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Alternative Fuels and Their Impact on Reducing Pollution of the Natural Environment

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1. Introduction

Climate policy pursued by the European Union, aims to limit climate change and strongly affects the transport industry through i.a. among others reduction of greenhouse gas emissions (Ministry of Energy 2016, Bauer et al. 2014). According to the estimates of the European Environment Agency in 2015, the transport industry, including urban transport and municipal services, accounted for over 25% of greenhouse gas emissions in the entire European Union (European Environment Agency 2018). A large share in CO_2 emissions is due to urban transport which accounts for 25% of gas emissions in total transport. The European Union guidelines, recorded in the White Paper of Transport in 2011 relate to pollution reduction and efficiency improvement in transport. Moreover, they focus on increasing the importance of public transport and reducing the role of oil-derived fuels for alternative fuels (Müller-Hellmann 2001), (Jacyna et al. 2015).

According to the adopted transport policy, by 2030, greenhouse gas emissions should be reduced to 20% in relation to 2008 and carbon dioxide emissions by approx. 60% compared to data from 1990. This goal should be achieved by a 50% reduction of conventional vehicles in urban transport and their elimination in the perspective of 2050 (European Commission 2011).

The objective of low-emission transport is to be supported among other things by implementing solutions provided for in the European Parliament Directive on the development of alternative fuels infrastructure, aimed at increasing the availability of infrastructure and amending the Directive 2009/33/EC on the promotion of ecologically clean and energy-saving road transport vehicles (Polish Alternative Fuels Association 2018).

2. Analysis of the alternative fuels market

The growing need to reduce dependence on imports and declining oil resources are the main factors increasing the growth of the global alternative fuels market. In addition, these factors affect energy companies and national governments in increasing investment in the alternative fuels market.

Alternative mobility solutions improve fuel supply security while opening the way for improved sustainability. Alternative fuels have significant advantages in reducing greenhouse gas emissions and pollution. In addition, they help reduce dependence on the use of fossil fuels in the transport sector.

Pursuant to Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the development of alternative fuels infrastructure, alternative fuels are fuels or energy sources that serve, at least partially, as a substitute for crude oil sources of energy in transport and which can potentially contribute to the decarbonisation of transport and the improvement of the environmental performance of the transport sector. These include, but are not limited to: electricity, hydrogen, biofuels as defined in art. 2 (i) Directive 2009/28/EC, synthetic and paraffin fuels, natural gas, including biomethane, in gaseous form (compressed natural gas - CNG) and in liquid form (liquefied natural gas – LNG), and liquid gas (LPG), (European Parliament 2014).

The transition from petroleum fuels to alternative fuels requires a change in fuel infrastructure, as most alternative fuels are not drop-in fuels (e.g. electricity, CNG, LNG, ethanol, hydrogen).

In the coming years alternative fuels will play a very important role in the development of the transport sector around the world, including in European Union countries. One of the key objectives of the EU is that alternative fuels become a widely available substitute for fossil fuels. Thanks

to the popularization of alternative fuels, it will be possible to achieve the benefits of reducing harmful emissions to the atmosphere, increase energy security through diversification of raw materials supply as well as obtain socio-economic benefits, including the creation of thousands of new jobs (Brooke 2010), (Pyza & Ziembicki 2016), (van Haaren 2011).

One of the most widely used varieties of alternative fuels is CNG, i.e. compressed natural gas, whose energy value of 1 m^3 is equal to 1 liter of gasoline. It is used primarily as a high octane fuel in internal combustion engines. CNG is a low-emission fuel that is an alternative to conventional car fuels, yet still clearly cheaper than them. Its ecological values are also connected with lower noise emission accompanying the combustion of CNG and hat is more, its use is safer than eg gasoline, as it has a higher lower explosion limit.

LNG (Liquefied Natural Gas) is also a fuel that is becoming more and more important in transport. LNG can be used both in liquefied form, mainly in means of transport, offering i. a. higher octane number than conventional fuels, as well as in the volatile form after being subject to regasification, eg as a network gas, or in areas outside the reach of gas distribution network. LNG as motor fuel has similar properties as CNG, combining ecological and economic values. This allows for a significant reduction of pollutant and noise emissions as well as a reduction in fuel purchase costs. Currently, the share of LNG in the global gas trade is over 25% (Energy Information Administration 2018).

LPG (Liquefied Petroleum Gas) is a mixture of propane and butane, which is obtained in the refining of crude oil and at the stage of oil production. LPG is widely used in transport, primarily in passenger cars, as motor fuel with an octane number of 90-120. In comparison to conventional fuels, LPG combustion results in significantly lower exhaust emissions, although it is usually associated with higher consumption (10-20%).

Hybrid systems combine two vehicle propulsion systems and usually consist of a gasoline engine that works in conjunction with an electric one. The use of such a system allows to reduce exhaust emissions up to 50% and significantly reduce noise. Although hybrid drives have been operating on a larger scale for around 20 years, when the Toyota Prius model hit the market, their popularity is limited, mainly due to the much higher price of vehicles available on the market. It should also be remembered that hybrid vehicles continue to use traditional fuels, so their

impact on reducing exhaust emissions is more limited than in the case of other types of alternative fuels.

Currently, one of the main and most widely promoted directions of automotive industry development is the electric vehicle segment, in which almost all leading manufacturers offer models of this type of vehicles. The use of electricity allows for low operating costs with low emissivity, depending on the source of energy.

Motor drives based on electrochemical fuel cells using hydrogen are relatively low-tech technology in the automotive industry. Due to insufficient level of advancement and costs, this technology has not been used on a mass scale so far. Hydrogen is defined in the long term as fuel of the future. It is renewable and at the same time ecological fuel. The market is in a very early stage of development and it was not until 2004 that the Japanese concern Toyota introduced the first serial vehicle powered by a hydrogen fuel cell, under the name Toyota Mirai.

The increasing demand for alternative fuels applies to several segments: passenger cars, vans, vehicles used in public transport and those used by municipal services. The degree of development of the electric car market in Europe varies significantly from country to country. The development of the electric car market is also evident in public transport and in transport used by municipal services. The share of individual fuels for passenger cars in individual EU countries in 2015 is shown in Figure 1.

The share of passenger electric cars powered by electricity in the European Union countries is at the level of 0.00%-0.4% of the total number of vehicles. The smallest share of personal electric cars in circulation may be observed in Greece, Poland, Romania, Slovakia and Slovenia. The largest share, however, occurs in the Netherlands and the United Kingdom. In the area of personal hybrid cars, their market share is at 0.00%-2.3%. The smallest share can be noted for Slovakia and Slovenia, while the largest for the Netherlands (2.3%). Among the European countries belonging to and not belonging to the European Union, the greatest development of electromobility has been noticed in Norway. The share of personal electric cars (battery powered and hybrids) is 23.63%.

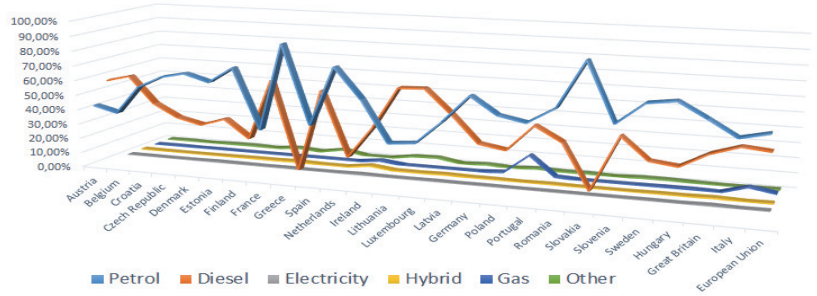

Fig. 1. Share of individual fuels for passenger cars in individual EU countries in 2015
Rys. 1. Udział poszczególnych rodzajów paliw dla samochodów osobowych w poszczególnych krajach Unii Europejskiej w roku 2015
Source: own study based on data from ACEA Report: Vehicles in use – Europe 2017.

The largest share of passenger cars fueled by gas can be noted in Poland (14.4%), Italy (5%) and the Netherlands (almost 2%), while the smallest share is in Croatia, Denmark, Estonia, Spain, Ireland and the United Kingdom (0, 00%). The countries with the highest share of other alternative fuels used in passenger cars are Greece (3.1%), Lithuania (2.9%), Ireland (2.5%), Finland (1.7%), and Poland and Latvia (about 1%).

The share of individual fuels for trucks and buses in individual EU countries in 2015 is shown in Figure 2.

The largest share of heavy electric cars and electric buses can be observed in Italy (1.9%), while the smallest is in Croatia, the Czech Republic, Finland, Greece, Latvia, Romania, Slovakia and Slovenia (close to 0.00%). Poland's share in the use of trucks and electric buses (including the hybrid) is at 0.01%. The average value for the European Union is low - the share of electric trucks and buses is at 0.3%, while hybrid ones at 0.04%. On the other hand, the use of gas in trucks and buses has the highest share in Slovenia (over 11%), Sweden (2.5%) and the Netherlands (1%). The largest share in the use of other alternative fuels can be noted for Greece (44%), while the smallest share for Austria, Croatia, Spain, Germany, Slovakia, Hungary or Italy (close to 0.00%).

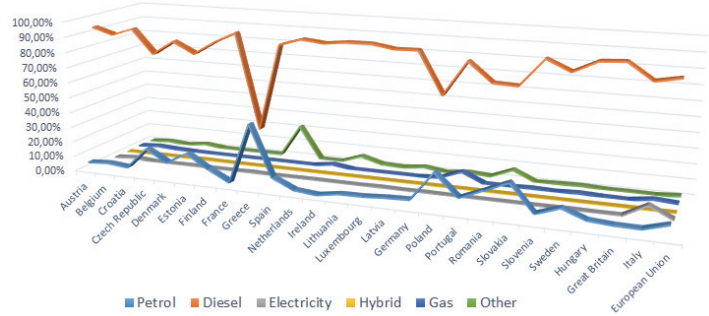

Fig. 2. Share of individual fuels for trucks and buses in individual EU countries in 2015
Rys. 2. Udział poszczególnych rodzajów paliw dla samochodów ciężarowych I autobusów w poszczególnych krajach Unii Europejskiej w roku 2015
Source: own study based on data from ACEA Report:
Vehicles in use – Europe 2017.

3. Pollution of the natural environment in the aspect of means of transport

The quality of the natural environment is an important factor affecting societies and thus indirectly affecting economic development (Ambroziak et al. 2014). Transport, which stimulates economic and social development, contributes to environmental pollution at the same time. Particularly high air pollution is caused by road transport, the share of which in transport of cargoes in 2016 was 85.2%, while in transport work it was 78.7%. A similar situation occurs in passenger transport, whose share in passenger transport amounted to 56.2%, while in passenger-kilometers it was 35.4%.

The presented data and the specificity of road transport, indicate the need to implement pro-ecological solutions in this branch of transport.

Air pollution from road transport depends on many factors. These include: the type of fuel, the type and basic features of the vehicle, the condition of the infrastructure, the vehicle's driving speed, the location of congestion, etc. (Ambroziak et al. 2014, Gołda & Zieja 2015, Jacyna et al. 2015, Jacyna-Gołda et al. 2016, Jacyna-Gołda et al. 2014, Pyza et al. 2017, Zieja et al. 2017).

The measure of air pollution is the degree of emission and concentration of individual primary pollutants, i.e. harmful exhaust gas compounds generated during driving. Among them there are: nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), lead (Pb) and solid particles (PM10) and (PM2,5) as well as dust and soot. Data from the Central Statistical Office show that road transport is responsible for more than 28% of the total emission of nitrogen oxides (NO_x), more than 27% of carbon monoxide (CO) emissions and more than 15% of dusts.

A much larger share of road transport and public transport in the emission of pollutants into the environment occurs in large urban agglomerations, especially well-developed cities and in city centers heavily burdened with traffic (Pyza et al. 2017).

Within the European Union, a European standard for exhaust emissions has been introduced for all new cars. The introduction of the EURO standard limits the emission of several of the most important harmful exhaust components – nitrogen oxides (NO_x), hydrocarbons (HC), carbon oxides (CO) and particulate matter (PM). Tables 1-2 show emission limit values for new vehicles with different engine types. Vehicles that do not meet the following standards are classified in the EURO 0 standard.

Table 1. Emission limit values from vehicles powered by gasoline, natural gas or LPG

Tabela 1. Graniczne wartości emisji pochodzącej z pojazdów zasilanych benzyną, gazem ziemnym lub gazem płynnym

Standard	CO [g/km]	HC [g/km]	NO_x [g/km]	HC + NO_x [g/km]	PM [g/km]
EURO 1	2.72	–	–	0.97	–
EURO 2	2.20	–	–	0.5	–
EURO 3	2.30	0.20	0.15	–	–
EURO 4	1.00	0.10	0.08	–	–
EURO 5	1.00	0.10	0.06	–	0.005
EURO 6	1.00	0.10	0.06	–	0.005

Source: own development based on (Regulation (EC) No 715/2007)

Table 2. Limit values for emissions from vehicles equipped with diesel engines
Tabela 2. Graniczne wartości emisji pochodzącej z pojazdów wyposażonych w silniki diesel

Norma	CO [g/km]	HC [g/km]	NO_x [g/km]	HC + NO_x [g/km]	PM [g/km]
EURO 1	3.16	–	–	1.13	0.14
EURO 2	1.00	0.15	0.55	0.70	0.08
EURO 3	0.64	0.06	0.50	0.56	0.05
EURO 4	0.50	0.05	0.25	0.30	–
EURO 5	0.50	0.05	0.18	0.23	0.005
EURO 6	0.50	0.09	0.08	0.17	0.005

Source: own development based on (Regulation (EC) No 715/2007)

Limiting the negative impact of transport on the environment and the local community requires undertaking two types of actions. On the one hand, these are activities promoting the use of ecological forms of transport, including means of transport, and on the other hand aimed at limiting traffic in areas with high saturation of means of transport.

Pro-ecological activities may have both local and national range. Activities on a national scale are regulations, among others in the area of lower road tolls for vehicles meeting higher emission standards and promoting the use of alternative fuels in transport.

In the field of local activities, it is necessary to distinguish aimed at limiting traffic in urban areas for vehicles fueled with traditional fuels, which is undertaken in some of European cities, including Poland. The development of vehicles fueled with alternative fuels significantly affects the reduction of air pollution, and in some cases noise. These vehicles use alternative fuels in relation to petrol and diesel.

The development of vehicles powered with alternative fuels is dynamic, especially in highly developed countries, which contributes to the improvement of the air condition. Poland, as a member of the European Union, also promotes this direction of motorization development by undertaking various types of activities, among others legislative. Following the Directive of the European Parliament and the Council 2014/94/EU on October 22, 2014 on the development of alternative fuels infrastructure, the Polish government has prepared the Act on electromobility and alternative fuels, which was adopted on January 11, 2018.

An important area that has an impact on reducing environmental pollution is electromobility, dynamically developing in European countries. The development of electromobility in Europe is stimulated by various incentives for electric car buyers. In most cases, they take the form of tax incentives (reductions or reliefs), often also in the form of direct surcharges to purchase vehicles. The types of incentives in selected European countries are presented in Table 3. The incentives vary depending on the country and they are (PwC Polska Sp. z o.o., 2017):

- Surcharges to purchase:
  - Austria: companies can receive a surcharge: up to EUR 1 500 for an electric vehicle and EUR 750 for a plug-in hybrid,
  - Germany: a surcharge program for the purchase of 400,000 vehicles: for electric vehicles up to EUR 4,000 and for hybrids up to EUR 3,000, wherein the price of a vehicle may not exceed EUR 60,000. The program lasts until 2020.
  - United Kingdom: surcharges for the purchase of electric vehicles and hybrids (plug-in). Vehicles with emissivity below 50 g CO_2/km and a range of over 70 miles may receive co-financing covering 35% of the cost of purchasing a passenger vehicle, up to GBP 4,500 or GBP 25,000 (depending on the vehicle category) and 20% of the purchase cost of the van vehicle, but not more than 8,000 GBP. Hybrid vehicles with a range of less than 70 miles and CO_2 emissions of 50-75 g/km can receive a purchase grant of GBP 2 500 (if the price of the vehicle does not exceed GBP 60,000).
- Reductions in registration fees relate to the exemption from the registration fee.
- Relief in fees/taxes borne by the owner:
  - Austria: exemption from car tax for electric passenger cars, the amount of which depends on the engine capacity,
  - Germany: exemption from car tax for electric cars for 10 years, period counted from the date of registration,
  - Norway: exemption from the tax on the purchase of an electric vehicle (which also means an exemption from import tax) and concessions for a hybrid vehicle (up to EUR 10,000),
  - United Kingdom: exemption from road tax.

- Additional tax/fees reliefs paid by enterprises:
  - Germany: limitation of unfavorable taxation of income from using a company vehicle for private purposes based on the price of an electric car,
  - Norway: a tax on electric company cars reduced by half
  - United Kingdom: excise duty exemption for electric cars and some hybrid cars. Exemption from corporate income tax, calculated on the basis of CO_2 emissions.
- Discounts in VAT apply to Norway and include the exemption from 25% VAT when leasing an electric vehicle.
- Other reliefs of a financial nature:
  - Austria: exemption from the CO_2 emission fee levied by companies when using a company car for private purposes,
  - Norway: exemption from annual toll for cars for electric cars,
  - United Kingdom: zero tax on electric cars.
- Discounts granted locally, e.g. in municipalities:
  - Austria: free parking,
  - Germany: free parking, separate parking spaces, the possibility of using bus lanes,
  - Norway: exemption from tolls for urban roads – urban toll, free parking, possibility of using bus lanes, free charging stations – 3,200 stations in office buildings, shopping centers and car parks,
  - Great Britain: in London, electric cars are exempt from road tolls, in some districts, their owners pay lower parking fees.
- Payments for investments in infrastructure:
  - Austria: co-financing for the construction of charging station installations intended for commercial use,
  - Germany: co-financing for the construction of a charging station (program value is EUR 300 million),
  - Norway: co-financing for the construction of fast charging stations, located every 50 km on the main roads.
  - United Kingdom: 500 GBP surcharge to cover the cost of installing electric car charging stations in homes.

Table 3. Catalog of incentives for buyers of electric cars used in selected European countries
Tabela 3. Katalog zachęt dla nabywców samochodów elektrycznych stosowanych w wybranych krajach europejskich

Type of incentive	Country			
	Austria	Germany	Norway	Great Britain
Subsidies for purchase	YES	YES	NO	YES
Discounts in registration fees	YES	NO	YES	YES
Relief in fees/taxes paid by the owner	YES	YES	YES	YES
Additional tax reliefs/fees paid by enterprises	NO	YES	YES	YES
Discounts in VAT	NO	NO	TAK	NO
Other financial relief	YES	NO	YES	YES
Discounts granted locally, e.g. in municipalities	YES	YES	YES	YES
Surcharge for investment in infrastructure	YES	YES	YES	YES

Source: own development based on (Rozwój elektromobilności w Polsce, Opracowanie PwC Polska Sp. z o.o., 2017)

Another area where solutions that reduce the emission of harmful compounds or noise should be sought for, is public transport. CNG installations are often used for public transport buses, but you can also point to examples of using electric and hybrid drives (London, Chicago, San Francisco, Rome, Warsaw, Krakow). All these activities are aimed at reducing emissions of compounds harmful to the environment, but they require not only legislative measures, but also financial support and actions aimed at public awareness in this area.

4. Environmental research in the field of using alternative fuels

Despite various types of activities supporting the development of alternative fuels, in subsequent years the main type of drive used in cars will remain gasoline engines and diesel engines. Nevertheless, their share will steadily decline in favor of vehicles powered by alternative energy sources.

In 2016, 15,982 electric vehicles were registered in Poland. Passenger cars accounted for 91.42% of this value, 6.44% heavy goods vehicles, 0.38% truck tractors, 1.14% buses, and special cars 0.62%.

According to the Electromobility Development Plan in Poland, by 2025, a million electric vehicles are to travel on Polish roads, which is supposed to drive the expansion of innovative industry. In addition, the replacement of combustion cars with electric cars should reduce the emission of harmful compounds both in the corridors of the TEN-T base network as well as locally in the area of cities and urban agglomerations.

The studies on the environmental effects of the development of electric vehicles in Poland in relation to air pollution were carried out taking into account their development forecasts until 2025.

Three scenarios for the development of electric vehicles were assumed in the analyzes: aggressive, moderate and conservative. It was assumed that the base year for analysis is 2025. In the aggressive scenario for the base year, an achievement of $LP_{2025}^{aggressive} = 1\,000\,000$ electric vehicles was assumed, in the moderate scenario, it was assumed to reach fifty percent of the number of electric vehicles for the base year of the aggressive scenario $Lp_{2025}^{moderate} = 50\% LP_{2025}^{aggressive}$, while in the conservative scenario, it was assumed to achieve twenty-five percent of the number of electric vehicles of the base year of the aggressive scenario $Lp_{2025}^{conservative} = 25\% LP_{2025}^{aggressive}$. Taking into account the number of registered electric vehicles in 2016 and adopted development scenarios, forecasts of the number of electric vehicles in particular years were estimated using the exponential regression function (Figure 3). The values of the regression function were estimated using a Microsoft Excel spreadsheet. Expression regression models have the form:

- Aggressive scenario

$$y = 715{,}54e^{0{,}8047x} \tag{1}$$

- Moderate scenario

$$y = 780{,}3e^{0{,}7181x} \tag{2}$$

- Conservative scenario

$$y = 850{,}93e^{0{,}6314x} \tag{3}$$

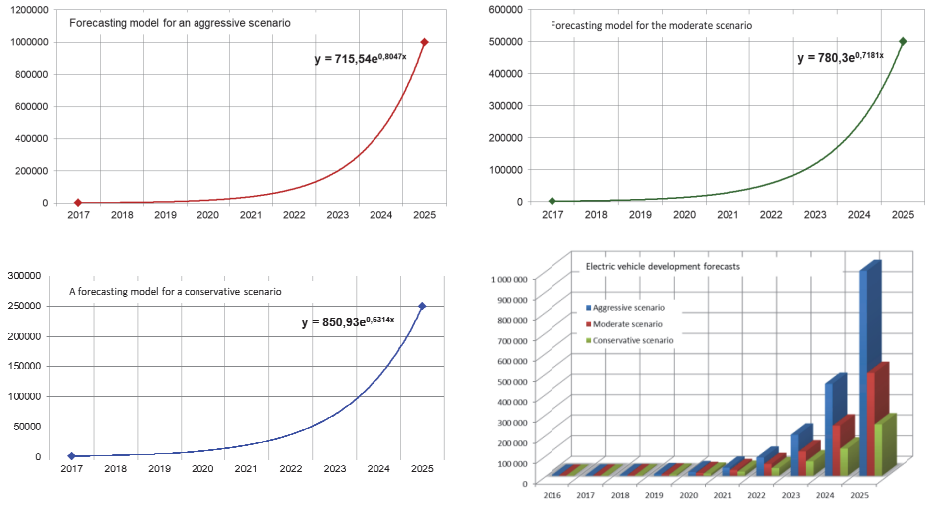

Fig. 3 Electric vehicle development forecasts in Poland together with forecasting models
Rys. 3 Prognozy rozwoju pojazdów elektrycznych w Polsce wraz z modelami prognostycznymi
Source: own development

It should be assumed that with the development of electromobility there will be a systematic reduction of the number of vehicles powered by petrol and diesel. The developed forecasts for three scenarios for the development of electric vehicles have been used in further studies for analyses related to the reduction of the emission of pollutants.

As part of the analysis, it was estimated to what extent the increase in the number of electric vehicles for the three development scenarios will translate into the volume of pollutant emissions from the transport sector. The limit values of emissions from petrol-powered vehicles and from vehicles equipped with diesel engines were adopted for the analyzes (Tables 1-2).

The analyses were carried out according to the following procedure:

- Estimation of the number of electric vehicles for particular years, using exponential regression models,
- Estimation of the number of vehicles, which will be reduced as a result of the development of electromobility, powered by petrol and equipped with

diesel engines. The following vehicle shares are assumed: 78.4% – gasoline-powered vehicles, 21.6% – vehicles equipped with diesel engines,
- Estimation of the annual mileage of vehicles in total, assumed the average annual mileage of the vehicle at 13 700 km,
- Estimation for individual types of vehicles (petrol-powered and diesel-powered) vehicle share structures with specific EURO standards,
- Estimation of the annual mileage of vehicles for individual EURO standards,
- Taking into account the annual mileage of vehicles for individual EURO standards and the limit values of emissions from petrol-powered vehicles and diesel engines, estimation of emission limits for individual pollutants.

The analysis refers to three pollution compounds, which are nitrogen oxides (NOx), carbon oxides (CO) and solid particles (PM). Analyzes in the scope of limiting the emissions of pollutants from the transport sector for three scenarios for the development of electric vehicles in Poland are shown in Figure 4.

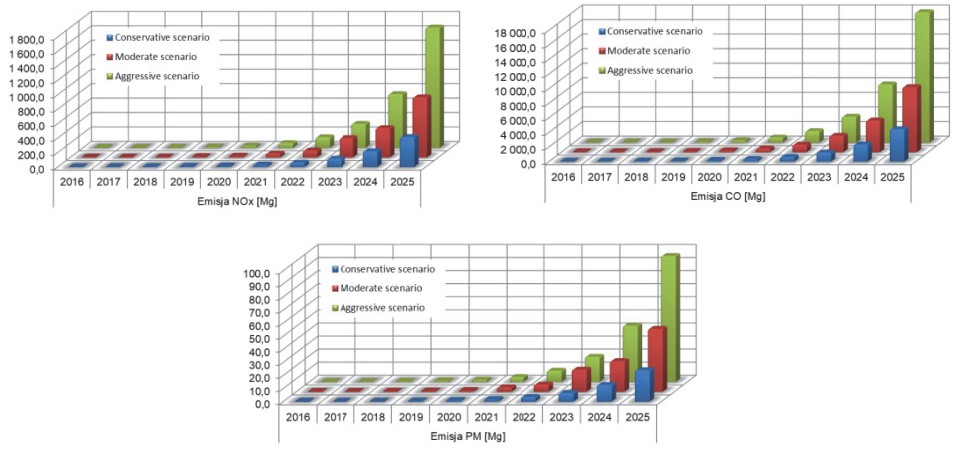

Fig. 4. Restrictions on the emission of pollutants from the transport sector for three scenarios for the development of electric vehicles by 2025
Rys. 4. Ograniczenia wielkości emisji zanieczyszczeń z sektora transportu dla trzech scenariuszy rozwoju pojazdów elektrycznych do roku 2025
Source: own development

The analysis carried out for three development scenarios of electric vehicles by 2025 showed that the limitations on the volume of pollutant emissions from the transport sector are growing exponentially. Due to the specifics of electric vehicles, it should be assumed that in the initial period of electromobility development, the largest pollutant emission limitations will occur in cities and urban agglomerations, smaller in the corridors of the TEN-T base network and other public roads. Due to the gradual development of charging infrastructure for electric vehicles, it is expected that these proportions will change in the perspective of further development of electromobility.

5. Conclusions

The development of electromobility is a priority of the European Union, which translates into a series of activities promoting and supporting this area of transport. Also in Poland, this area of transport is widely promoted, which should bring in the next years a number of tangible benefits both in terms of reducing environmental pollution and the development of innovative industry.

The research shows that the limitations in environmental pollution in the first years of implementing electromobility in Poland will be small, which is related to the low number of electric vehicles and the slow persuasion of vehicle users to this type of vehicle. A significant increase in environmental pollution restrictions should take place in the following years, together with a dynamic increase in the number of electric vehicles, this increase will be in exponential mode and for example for carbon monoxide the limit in 2025 will be: for aggressive scenario 17,899.1 Mg, moderate 8,960.6 Mg, conservative 4,469.9 Mg.

The development of electromobility will occur in two areas, the first is the development of electric vehicles in individual transport, the second concerns public transport and electric buses, an example of which is the government e-bus program under which actions aimed at purchasing electric buses by local government will be supported.

Electromobility and the development of alternative fuels are activities that effectively affect the natural environment, which requires support under various sectoral programs. These are activities that contribute to environmental protection not only on a local or continental scale, but also globally.

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Paliwa alternatywne i ich wpływ na ograniczenie zanieczyszczenia środowiska naturalnego

Streszczenie

W pracy odniesiono się do zagadnienia ochrony środowiska w aspekcie rozwoju paliw alternatywnych. Zgodnie z Dyrektywą Parlamentu Europejskiego i Rady 2014/94/UE z dnia 22 października 2014 r. w sprawie rozwoju infrastruktury paliw alternatywnych, paliwa alternatywne to paliwa lub źródła energii, które służą, przynajmniej częściowo, jako substytut dla pochodzących z ropy naftowej źródeł energii w transporcie i które mogą potencjalnie przyczynić się do dekarbonizacji transportu i poprawy ekologiczności sektora

transportu. W tym aspekcie dokonano analizy dokumentów normatywnych istotnych z punktu widzenia stosowania paliw alternatywnych w obszarze transportu. Odniesiono się również do obecnego stanu rynku paliw alternatywnych jak również przedstawiono perspektywy jej rozwoju. Przedstawiono problematykę zanieczyszczenia środowiska przez pojazdy samochodowe oraz wskazano na działania promujące elektromobilność w wybranych krajach europejskich. W ostatniej części pracy przedstawiono wynik badań środowiskowych w zakresie wykorzystania paliw alternatywnych w Polsce. Przedstawiono prognozy dla pojazdów elektrycznych z uwzględnieniem trzech scenariuszy ich rozwoju a następnie przy założonych warunkach brzegowych oszacowano wielkości ograniczeń emisji zanieczyszczeń z sektora transportu do roku 2025.

Abstract

The paper refers to the issue of environmental protection in the aspect of the development of alternative fuels. Pursuant to Directive 2014/94 / EU of the European Parliament and of the Council of 22 October 2014 on the development of alternative fuels infrastructure, alternative fuels are fuels or energy sources that serve, at least partially, as a substitute for crude oil sources of energy in transport and which can potentially contribute to the decarbonisation of transport and the improvement of the environmental performance of the transport sector. In this aspect, the analysis of normative documents relevant to the use of alternative fuels in the area of transport was made. Reference was also made to the current state of the alternative fuels market as well as prospects for its development. The problems of environmental pollution by motor vehicles were presented and actions promoting electromobility in selected European countries were pointed out. The last part of the work presents the result of environmental research on the use of alternative fuels in Poland. The forecasts for electric vehicles are presented, taking into account three scenarios of their development and then, with the assumed boundary conditions, the values of pollutant emission limitations from the transport sector were estimated until 2025.

Słowa kluczowe:
elektromobilność, paliwa alternatywne, ochrona środowiska

Keywords:
electromobility, alternative fuels, environmental protection