure for electric car services.

In addition, regarding the psychological aspect of drivers, the adoption of new technologies for the use of more energy-efficient cars and their trust in electric car services that meet the requirements of hygiene standards are being discussed.

Future research should use a method of selecting a probability sample to increase the study's generalizability by analysing the effects of electromobility on climate change in various nations. Consequently, future studies may incorporate additional moderators, such as electric car prices, infrastructure, people's expectations, and others.

7. Conclusions

Summarizing the factors promoting the development of electromobility, as a means to mitigate CO2 emissions, show that the rapid development of electric vehicles is the beginning of a new era, shaped by a number of influential factors. Electric cars have not only changed the automotive industry, but are constantly reshaping the very structure of modern transport ecosystem, proving the human ability to change and adapt. The latest scientific investigations are centred on the morbidity and mortality associated with heat and climate change. Further research is required in the future, particularly in transdisciplinary and cross-sector areas, to investigate newly emerging issues with limited evidence-based foundations and to gain a more comprehensive understanding of climate-sensitive health outcomes. Subsequent research endeavors may contribute to the body of knowledge by investigating additional climate-related repercussions and more extensive psychosocial health consequences. Furthermore, the majority of research on the health effects of climate change has been undertaken by scholars associated with scholarly institutions situated in affluent nations. It is imperative to confront this inequity, given that the repercussions of climate change disproportionately affect countries with lesser income levels and will persist in doing so.

After reviewing scientific articles on electromobility development, which were often based on expert surveys, it can be stated that different experts usually named the following main ones, which have the greatest influence on the development of electromobility: battery price, driving distance, charging time and battery technology themselves. Thus, specifically, with electric car batteries related factors and their future technological progress is a crucial factor.

Analysis of the influencing factors show that the development of electromobility depends on many different factors. Factors such as the purchase price of electric cars, personal income, government incentives, the benefits of financial instruments to reduce taxes or energy costs are often mentioned. However, charging stations are a crucial factor influencing electromobility, especially in rural areas.

Comparison of registered number of electric cars with GDP per capita in the highest-income EU countries show that the inhabitants are not always interested to change their cars into electro vehicles, though CO2 emission are at the highest level. Comparison of the same factors in the low-income EU countries also determined the same trend as in the highest-income countries. The most electric vehicles were registered in the countries, with the middle-income level.

Government policies and incentives used in various EU countries to stimulate electromobility also differs. The research findings suggest that the public sector must be the initiator of this policy, with subsidies and taxes encouraging consumers' environmental awareness to increase demand for electric cars. The private sector could take advantage of the increase in demand, and then public sector intervention could be reduced, maintaining the level of EV adoption. Researches agree with the contribution of financial incentives to market development in the early stages of EV adoption, but concludes that non-financial incentives, including road priority, charging infrastructure density and fuel price, are better predictors of EV development. For example, in Lithuania from June 2 of 2022, natural persons and legal entities are given compensations for purchased pure electric cars.

Analysis shows that there is a huge gap between the old and new EU countries in terms of the number of electric vehicles growth. In 2021 a leader was Norway in the field of electromobility: battery electric cars consisted 64,5%, in Sweden – 19%, in Germany 13,6. France, Italy, Spain, and Austria are also in the top in terms of the number of electric cars. In turn, Cyprus, Latvia, Croatia, Estonia and Lithuania were among countries with the fewest electric cars.

On the other hand, European countries with a longer history of electromobility have better electro vehicles infrastructure, and more such vehicles in use. Other new

EU countries as Lithuania, Poland, the Czech Republic, Slovakia and Hungary, are just beginning their electromobility age, which is usually associated with national income, the lack of electric car infrastructure, the small number of electric cars in use, and resale value of used electric cars.

The usefulness of the proposed research results for scientists, business practitioners and society is giving comprehensive and comparable information and understanding about awareness of inhabitants, effectiveness of policies used by governments and incentives on development of electromobility and determining the obstacles in lower-income and higher-income level EU countries. Research results also give the insights to strengthen researches and measures for reduction of CO2 emissions, especially in lower-income countries, considering that the impacts of climate change will continue to affect these countries.

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