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Review

Selected Determinants of Sustainable Transport in the Context of the Development of a Low-Carbon Economy in Poland

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Abstract: Road transport is one of the key elements of economic development that helps build social and territorial cohesion. The economic development that has taken place in Poland over the last three decades has led to an improvement in road infrastructure throughout the country. Construction of new roads and improvement of existing ones promotes economic development. However, as the number of cars increases, so does the level of air emissions. In reducing pollutant emissions, the analysis of the technological possibilities used and the improvement of their efficiency with the simultaneous minimization of generated pollution is also of particular importance. The purpose of the publication is to present development trends in road transport in Poland and the possibility of reducing emissions in this respect. The method of analysing strategic documents and statistical data was used to achieve this goal. Moreover, the article shows perspectives for reducing the level of emissions from road transport and refers to the assumptions related to the modernization of the transport sector and reducing its share in carbon emissions and its sustainable development in cities.

Keywords: energy; economy; low-carbon development; electromobility; road transport

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1. Introduction

Air pollution is a major public health problem causing premature deaths. The World Health Organization (WHO) has estimated the number of premature deaths in Europe at 0.5 million people [1]. At the same time, transport contributes to climate change, air pollution, and noise. In the last few years, there has been a decrease in pollutant emissions in the European Union (EU-28) for many substances, e.g., NO_x by 46%, CO by 49%, PM2.5 by 31%, and PM10 by 29% [2,3]. This confirms the effectiveness of the implementation of air pollution control strategies. Despite these changes, the achieved levels of air pollution in cities still exceed the standards in the EU countries.

The implementation in Poland of low-carbon economy is associated with the reduction of greenhouse gas emissions and other air pollutants. The expectations for improving air quality are related to a reduction in the use of carbon in energy production, enhancement of energy efficiency, implementation of new technologies, as well as increasing the standard of living of society [4–6]. The rate of economic growth is largely determined by industrialization, urbanization, improvement of transport infrastructure, etc. These factors largely affect energy consumption. Higher energy consumption in Poland is associated with economic growth [7–9]. Building an economy based on strong foundations should strive to minimize or eliminate the side effects of economic growth, such as increasing negative environmental

impacts [10,11]. It should be emphasized that the development of low-carbon transport in Poland and the related increase in the number of electric cars should be considered in relation to the methods of generating electricity. In Poland, over 80% of electricity is generated by burning fossil fuels. As a result, the mere increase in the number of electric cars will, to a large extent, only change the place where pollutants are emitted into the air. Only a radical reduction in the use of fossil fuels for the production of electricity will help to positively influence the development of low-carbon transport in Poland in a comprehensive manner [12]. Despite the use of modern exhaust gas treatment technologies, greenhouse gas emission, including CO_2, is still a big problem [13,14]. Mobility is one of the important measures influencing the shaping of the internal market as well as the quality of life of residents through the development of infrastructure. Investments in road infrastructure are characterized by a positive impact on economic growth [15]. The method of analysing strategic documents and statistical data was used to achieve this goal. Moreover, the article shows perspectives for reducing the level of emissions from road transport and refers to the assumptions related to the modernization of the transport sector and reducing its share in carbon emissions and its sustainable development in cities [16,17].

Section 1 presents the general framework and thematic scope of the publication. A review of the literature on environmental hazards from road transport and its impact on development activities in Poland is included in Section 2. It also presents statistical data on the types of used fuel, types of motor energy, and the age of used cars. Visible changes taking place in the Polish realities are depicted. Section 3 contains the methodology and goals. Section 4 discusses actions taken at the EU level and indicates their impact on the development of urban mobility and functional urban areas in Poland. Section 5 is a discussion, and the article ends with the conclusions contained in Section 6.

2. Literature Review

Due to its strategic location at the intersection of Europe's main north–south and east–west lines, Poland is expanding its transport infrastructure. However, the existing transport network system, due to the lack of a comprehensive system of highways and expressways, does not serve to efficiently allocate industry and services. Since its EU accession, Poland has invested strongly in the development of a fast road transport network. As a result, the total length of modern, high-speed roads has increased from around 500 km in 2005 to over 3000 km in 2015 [18]. In the road quality ranking according to the World Economic Forum in 2018, Poland came 65th, rising 57 places compared to 2011. Although the number and quality of Polish roads is improving dynamically, there is still a great deal to be done.

Sustainable development requires ensuring the mobility of residents while minimizing the nuisance to the environment [19]. The sustainable development of transport systems can enhance economic growth; it requires action between economic performance, environmental protection, and social development. From an ecological point of view, this goal is to understand the mutual environmental impacts and practices in the industry and to integrate environmental considerations into all aspects of the transport industry [20]. Transport should be cost-effective and should adapt to changing requirements. In the social dimension, this goal consists in raising the standard and quality of life.

Electric transport plays an important role in sustainable development. Its development affects the support of other sectors of the economy [21]. Table 1 shows passenger cars by type of motor energy in 2012–2018 in Poland. In the perspective of several years, an increase in electromobility should be expected, which will bring measurable positive environmental effects. The data in Table 1 show that the number of cars with electric motors in Poland is slowly but steadily increasing.

Table 1. Types of motor energy in passenger cars in 2012–2018 in Poland [22].

Type of Motor Energy	2012	2013	2014	2015	2016	2017	2018
Petroleum products	10,811,000	10,937,607	11,085,536	11,315,095	11,694,188	12,156,450	12,414,546
Including Diesel	4,830,000	5,259,881	5,675,734	6,090,488	6,554,145	6,874,307	7,292,917
Electricity	-	2270	4218	7765	14,610	26,223	3018
Hybrid electric petrol	-	2270	0	326,977	323,979	402,037	42,237
Hybrid diesel-electric	-	-	-	-	-	-	2285
Total	10,811,000	10,942,147	11,089,754	11,649,837	12,032,777	12,584,710	12,462,086

2.1. Goals of the Climate and Energy Policy

Global environmental threats undoubtedly include gas and dust atmospheric pollution, which, due to their transboundary range, lead to contamination of large areas and pose a threat to human health [23]. Air pollution that is caused by liquid road fuel transport occurs at a low level, almost directly on the ground, which is more harmful to people than emissions from other sources, e.g., from the energy sector. Air pollution with particulate matter (PM2.5 and PM10) is an important problem for metropolises and urban-industrial agglomerations both in Europe and Poland [24–26]. The EU's long-term goals are to achieve air quality without unduly affecting quality of life and human health [27]. For this reason, countries and international organizations undertake a number of actions to reduce its negative impact. The European Union (EU) is taking active steps to combat climate change. The European Parliament is developing legislation that defines general air quality standards for pollutant concentrations, energy efficiency and fuel quality, and limits on total pollutant emissions for the member states. This legislation is complemented by policies and measures that promote environmental protection and its integration into other sectors [28]. The main goals of the EU climate and energy policy until 2030 are aimed at creating a low-carbon economy through a wide-ranging 40% reduction in greenhouse gas (GHG) emissions, increasing renewable energy sources (RES) to min. 32% of energy consumption in the EU, increasing energy efficiency by min. 32.5%, guaranteeing min. 15% of electricity interconnection levels between neighbouring member states, and supporting research and innovation (R&D) initiatives with funding tools [29] (e.g., Regional Development Funds for 2021–2027 provided for in the National Energy and Climate Plans (NECP)).

The Communication on a Low-Carbon Mobility Strategy of 20 July 2016 (KE, 2016a) [30] emphasizes the need to increase the efficiency of the transport system, the transition to low- and zero-carbon vehicles, and the use of renewable energy in transport, which are hampered by uncertainties in electrification of transport (battery development and related prices). Nykvist and Nilsson showed that battery costs may decline more than previously predicted [31]. According to Edelenbosch et al. (2018) [32], the penetration of the electric vehicle market is strongly dependent on the cost of batteries. They presented absorption scenarios ranging from insignificant to almost full penetration of the electric vehicle market in 2050 in the absence of a climate policy depending on the trajectory of battery costs. A continuation of these activities was the introduction of the Euro 6 ISC-FCM (Service Conformity Fuel Consumption Monitoring) standard on 1 January 2021. It introduces new restrictions for manufacturers of passenger cars, delivery vans, and trucks [33,34]. The main change introduced by this standard concerns the requirement to carry out pollutant emission tests not only in laboratory conditions but also on the road. From a technological point of view, this means that passenger vehicles must have fuel combustion monitoring devices [35].

2.2. Road Transport in Poland

According to Eurostat data [36] in Poland, in 2017, there were 593 cars per one thousand residents. Luxembourg is the leader, with a result of 670 cars per one thousand residents. A large number of cars per one thousand inhabitants was also found in Italy (625 cars) and Finland (617 cars).

The average age of cars on Polish roads in 2018 was about 14.1 years; the average for European countries is 11.5 years. The import and sale of used cars is much greater than the sale of new cars [37,38]. Only 8% intend to buy a new one. It should be emphasized that the old and non-ecological cars that dominate in Poland will largely contribute to the excessive emission of harmful substances and GHG into the air. Due to the higher age of cars and the lower share of cars with electric and hybrid propulsion, the shares of pollutants of individual harmful substances are higher than in most EU countries. Nitrogen oxide had the largest share in the emissions of pollutants from road transport in Poland in 2017: 37% in the total emissions of this substance into the air, exceeding other sources of pollution, such as combustion processes in industry or combustion processes in the energy sector [39]. It should also be noticed that the high share of carbon monoxide from road transport was 23.14% in 2017 (Table 2). On the other hand, the lower share was attributed to suspended particulate matter PM2.5 (10.18%) and PM10 (7.79%) [40,41].

In the Polish reality, spatial development of cities, often associated with suburbanization processes, causes the lack of coordination of development activities that strengthen the habit of everyday use of a passenger car for private purposes by too many people. This phenomenon intensifies the scale of problems related to city transport services. This is even more important because not only the behaviour of its inhabitants but also car traffic generated from external areas, i.e., functional areas of the city as well as further areas, have an impact on the crowded state of inlet routes to the city and streets in the city itself.

Table 2. The share of emissions of carbon oxides and nitrogen oxides as well as particulate matter PM2.5 and PM10 in Poland in 2017 by SNAP (Selected Nomenclature for sources of Air Pollution) category [42].

Emission Source	CO		NO_x		PM2.5		PM10	
	Mg	%	Mg	%	Mg	%	Mg	%
Combustion processes in the energy production and transformation sector	51,190.17	2.01	168,902.5	21.02	6027.68	4.09	11.22	4.55
Combustion processes outside industry	1,505,800.40	59.21	85,722.70	10.67	68,503.2	46.51	114.65	46.52
Combustion processes in industry	212,827.42	8.37	73,354.00	9.13	31,019.68	21.06	33.23	13.48
Production processes	68,227.72	2.68	25,591.90	3.18	7093.82	4.82	17.27	7.01
Extraction and distribution of fossil fuels	301.67	0.01	1357.50	0.17	633.2	0.43	6.33	2.57
Road transport	588,443.54	23.14	297,356.3	37.00	14,993.48	10.18	19.20	7.79
Other vehicles and devices	96,257.38	3.79	84,709.60	10.54	11,459.76	7.78	11.46	4.65
Waste management	19,661.59	0.77	2209.10	0.27	4391.1	2.98	4.49	1.82
Agriculture	541.48	0.02	64,457.90	8.02	3159.32	2.15	28.45	11.54
Total	2,543,251.37	100.00	803,661.5	100.00	147,281.24	100.00	246.31	100.00

In the centres of large cities in Poland, up to 80% of exceedances of permitted air standards come from transport. Pollutants emitted from exhaust pipes constitute 7% of traffic pollution. A dozen or so percent are particles worn off of tires and brake pads [43]. Dust materials arise in natural processes (e.g., Aeolian erosion, sandstorm, wood pollen) and anthropogenic ones (e.g., burning of fossil fuels). The sources of the latter may include dust abrasion processes of tires, brakes, and road surfaces. Secondary emission, i.e., the picking up of dust lying on the roads by the wind, is a problem that mainly large cities face [44–46].

Holmberg and Erdemir (2019) [47] showed that energy consumption and friction losses in electric passenger cars are on average 3.4 times lower compared to cars powered by an internal combustion engine. The transition from fossil fuels to renewable energy sources can reduce energy losses due to friction in energy production by over 60%. In this context, various policy and car production measures are being introduced at the international level to accelerate the development and adoption of alternative fuel vehicles [48]. According to data from the end of July 2021, there were 28,301 electric cars registered in Poland. In

the first half of 2021, individual customers were most likely to buy brands such as Toyota Yaris (4827 pcs.), Dacia Duster (3854 pcs.), Toyota Corolla (3072 pcs.), Hyundai Tucson (2622 pcs.), and Kia Sportage (2542 pcs.) [49]. The share of electric cars in Poland is one of the lowest in the EU. This market is relatively young and still concerns a small number of models. The electromobility revolution in Poland is still in the future, which requires a number of treatments, including on the part of the state authorities.

In Poland, there is also a visible lack of protection and control of changes in space that cause fragmentation of existing natural systems, including ecological corridors and aeration wedges in cities. This process is often associated with the lack of a vision for urban development formulated by municipal authorities, especially where such a vision is most needed. Cities should not develop in a chaotic way, and green areas in the city are very important for ensuring better quality of the environment in urban areas [50]. At the same time, the lack of effective mechanisms for implementing spatial policy often triggers the possibility of implementing individual and commercial investments in areas not covered by the local plan based on administrative decisions. According to the well-established case law, such decisions do not have to show compliance with the general spatial policy of the city, which, by undermining the logic of the spatial planning system, ultimately limits public control over investment processes.

3. Methodology and Goal

The authors of the article reviewed the literature on air pollution by road transport and indicated the goals of the climate and energy policy in the perspective of 2030 in Europe. The next step was to identify the determinants influencing road transport in Poland. Attention was paid to the number of vehicles driven in various ways (Table 1), types and sources of pollution (Tables 2 and 3), the number of charging infrastructure (Table 4) as well the total number of electric and plug-in hybrid cars sold in Europe (Table 5). The activities of sustainable development in cities were analysed on the basis of urban mobility and the development of the electric car market on the Polish market.

This article focuses on the presentation of selected determinants of sustainable transport in the context of the development of a low-carbon economy in Poland. The purpose of the publication is to present development trends in road transport in Poland and the possibility of reducing emissions in this respect. The presented research goal was a determinant of the use of methods in the field of social research, which included:

- the analysis of source documents,
- the analysis of the literature,
- deductive method, and
- tables and charts.

The methodology of our own research was adapted to the assumed goal and scope of the research. The conducted research also helped to indicate the main directions and prospects for further low-carbon road transport development. The presented data became the basis of the socio-economic characteristics. The authors of the study are aware that not all research problems related to the topic of the article are discussed.

4. Development Potential for Low-Carbon Road Transport

4.1. Actions for the Development of Low-Emission Transport

The use of economic, legal, and educational tools in the fight against air pollution from transport should be complementary to make it effective. Coordinated actions are being taken in the EU to reduce the harmful effects of transport through the integration of transport and ecological policies [51]. These activities achieve their goals. The EU Directive on air quality 2008/50/EC [52], which has been in force since 11 June 2008, is the basis for limiting the health risks caused by particles and nitrogen dioxide. This directive obliges to establish national laws and regulations, which are then implemented in EU countries at regional or national level or applied in cities and communities based on complex national or local special laws or exemptions.

It is also necessary to mention the National Emission Ceilings Directive (EU) 2016/2284 [53] adopted under the "Clean Air for Europe" program on national emission reduction commitments. The directive was implemented to contribute to the reduction of the impacts of transboundary air pollutants and ground-level ozone precursors. It sets limit values for 2020 and 2030 for the pollutants NO_x, SO_2, VOC, and NH_3 as well as PM2.5. [54].

An important element of the changes taking place in the area of production of ecological means of transport may be the use in the engineering industry of such technical solutions that will not only increase the quality of final products, reducing the costs of their production, but will also significantly reduce pollutant emission [55,56].

The share of pollution from the road transport sector in Poland is about 10% and varies between voivodships. This depends, among other things, on factors such as population density, traffic volume, and number of roads. These pollutants consist of compounds such as: NO_x, CO, heavy metals, methane, particulate matter (PM), and aromatic hydrocarbons. Table 3 presents air emissions accounts in tonnes in Poland in 2012–2018 in transport and storage. The data show that emissions of CO_2, NO_x and methane are increasing successively from year to year. The largest increase is seen in CO_2, NO_x at the turn of 2016 and 2017 (Table 3).

Table 3. Air emissions accounts in tonnes in Poland in 2012–2018 in transport and storage [57].

Emission Sources	2012	2013	2014	2015	2016	2017	2018
Carbon dioxide	22,830,272	21,904,369	22,382,776	23,476,613	27,445,157	33,029,253	34,215,639
Nitrous oxide	910.73	874.37	888.24	941.54	1072.41	1312.58	1356.7
Methane	5214.75	5310.75	5217.62	5717.28	6172.00	6186.38	6602.85

One third of the final energy in Europe is used by transport [58,59]. It is mainly based on crude oil. This is a significant greenhouse gas emission in the EU and contributes significantly to climate change. Motor vehicles account for more than 70% of total greenhouse gas emissions from transport. Sea and air transport account for the remainder.

In cities with heavy traffic, transport remains the main source of air pollution. NO_x and particulate matter (PM) have a major impact on the environment and human health. The concentration of air pollutants is still too high despite efforts in recent years focused on introducing fuel quality standards and using cleaner technologies [60–62].

Road traffic is also the most common source of noise. Prolonged exposure to noise can have a variety of health effects, including irritability, sleep disturbance, negative effects on the cardiovascular and metabolic systems, and cognitive impairment in children. In addition, transport networks divide natural areas into smaller plots of land with serious consequences for animals and plants [63].

More and more attention is also paid to the issue of greener transport in cities [64]. An example of this type of solution is the exclusion of city centres for cars that do not meet current emission standards. In Poland, no city has yet introduced such a restriction. Polish cities, e.g., Sopot, educate and encourage residents to use other forms of communication, e.g., public transport, largely based on innovative, pro-ecological solutions, such as electric vehicles or CNG-driven vehicles, e.g., for children and schoolchildren as well seniors, it is free. It encourages residents to use services such as car-sharing, and for electric car owners, there are preferential rates for parking in the parking zone, and infrastructure for charging them is being built. Despite the introduced incentives, the car is the most frequently used means of travel. Changes in pro-ecological behaviour in the Polish realities are progressing slowly. Income constraints, reserve, and scepticism towards zero-carbon mobility and the sharing economy emphasize the role of public collective transport as an alternative to individual motorization. Individual road transport in Poland will be based on traditional combustion engines for many years to come. On the other hand, public transport, due to its massiveness and the use of electric drive (city railways, metro, trams, trolleybuses), is much more environmentally effective [65]. According to the scenarios

included in the Transport and Mobility Strategy of the Gdańsk-Gdynia-Sopot Metropolitan Area until 2030, the effectiveness of the transport policy means the possibility of using mobility management tools by road and transport authorities and local authorities to stimulate rational transport behaviour of residents as well as effective and efficient traffic management and transportation. As part of the "Mobile metropolis" project, space design activities are carried out to encourage walking, cycling, and public transport [66]. Other cities in Poland have exchanged a large part of the bus fleet for electric vehicles and also promote public transport by offering various amenities and discounts.

4.2. Electric Cars

The European Commission is actively promoting the concept of multi-annual plans for the development of urban mobility and functional urban areas. It plans the inclusion of mobility activities in the broader strategy for their development. The development of plans and their implementation can help cities efficiently use existing transport infrastructure and transport services and effectively use urban mobility instruments. The use of the least environmentally invasive forms of transport, the use of alternative fuels, or the development of innovative technologies that can neutralize the risks posed by transport are encouraged.

Electric cars will become common on our roads. This will increase the demand for electricity. It is necessary to take into account the energy transition and the actual consumption of electricity [67–71].

Directive 2014/94/EU [72] of the European Parliament and the Council of 22 October 2014 on the development of alternative fuel infrastructure imposes an obligation on member states to develop alternative fuel infrastructure [73]. The national policy framework provided that around 70 thousand electric vehicles were to be registered in Poland in 2020, which, in the light of the latest data, seems to be an impossible goal. At the end of 2020, 18,875 electric passenger cars were registered in Poland, 53% of which were battery electric vehicles (BEV), and the remaining 47% were plug-in hybrid electric vehicles (PHEV) [74]. The draft strategy for sustainable transport development until 2030 establishes the development of low-emission public transport, supporting joint car sharing as well as the use of autonomous transport in public transport. After 2020, changes in the tax system are planned to reward the purchase, possession, and use of vehicles with less pressure on the environment. This strategy also promotes rail transport, focusing on modernizing the rolling stock and the "joint ticket" project for the entire rail journey. These actions can effectively reduce the number of cars travelling on Polish roads.

According to data at the end of July 2019, in Poland there were [75]:

- 971 charging points with normal power,
- 486 high-power charging points, and
- 29 natural gas refuelling stations (CNG)

and used were:

- 4009 electric vehicles,
- 2321 plug-in hybrid vehicles, and
- 4900 vehicles powered by natural gas CNG.

In 2017, over 2 million electric vehicles were driven around the world. There are many new models of electric cars on the market from all major manufacturers—Nissan, Renault, BMW, Mercedes, Volkswagen, Peugeot, Skoda, and others. The prices of these cars are falling, and their range is increasing. According to Bloomberg New Energy Finance [76], before 2040, sales of electric vehicles will exceed sales of internal combustion vehicles, and the prices of some models of electric cars will be equal to the prices of internal combustion vehicles in 2024, while in 2025, they may already be lower than them. The construction of infrastructure related to charging electric cars has to keep up with this. Table 4 shows the number of petrol stations in Poland in 2013–2019. The presented data show a systematic increase in the infrastructure of LPG vehicle-charging stations. There has been a slow but

steady increase in the number of electric car-charging stations and a slight increase in LNG charging stations.

According to the European Union Directive 2014/94/EU on the development of alternative fuels infrastructure, by 2020, Poland is required to provide adequate infrastructure for electric vehicles, including the construction of charging stations. The governments of most countries are introducing or have already implemented appropriate laws to encourage customers to purchase electric vehicles [72]. Various subsidy systems already exist in 17 European countries (e.g., Germany, France, Great Britain, Spain, Romania, Norway, the Netherlands, and Slovenia). Norway is definitely the leading country in electromobility. In June 2017 alone, electric cars constituted 42% of newly registered vehicles there. Customers are exempt from 25% VAT and highway tolls, road tax is also reduced, and in some regions, it is not necessary to pay for parking. In turn, in the Netherlands alone, electric vehicles account for 6.4% of all cars. In Sweden, it is 3.4% [77].

Table 4. Total number of infrastructure in 2013–2019 [78].

Year	Electricity Filling Stations	LPG Filling Stations	Natural Gas Filling Stations	Total Filling Stations
2013	4			4
2014	119	5460	0	5579
2015	298	5420	28	5746
2016	319	5390	27	5736
2017	507	6287	28	6822
2018	714	7432	29	8175
2019	849	7500	29	8378

To accelerate the development of electromobility, a number of financial incentives should be implemented that reduce the price difference between an electric car and a conventional one [79]. These may be exemptions from taxes, e.g., excise duty, which in Poland, applies to electric, hydrogen-powered vehicles, or plug-in hybrid vehicles, in which the tax obligation in excise duty arose after 18 December 2018. At the same time, in relation to hybrid plug-in vehicles, release will be in force until 1 January 2021 [80]. Moreover, an effective incentive for entrepreneurs may be the use of depreciation charges for electric vehicles, put into use after 18 December 2018, and support for investment of other solutions supporting low-carbon development in road transport [81,82].

Such activities include support for:

- production of liquid biofuels, bio components, or other renewable fuels [83,84];
- development or construction of infrastructure for the distribution or sale of liquefied or compressed natural gas [85];
- producers of means of transport using compressed natural gas (CNG) or liquefied natural gas (LNG);
- the functioning of public transport, in particular in urban agglomerations; spas; in areas where, in accordance with the provisions on nature protection, forms of nature protection have been established; with use of liquid biofuels; other renewable fuels; and compressed or liquefied natural gas;
- research related to the development of new types of bio components;
- educational programs promoting the use of renewable fuels;
- purchase of new vehicles powered by liquid biofuels, compressed (CNG), or liquefied (LNG) natural gas; and
- promotion of the use and production of liquid biofuels and bio components [86,87].

The proliferation of electric cars may contribute to more sustainable development in the transport sector, but prevalence rates are still low in most countries.

Below is a list of five countries with the LOWEST ECV market in the EU (and their GDP per capita) in 2019 [88]:

1. Estonia—0.3% (GDP of €21,160)

2. Lithuania—0.4% (GDP of €17,340)
3. Slovakia—0.4% (GDP of €17,270)
4. Greece—0.4% (GDP of €17,500)
5. Poland—0.5% (GDP of €13,780)

Table 5 shows sales of electric and plug-in hybrid cars in the first quarter of 2019 and 2020.

Table 5. Total number of electric and plug-in hybrid cars sold in Europe in the first quarter, 2019–2020 [89].

Country	Q1 2020	Q1 2019	% Change
Austria	3623	3030	19.6
Belgium	7691	4203	83.0
Cyprus	4	5	−20.0
Czech Republic	1320	197	570.1
Denmark	4159	2228	86.7
Estonia	65	21	209.5
Finland	4560	1809	152.1
France	35,383	14,503	144.0
Germany	52,449	23,326	124.9
Greece	159	97	63.9
Hungary	1004	613	63.8
Ireland	2687	2051	31.0
Italy	8350	2266	268.5
Latvia	66	25	164.0
Lithuania	87	44	97.7
Luxembourg	790	-	-
Netherlands	11,971	10,344	15.7
Poland	1278	634	101.6
Portugal	4777	3050	56.6
Romania	271	213	27.2
Slovakia	324	106	205.7
Slovenia	387	197	96.4
Spain	7254	4482	61.8
Sweden	18,473	9837	87.8
European Union	16,7132	83,281	100.7

The largest increase in sales of electric cars at the turn of 2019/2020 was recorded in the Czech Republic (570.1%), Italy (268.5%), and Estonia (209.5%). The rate is closed by the Netherlands (15.7%) and Cyprus, where sales decreased by 20%. Compared to other European Union countries, Poland is in the middle position, with an increase of 100.1%. This confirms the upward trend in sales of electric cars in Poland.

5. Discussion

Inadequate urban infrastructure, often incorrect distribution of car traffic in the city, and concentration of activities mainly in urban areas do not help in reducing excessive GHG emission, which is the source of road transport. Furthermore, the growing number of cars travelling on the road increases GHG emission to the air. The number of cars and the number of kilometres they drive is growing so fast that the implemented legal solutions that impose higher ecological standards on car manufacturers, aimed at reducing CO_2 emission, are not able to stop the growth of GHG emission. The increase in congestion on the roads affects the security risk and the increase in time needed for travel as well as the rising cost of transporting people and goods. Therefore, it is so important to make investments to reduce GHG emission caused by road transport.

Due to its location in Central Europe, Poland is expanding its infrastructure thanks to the use of funds from the cohesion policy. Despite the significant improvement in the quality and quantity of road infrastructure, much remains to be done and more so since the number

of cars on Polish roads is growing every year. Old and non-ecological cars dominate, largely contributing to the excessive emission of harmful substances and greenhouse gases into the air. Due to the higher age of cars (the average age in Poland in 2018 is 14.1 years) and the lower share of electric and hybrid cars (Table 2), the shares of pollutants in particular harmful substances are higher than in most EU countries (Tables 3 and 4). Another negative aspect of road transport is noise, which negatively affects our health, including irritability, sleep disturbances, negative effects on the cardiovascular and metabolic systems, and cognitive impairment in children.

In this context, various policy measures (e.g., Directive 2008/50/EC, 2016/2284) and standards (e.g., Euro 6D ISC-FCM) are being introduced at the international level to improve the accessibility of transport options for people and businesses while mitigating the negative environmental impact. Environmental awareness of climate change is growing. This translates into slow but steady growth, for example, in the electric car market in Poland.

Although it is still in the growth phase, it undoubtedly has great development opportunities ahead of it. More and more attention is also being paid to the issue of greener transport in cities. Shaping and strengthening the ecological awareness of the inhabitants of Poland is of key importance for the implementation of environmental protection standards. An example of this type of solution is the exclusion of city centres for cars that do not meet the current emission standards, encouraging residents to use car-sharing services, preferential parking rates for electric cars, or replacing the bus fleet with electric vehicles, as well as other amenities and discounts for the use of public transport.

6. Conclusions

In the era of global market and very high competition, no production plant can afford to use inefficient and above all environmentally harmful technology [90]. Contemporary pursuit of a significant reduction in pollution emissions forces modern industry to constantly improve [91], which contributes to obtaining products of very good quality, which are created using less energy.

The rapid development of urban areas in Poland, especially over the last 30 years, is partly related to errors in spatial planning, including the organization of transport infrastructure. The main problems on Polish roads, largely located in urban areas, are the excessive number of vehicles on the road, including cars older than 10 years; ones not meeting the ecological standards that must be met by currently produced cars; maladjustment of the road network, including the lack of an adequate number of parking lots (e.g., at interchanges), bridges, bypasses, ITS solutions—Intelligent Transportation Systems (IT systems for traffic management e.g., vehicle traffic monitoring and supervision system, parking management system, management system street lighting, etc.),; and organizational maladjustment related to the city's transport system (e.g., increasing traffic congestion, bottlenecks forming traffic jams, load on transport infrastructure, low capacity of urban road systems), etc.

Directives of the European Parliament and the Council on the development of alternative fuel infrastructure imposes an obligation on member states to develop alternative fuel infrastructure. However, the barrier to buying electric cars is their high price, so for now, electric passenger cars are not driven much in Poland. Various incentives and subsidies being introduced as well as the development of charging infrastructure in the coming years may change this situation. It should be emphasized that the development of electromobility in the country, which bases electricity generation almost 80% on coal, only causes GHG emission to be shifted from city centres and from other places characterized by heavy traffic to coal power plants. Therefore, to obtain an ecological effect, it is necessary to develop low-emission methods of energy production, including renewable ones. The development of electromobility in Poland has a positive effect on the reduction of harmful dusts and gases that are emitted by old and non-ecological cars.

It is also necessary to introduce restrictions on entry to the centres of large cities of old and non-ecological cars, as is the case, for example, in Berlin. Polish cities create restricted car traffic zones in city centres, but there are no regulations prohibiting the entry of cars that do not meet current environmental standards into their centres. National authorities should also limit private transport traffic to broadly understood public transport.

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