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Analysis of the Objectives of the EU's New Climate and Transport Policy - An Attempt to Identify the Most Significant Challenges for Companies from the Polish Road Transport Sector

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Abstract:

Purpose: *The main objective of the study is to analyze the goals and initiatives of the EU in the field of climate and transport policy, with an emphasis on how these two policies intersect. Through these considerations, the authors attempted to identify and analyze the most important challenges currently faced by companies operating in the Polish road transport sector.*
Design/Methodology/Approach: *The study utilized secondary information sources, mainly available literature on the subject, statistical data from industry reports, and databases from GUS and EUROSTAT. The descriptive statistics method was applied, mainly tabular, graphical, and parametric description of the statistical population, with elements of statistical inference.*
Findings: *The new EU policy imposes a series of requirements on transport sector companies that can affect their competitiveness. Particularly important are requirements related to CO2 emissions reduction, promotion of low-emission transport, and adaptation of infrastructure to new technologies.*
Practical Implications: *For Polish companies, the key will be finding a balance between meeting environmental requirements and maintaining market competitiveness.*
Originality/Value: *Ambitious goals related to emissions reduction and increased energy efficiency offer new opportunities for innovation and modernization. However, implementing these objectives requires significant capital and time investments, which can be a barrier, especially for small and medium-sized enterprises.*

Keywords: *Climate policy, road transport, transport policyscenario analysis, decarbonisation, emission of CO2.*

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1. Introduction

The European Union (EU) has been a pioneer in global climate protection efforts for years. It is committed to dynamic policy transformations aimed at achieving carbon neutrality by the mid-21st century. In this context, both the EU's climate and transport policies play a crucial role in shaping sustainable environmental changes. Transport is one of the main sources of greenhouse gas emissions in Europe, and at the same time, it is a vital component of the economy that connects people, goods, and services. Therefore, an integrated approach to these two policy areas is purposeful.

Over recent decades, global concern about the state of the natural environment, as well as its dynamic changes, has led to intense interest in many aspects of human activity. One sector significantly impacting the environment is road transport. Its increasing contribution to greenhouse gas emissions, air pollution production, and other adverse effects on the environment and human health has made it the subject of numerous studies and analyses.

Road transport plays a pivotal role in the Polish economy, serving not only as an essential economic sector but also as the foundation for other industries' operation. The formation and development of this sector are the result of not only investments and actions taken by enterprises but also external factors such as changes in the law, technologies, or global economic trends. Given the dynamic transformations both in the country and globally, road transport enterprises face many challenges. Understanding their nature and scope is crucial for the industry's further development and for making effective business decisions by its representatives.

This article concludes a publication series undertaken within the research project entitled "Readiness of the Polish road transport sector for decarbonization and new challenges related to the EU climate policy." The deliberations presented in previous scientific papers concerning the analysis of the state of the road transport means structure in Poland in the context of emission issues and the transition to sustainable mobility, applying selected elements of optimization theory tools, as well as projections of future possible scenarios considering the technological, economic, socio-demographic, political-legal environment in three-time horizons, provide an excellent supplement and aid in better understanding the inquiries made here (Pyra, 2023).

The main aim of the paper is to analyze the EU's objectives and initiatives in the areas of climate and transport policies, emphasizing how these two policies interrelate. Through these considerations, the authors have attempted to identify and analyze the most significant challenges currently faced by companies operating in the Polish road transport sector. Hoping to provide valuable information and conclusions, they aim to contribute to the ongoing debate on sustainable development in the mobility sector and search for solutions that minimize transport's negative impact on the environment.

2. Emissivity Assumptions

Considering the fact that the gathered data does not allow for unequivocal and precise (at the level of individual data records) determination of the emissivity (class) of vehicles in the groups covered by the analysis, it was necessary to adopt certain assumptions. To approximate the emissivity structure of the analyzed road fleet, a key was developed based on emission standards (Tables below). Emission standards were introduced progressively, changing the requirements for the maximum emissivity of vehicles. This means that knowing the year of vehicle production, one can determine which emission standard its engine meets. Thus, by matching data for a specific year concerning the age structure of vehicles in a given group, using this key, one can determine the emissivity structure of the entire fleet.

Table 1. *Emission standards applicable in the EU*

Standard	Application start date	Vintages	Vehicles >3,5 DMC
EURO 1	1992	-	-
EURO 2	1997	-	-
EURO 3	2001	2000-2004	2000-2004
EURO 4	2006	2005-2009	2005-2009
EURO 5	2011	2011-2015	2009-2014
EURO 6	2014	2015-2019	2015
EURO 6c	2019	2019-2020	
EURO 6d	2021	2021	
EURO 7	2025		

Source: *Own elaboration based on https://inewi.pl/Blog/european-emission-standard-what-is-it-and-who-it-affects, accessed 20.07.2023.*

Each of the standards listed in the table above is associated with specific upper emission limits for various types of pollutants (table below). Progressively, as new emission standards were adopted, values for individual types of pollutants were reduced.

Table 1. *Emission limit values for gasoline engine standards*

		EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EURO 6	EURO 6c	EURO 6d
CO	[g/km]	2,72	2,2	2,3	1	1	1	1	1d
HC	[g/km]			0,2	0,1	0,1	0,1	0,1	0,1

Nox	[g/km]			0,15	0,08	0,06	0,06	0,068	0,068
HC+Nox	[g/km]	0,97	0,5						
PM	[g/km]					0,005	0,005	0,0045	0,0045
Solid particles							$6x10^{11}$	$6x10^{11}$	$6x10^{11}$

Source: *Own elaboration based on https://www.flotman.pl/blog/eu-co2-emissions-regulations-which-cars-will-not-be-allowed-to-sell, accessed 20.03.2023.*

Table 2. *Emission limit values for diesel engine standards*

		EURO 1	EURO 2	EURO 3	EURO 4	EURO 5	EURO 6	EURO 6c	EURO 6d
CO	[g/km]	2,72	1	0,64	0,5	0,5	0,5	0,5	0,5
HC	[g/km]								
Nox	[g/km]			0,5	0,25	0,18	0,08	0,08	0,08
HC+Nox	[g/km]	0,97	0,7	0,56	0,3	0,23	0,17	0,17	0,17
PM	[g/km]	0,14	0,08	0,05	0,025	0,005	0,005	0,045	0,045
Solid particles						6x10[11]	6x10[11]	6x10[11]	6x10[11]

Source: *Own elaboration based on https://www.flotman.pl/blog/eu-co2-emissions-regulations-which-cars-will-not-be-allowed-to-sell, accessed 20.07.2023.*

Depending on the type of fuel (gasoline, diesel), these standards present slightly different requirements for the maximum levels of various pollutants. Standards for gasoline engines differ from those for diesel engines within the same version of the requirements (standards).

For potential conversions of fleet structure to estimated total emissions, one can use very simplified and generalized requirements compared to those related to the sale of new vehicles and the average emissions of the entire sales volume. In 2020, it was 120g/km CO2 emissions, and in 2021 it was reduced to 95 g/km. However, in practice, EU law also considers the weight of the vehicles sold, which can lead to an increase in the aforementioned threshold for certain manufacturers (e.g., Daimler - 103 g/km) or a decrease (FCA - 91 g/km).

Another way of conversion may result from the analysis of the vehicle testing procedure as part of the homologation process provided for in the latest version of the EURO 6D Temp emission standard.

Alternatively, one can also use the EMEP/CORINAIR methodology along with, for example, the vehicle classification used by the European Environment Agency (Bokolo, 2023). However, this requires having a series of more detailed data that was not collected during the conducted research.

Based on Eurostat data regarding total CO2 emissions from road transport in the transport sector, data on performed transport work (GUS) and the structure of the performed transport work in terms of vehicle age, values of CO2 emitted in 2019 by different age groups of vehicles were determined (table below).

Table 3. *Structure of transport work and total CO2 emissions by vehicle age (2019)*

	Structure		Transport work [mln Tkm]	Emission [t CO2]
	[t]	[Tkm]		
0– 5 years	29,2%	50,9%	201 213,30	10 434 842,05
6–10	31,7%	27,9%	110 291,77	5 719 687,49
11–14	23,1%	15,6%	61 668,52	3 198 104,83
15–20	23,7%	4,9%	19 370,24	1 004 532,93
21–25	27,3%	0,7%	2 767,18	143 504,70

Source: *Own elaboration based on GUS and Eurostat data.*

The data allows for the conclusion that the youngest vehicles performing the most transport work are responsible for the highest emissions. This observation is very significant in the context of further simulations and calculations, as it supports the assumption that replacing the oldest and old vehicles with new ones will result in a strong and beneficial effect in the context of reducing CO2.

New, less emitting vehicles performing the most transport work means a larger scale of CO2 reduction with a relatively slow fleet replacement.

Another issue requiring the adoption of assumptions is the average emission for a vehicle powered by a given type of drive, expressed in g/Tkm. On one hand, information on the average fuel consumption of trucks can be used to attempt to determine the average CO2 emission. As press releases from industry portals indicate, burning 1 liter of gasoline results in the emission of approx. 2.3 kg of CO2, while 1 liter of diesel fuel emits 2.6 kg of CO2, and 1 liter of LPG emits 1.7 kg of CO2 (Econolgie, 2008).

Therefore, gas fuels are not completely zero-emission (Battulga, Dhakal, 2023), and thus do not provide a solution to the need for rapid CO2 emission reduction in road transport. Knowing the emission per 1 liter of fuel requires comparing it with combustion data.

This raises another problem of obtaining reliable data. While press information or information available from online truck user forums indicates average consumption levels of 25-30-40 l / 100 km and 10-15 l / 100 km for trucks with a gross vehicle weight up to 3.5t (Webfleet, 2020), these ranges are very wide. In practice, actual fuel consumption depends on many factors (e.g., road slope, wind strength, type of cargo, etc.), so determining emissions based on these estimates would be far too inaccurate.

In another approach, determining the actual CO2 emission requires a series of calculations taking into account factors such as air resistance or rolling resistance at a specified cargo weight, trailer/chassis structure, and many other factors. Specialized software (e.g., CO2MPASS; Karwas, 2018) or methodologies such as the simulation program developed by the EU – VECTO (Biro and Kiss, 2023) are used to determine these values.

The emission data obtained in one of the aforementioned ways still needs to be converted to Tkm, i.e., the transport work performed. Under current conditions (lack of public access to actual combustion data for even a fraction of operating trucks) and considering the main objective of this study, such calculations will not be performed.

In the future, when the system for reporting actual combustion and emissions (Vlieger, 1997) is fully operational and OBS data is publicly available, more detailed studies and simulations will be possible. Currently, this data is primarily collected by vehicle manufacturers to meet regulatory requirements – it is possible that they will be made publicly available at a later time.

In the context of the calculations and simulations being conducted, the data contained in the report of the European Federation for Transport and Environment AISBL, issued in October 2021, titled "Easy Ride: why EU truck CO2 targets are unfit for 2020s" seems more useful at this moment.

The report presents an analysis of preliminary data collected by the EU as part of the baseline project for reducing CO2 emission levels in transport. This refers to data collection from June 2019 to July 2020 regarding CO2 emissions for newly sold trucks. Data was collected for 9 subcategories of vehicles (Table 5).

In the group of vehicles making up the dataset for the baseline period, vehicles from the 5-HL subcategory dominated in terms of the number of vehicle registrations, accounting for just over 60% of all vehicles registered during the period in question. Given their share in the structure, they had a strong impact on the calculation of the reference CO2 emission value.

The average CO2 emission value for vehicles in the 5-HL group was 56.6 g/Tkm. Calculations naturally took into account the assumed average annual mileage and average cargo weight. Ultimately, the share of 5-LH subcategory vehicles was lower than directly indicated by the sales structure, but still significantly high compared to other subgroups.

The figure below presents data on emissions in individual subgroups.

Table 4. *Heavy-duty vehicle (HD) subgroups considered in the data set concerning CO2 emissions of newly sold vehicles during the baseline period*

Description	Group	Sub-group	Cabin type	Engine power	Annual mileage
Rigid, 4x2 axle, GVW > 16 t	4	4-UD	All	< 170 kW	60,000 km
		4-RD	Day cab	≥ 170 kW	78,000 km
			Sleeper cab	≥ 170 kW & < 265 kW	
		4-LH	Sleeper cab	≥ 265 kW	98,000 km
Tractor, 4x2 axle, GVW > 16 t	5	5-RD	Day cab	All	78,000 km
			Sleeper cab	< 265 kW	
		5-LH	Sleeper cab	≥ 265 kW	116,000 km
Rigid, 6x2 axle	9	9-RD	Day cab	All	73,000 km
		9-LH	Sleeper cab		108,000 km
Tractor, 6x2 axle	10	10-RD	Day cab	All	68,000 km
		10-LH	Sleeper cab		107,000 km

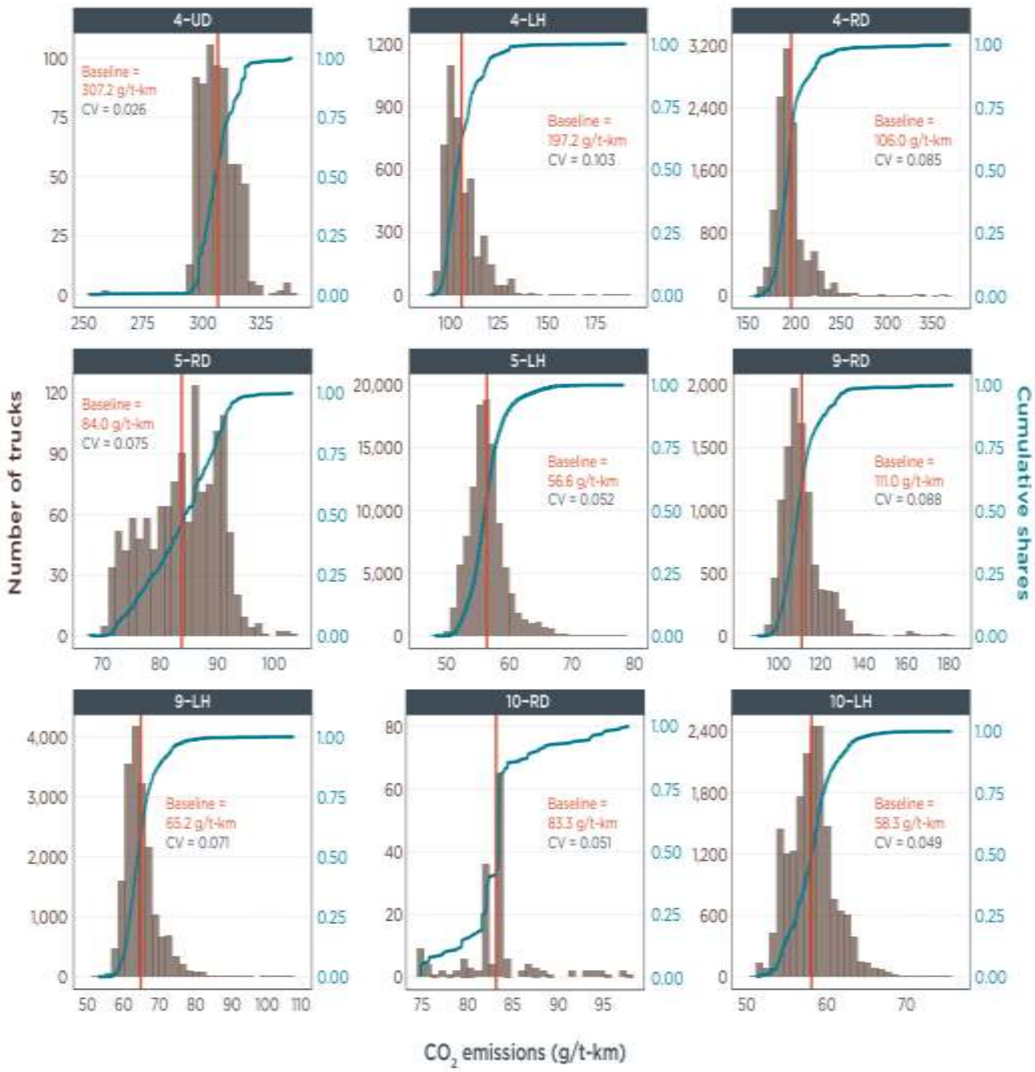
Source: *https://www.atlasevhub.com/resource/easy-ride-why-the-eu-truck-co2-targets-are-unfit-for-the-2020s, accessed 20.07.2023.*

Considering that the study involved new vehicles, type approval data was also available for them, making it possible to precisely determine fuel consumption and CO2 emissions, which were then compared with the collected data. The table below presents a summary of the average CO2 emissions for each subcategory, converted to Tkm, km, and data on average fuel consumption.

Table 6 illustrates that in reality, CO2 emissions vary significantly between individual subgroups. Considering the above, assumptions were made regarding the average CO2 emissions [g/Tkm] – the so-called emission key (table below) for vehicles according to drive, in line with the data structure related to the domestic market. The average emission value for the emission key is 52.2857 g/Tkm.

The adopted CO2 emission values per Tkm for different types of drives are essentially within the ranges resulting from the previously cited empirical data from the baseline period in the context of EU reference values. Comparing the emission values determined using the adopted indicators with the values determined based on the average CO2 emission for all vehicles covered by the 2019 study allows us to conclude that there is only a 1% error in the total value.

Figure 1. *The baseline value for each subgroup, alongside a histogram and a cumulative share plot of the distribution of the CO2 emissions around this average*



Source: *Ragon P.L., Rodriguez F. 2021. CO2 emissions from trucks in the EU: An analysis of the heavy-duty CO2 standards baseline data, ICCT 35.*

This is an acceptable error, considering that reduction targets are in the order of tens of percent. Discrepancies at the level of specific drive groups result from the way emissions were determined based on the average value, which meant determining emission values for zero-emission vehicles, and zero-emission vehicles do not generate CO2 pollutants. Moreover, the CO2 emission key values for specific drives are different than the average value determined for all vehicles.

Table 5. *CO2 emissions and fuel consumption in the baseline reporting period*

Sub-group	CO_2 emissions (gCO_2/t-km)	CO_2 emissions (gCO_2/km)	Fuel consumption (Liters/100 km)[a]
4-UD	307.2	814.1	31.1
4-RD	197.2	627.0	23.9
4-LH	106.0	786.4	30.0
5-RD	84.0	861.7	33.2
5-LH	56.6	783.5	30.0
9-RD	111.0	696.9	26.6
9-LH	65.2	873.3	33.4
10-RD	83.3	854.1	32.7
10-LH	58.3	806.5	30.8

Source: *Ragon P.L., Rodriguez F. 2021. CO2 emissions from trucks in the EU: An analysis of the heavy-duty CO2 standards baseline data, ICCT 35.*

Table 6. *Structure of HD vehicles in Poland by type of drive and baseline values for CO2 emission simulations for specific drive types (2019)*

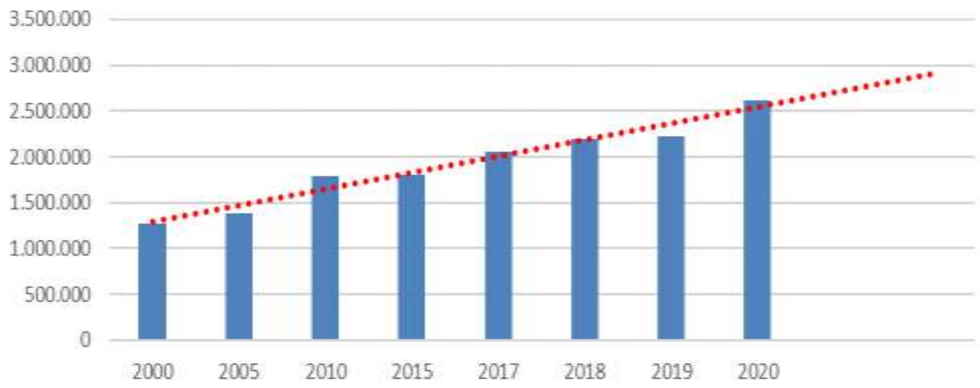
	Structure indicator	Work [Tkm]	Average emission* [t]	Designated emission [t]	Key emission [g/Tkm]
Gasoline without hybrids	15,622%	61 757	3 459 404	4 014 231	65
Hybrid gasoline	0,001%	3	166	148	50
Diesel no hybrids	70,727%	279 593	15 661 662	17 614 329	63
Diesel hybrid	0,005%	20	1 146	1 023	50
Diesel BIO	0,001%	3	172	123	40
Alternative energy	13,644%	53 935	3 021 202	0	
Bioethanol	0,000%	1	72	71	55
Electric	0,065%	256	14 335	0	
LPG	4,424%	17 488	979 597	751 976	43
CNG	0,000%	0	0	0	43
LNG	0,000%	0	0	0	43
Other	9,155%	36 190	2 027 198	0	0
			22 143 751	22 367 565	
	alternative together reduction		14 335	1%	Difference

Note: ** Previously determined – it is 56.02 g/Tkm.*
Source: *Own calculations based on GUS and Eurostat data.*

3. The Transport Sector and Automobile Transport in Poland

Based on data from the Central Statistical Office (GUS), in 2019 the Polish transport sector transported a total of 2,220,601 tons of cargo, and in 2022, 2,613,745 tons of cargo. This was an increase in the total cargo mass of 17.7 percentage points year-on-year (figure below). In comparison to 2010, this was an increase of 45.5 percentage points.

Figure 2. *Total cargo mass transported by the Polish transport sector (in total tons) in the years 2000-2020*



Source: *Own elaboration based on GUS and Eurostat data.*

Analyzing data from the Central Statistical Office (GUS) pertaining to the total weight of cargo transported by the Polish transport sector, a consistent upward trend is observed, ongoing since 2000. The average growth rate for the years 2017-2020 is about 9.9%, which means that each year about 10% more cargo weight is transported.

Focusing solely on road transport, it accounts for over 80% of the mentioned cargo weight. Based on data for the years 2017-2020, the average share of road transport in the total weight of transported cargo is 86.6%. The remaining cargo weight is transported by rail (8.4%), pipeline (2%), river (0.2%), and maritime (0.3%). Thus, road transport plays a very significant role in terms of the weight of transported cargo. From the perspective of transport work, road transport also has a very large share in the entire structure of performed transport work.

Automobile transport throughout the period 2000-2020 increased its share in the transport work performed in the entire sector. In 2010, it accounted for 214,204 million tkm, and in 2020 for 461,582 million tkm. This was therefore more than a twofold increase in transport work over a decade.

In the context of passenger transport, road transport is also a significant branch. However, the share of automobile transport in passenger transport, over the years

2000-2020, was declining in favor of other modes of transport. Based solely on the period of 2017-2020, its average share in the total number of transported passengers was 48.7%. The impact of the pandemic on 2020 data is also noticeable, in which a general decrease in the number of passengers by 45.64 percentage points year-on-year was recorded.

But it's still significant, although the downward trend persists. It can be assumed that the automobile transport of people, partly related to transport within urban and suburban communication, is the subgroup that will be most resistant to being displaced by other transport branches.

This is due to the fact that there is no substitute that does not require large investment outlays. In some cities or places, there is also no possibility for the implementation of infrastructure investments for substitute forms of transport. Therefore, it is worth mentioning the GUS data on the annual mileage of vehicles used in intercity urban communication (table below).

Table 8. *Mileage of buses in intercity communication broken down by provinces*

Province	Yearly mileage in thousands vehicle kilometers		Average mileage of 1 bus in km			
			yearly		daily	
	2019	2020	2019	2020	2019	2020
Polska	**719 621**	**415 083**	**75 171**	**67 933**	**205**	**186**
Dolnośląskie	50 708	26 862	67 020	43 508	183	119
Kujawsko-pomorskie	63 046	30 118	56 376	54 384	154	148
Lubelskie	39 069	17 411	68 100	63 106	186	172
Lubuskie	15 749	8 721	62 545	64 361	171	176
Łódzkie	35 159	27 138	51 312	50 014	140	137
Małopolskie	38 077	15 579	81 552	72 867	223	199
Mazowieckie	152 084	73 936	96 036	89 004	263	243
Opolskie	43 671	52 113	121 714	156 167	333	427
Podkarpackie	80 914	43 997	91 843	79 994	251	219
Podlaskie	32 092	16 332	76 029	56 590	208	155
Pomorskie	34 760	24 881	64 899	57 040	177	156
Śląskie	30 680	19 048	70 447	62 452	192	171
Świętokrzyskie	13 037	4 769	86 452	62 503	236	171
Warmińsko-mazurskie	14 870	6 611	72 044	60 540	197	165
Wielkopolskie	32 409	20 530	58 701	51 235	160	140
Zachodniopomorskie	43 296	27 037	72 839	61 350	199	168

Source: *GUS data on the transport sector in Poland.*

In urban communication, buses are the dominant means of transport, with approximately 12% being powered by alternative fuels or having an alternative drive system.

The data also reveals that the inventory (i.e., the numerical state of the bus fleet) is not in continuous operation 100% of the time. However, noticeably more buses with alternative drives are in operation relative to their inventory than buses with traditional drives. This means that new buses with alternative drives (with lower emissions) are used to a greater extent as soon as they are put into operation (added to the inventory).

Turning to freight transport carried out by road vehicles, a detailed analysis of the Central Statistical Office (GUS) data for the years 2019-2020 offers a very interesting observation. It turns out that the structure of the transport performed, expressed in tons of transported cargo, viewed from the perspective of the age of the vehicles that carried out the transport is very intriguing (Table 9). From the perspective of cargo weight alone, the structure seems to be very balanced and mainly consists of vehicles aged 0-14 years, supplemented by vehicles aged 15-20 years, with vehicles older than that accounting for less than 5% of the total cargo weight. In 2020, however, there is a noticeable increase in the share of vehicles aged 0-3 years to 31.7%, making them seem to dominate over the others.

Table 9. *Structure of transported cargo weight and transport work by vehicle age in 2019-2020*

Age		Total		Transport			
				commercial		economic	
		tons	t·km	tons	t·km	tons	t·km
		In percentage [%]					
Ogółem	**2019**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**
	2020	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**
0– 5	2019	29,2	50,9	31,4	52,3	23,4	38,6
	2020	31,7	54,1	33,4	55,5	27,1	41,2
6–10	2019	23,1	27,9	24,0	28,4	20,5	23,5
	2020	23,7	25,2	24,6	24,9	21,4	27,7
11–14	2019	27,3	15,6	26,0	14,7	30,9	23,9
	2020	26,6	14,4	25,7	13,9	28,9	18,7
15–20	2019	16,8	4,9	16,0	4,1	19,0	11,7
	2020	14,0	5,7	12,7	5,1	17,4	10,5
21–25	2019	3,6	0,7	2,6	0,5	6,2	2,3
	2020	4,0	0,7	3,5	0,6	5,3	1,9

Source: *GUS data on the transport sector in Poland.*

From the perspective of transport work, vehicles aged 0-5 years dominate the structure, accounting for over 50% of the entire transport workload. This is justified, as vehicles aged 0-5 years are relatively underused, hence presenting a higher level of reliability. As a result, they are perfectly suited for long-haul transportation.

Discussing transport work, which refers to the distance traveled with a load of a specific weight, is important in the context of the primary focus of this study – pollution emissions. Motor vehicles emit pollutants while on the move. Therefore, the above observation is significant as it provides a basis for the assumption that introducing new vehicles to operation will replace older ones, primarily in long-distance transport. As a result, the pollution reduction effect generated by the sector will be greater than that resulting from a change in the structure of the vehicle fleet.

According to official statistics from the Central Statistical Office (GUS), in 2019 in Poland, there were 6,990 companies, of which only 496 companies (7.09%) had 5 or fewer vehicles. On the other hand, companies with over 100 vehicles accounted for 4.04% of the total number of companies (283 companies).

Thus, the transport market belongs to medium-sized companies, owning between 6 and 49 vehicles. Data from 2020, however, shows a 1.1 percentage point year-on-year increase in the total number of companies (79 companies). Interestingly, among the companies ranging from those with the smallest fleet to those with up to 19 vehicles, there was a decrease of about 1.5 percentage points year-on-year. The number of companies with 20-49 vehicles increased by 4.4 percentage points year-on-year, in companies with 50-99 vehicles by 10.6 percentage points year-on-year, and in the largest companies with over 100 vehicles by 1.1 percentage points year-on-year.

This indicates a continuation of the market consolidation trend (Dziubak, 2020). In the context of transport decarbonization goals, this is a favorable trend, as companies with larger fleets of heavy-duty vehicles will likely be the first to introduce zero-emission vehicles into their resources.

The issue of investing in new means of transport is directly related to the financial aspect of the operations conducted by transport companies. In 2019, as reported by GUS, revenues from passenger transport by road amounted to PLN 10,396.7 million (in 2020 they fell to PLN 9,151 million – a decrease of 11.98 percentage points year-on-year). Meanwhile, revenues from the carriage of goods by road in 2019 amounted to PLN 133,129.3 million (in 2020 they increased to PLN 134,135.7 million – an increase of 0.7 percentage points year-on-year).

In a broader context, expenses of companies from the transport sector in 2019 amounted to PLN 316,147.3 million, of which PLN 275,228.1 million were revenues of private companies (in 2020, revenues of private companies fell by 0.7 percentage points year-on-year, with a 3.15 percentage point decrease in the total value of revenues of companies from the sector year-on-year).

Meanwhile, the cost of revenue in 2019 was PLN 292,264.7 million (in 2020 they fell by 2.98 percentage points year-on-year), of which the cost of goods sold amounted to PLN 262,745.9 million (in 2020 they were down by 0.8 percentage points year-on-year). As a result, companies from the transport sector achieved a net financial result of PLN 4,375.6 million (in 2020, only PLN 1,980.2 million).

It should be remembered that this data pertains to the period (2019/2020), when the amount of cargo transported increased by 14.34 percentage points year-on-year, and the transport work performed by 20.9 percentage points year-on-year. The increase in the costs of current operations thus led to a decrease in the generated financial result. Consequently, companies have fewer financial resources from current periods that they can allocate to potential investments in transport means.

4. Legal Regulations at the EU Level

The European Green Deal, in a broad sense, is the EU's response to climate change and the challenges associated with it. In its current phase, the Green Deal primarily focuses on mitigating one of the main causes of climate change - the emission of pollutants into the planet's atmosphere. The fundamental aim of the Green Deal is to establish a climate-neutral Europe. In practice, the focus has been on creating a "resource-efficient" economy while maintaining its competitiveness. This aims to achieve three overarching goals (Trzcielińska and Kaps, 2021):

- Achieving a net-zero greenhouse gas emission level by 2050;
- Decoupling economic growth from resource consumption;
- Ensuring a uniform pace and scope of introducing these changes across all EU areas.

The above goals are largely visionary in nature, encompassing many detailed and intricate components of the EU economy. However, it is essential to note that both the European Commission (EC) and the member states seem determined to implement a single version of the Green Deal vision. Preliminary funding of 0.6 trillion euros has also been provided.

Broadly speaking, the European Green Deal is the direction of EU development for the upcoming decades, with its realization ensured through legislative initiatives in areas covered by the transformation envisaged by the Deal. In June 2022, the European Parliament debated the details of an initiative termed "Fit for 55", which is a package of solutions in the fields of climate policy, energy, land use, taxation, and transportation.

Many of the proposals were accepted (including those related to transportation). The initiative aims to support and create conditions to achieve one of the Green Deal's significant goals - the reduction of greenhouse gas emissions by 2030.

Fit For 55 consists of 13 legislative acts, introducing certain changes in areas closely related to shaping and influencing pollutant emissions (Kwilinski, Lyulyov, Pimonenko, 2023). The most crucial changes introduced by the Fit For 55 initiative are listed in the table below.

Table 10. *Main elements of the Fit For 55 package*

Action/Area	Explanation/Legal Regulation
EU Emissions Trading System (EU ETS)	Amendment to Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Community. The mechanism has significantly reduced emissions in the power and heating sectors and partially in the industry in recent years. Shipping is likely to be included in the ETS. The heating sector will be fully priced - either within the reformed ETS. Separate, new emissions trading system for fuel distribution for road transport and buildings has been proposed.
Shared Effort to Reduce	Amendment to Regulation 2018/842 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement.
Carbon Dioxide Removal from the Atmosphere	Amendment to Regulation 2018/841 regarding scope, simplification of compliance provisions, setting of Member State targets for 2030, and a commitment to achieve collective climate neutrality by 2035 in the land use, forestry, and agriculture sectors. Among other things, a proposal was made to plant 3 million trees.
Renewable Energy Sources	Amendment to Directive 2018/2001, Regulation 2018/1999, and Directive 98/70 concerning the promotion of energy from renewable sources. According to the proposal, by 2030, 40% of energy must be produced from renewable sources.
Reducing Energy Consumption in the EU	Draft Directive on energy efficiency. As part of the project, the public sector will be obliged to renovate 3% of its buildings every year.
Zero-Emission Mobility	Amendment to Regulation 2019/631 regarding strengthening CO2 emission standards for new passenger cars and new light commercial vehicles in line with the Union's more ambitious climate targets. More stringent CO2 emission standards are expected to be introduced. By 2030, instead of the current emission reduction level of 37.5% (compared to 2021) for passenger cars, a level of 55% is indicated, and for light commercial vehicles instead of 31%, 50% is proposed.
Alternative Fuel Infrastructure	Draft Regulation on the development of alternative fuel infrastructure and repealing Directive 2014/94/EU. It is foreseen to oblige Member States to increase the charging capacity for zero-emission vehicles in proportion to their sales.
Energy Taxation	Draft Directive on restructuring the EU framework provisions on

	taxation of energy products and electricity.
Price Adjustment at Borders considering CO2 Emissions	Draft Regulation establishing a mechanism for adjusting prices at borders considering CO2 emissions. A price for CO2 emissions is to be introduced for the import of certain products.
Social Climate Fund	Establishment of a fund to which 25% of funds from emissions trading related to fuels used in buildings and road transport would flow.

Source: *Zalewski W., Kłaczyńska Lewis K. 2022. Pakiet zmian legislacyjnych „Fit for 55" to główne narzędzie realizacji celu ograniczenia emisji o co najmniej 55% do 2030 roku oraz osiągnięcia neutralności klimatycznej w perspektywie 2050 r. https://www.ey.com/pl_pl/law/pakiet-fit-for-55-cbam, accessed 20.07.2023.*

It should also be mentioned that apart from the Fit for 55 initiative, the EU has already undertaken many legislative initiatives for "clean" road transport – e.g., "Clean Power for Transport: A European Alternative Fuels Strategy" (Dir., 2013), "European Strategy for Low-Emission Mobility", "Europe on the Move. An Agenda for a Socially Fair Transition Towards Clean, Competitive and Connected Mobility for All" and others (Motowidlak, 2018).

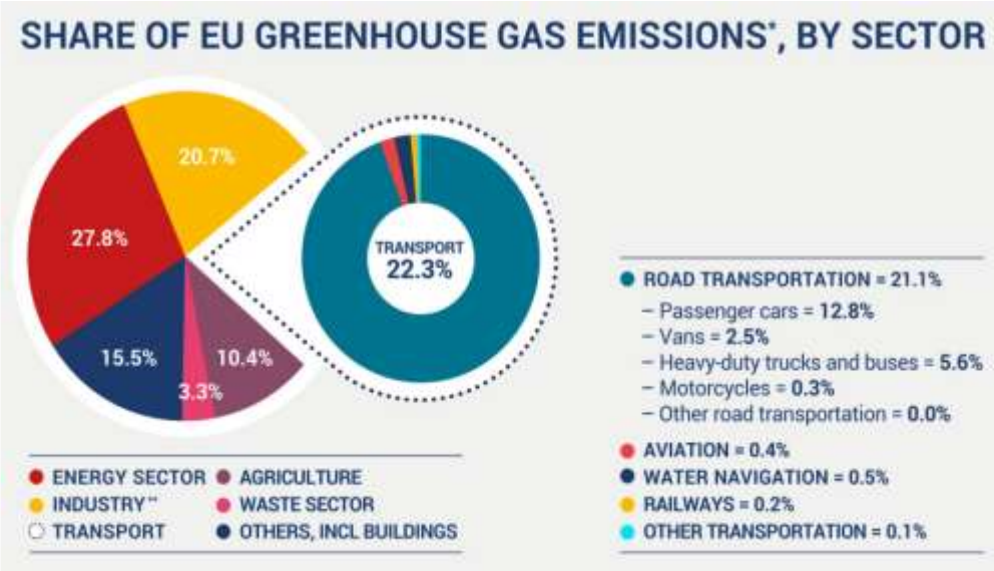
Focusing on transport, which is covered both by the Fit For 55 initiative and the European Green Deal, 2022 saw an update of CO2 emission targets. According to the proposed amendments to Regulation 2019/631, relating to CO2 emission standards for new passenger cars and for new light commercial vehicles, there is (as postulated in the proposed amendments) a tightening of exhaust emission standards, as a result of increasing CO2 emission reduction targets.

Proposals foresee changing the current emission reduction target from 37.5% to 55% for passenger vehicles and from 31% to 50% for light commercial vehicles by 2030. In the previous target framework, the CO2 emission reduction was to be 15% in 2025, which would now imply updating this target to 25%. Importantly, these targets also apply to heavy-duty vehicles.

Meanwhile, the target related to the share of zero-emission vehicles in the number of new vehicles is to be changed from 35% (for passenger vehicles) and 30% (for light commercial vehicles) to 100% by 2035. Comparable targets have been set for heavy-duty vehicles. This stems from the overarching objective of reducing CO2 emissions in transport by 90% by 2050.

Furthermore, based on data and estimates from the European Commission, the transport sector accounts for about 25% of CO2 emissions, of which around 71% are emissions from road transport. Referring to information provided by the European Environment Agency (EEA), transport accounts for 22.3% of total CO2 emissions, with road transport alone accounting for 21.1% of total CO2 emissions in the EU (Figure 3).

Figure 3. *Share of transport in total CO2 emissions in the EEA*



Source: *https://www.acea.auto/files/ACEA_preliminary_CO2_baseline_heavy-duty_vehicles.pdf, accessed 20.03.2023.*

An essential issue in the context of CO2 emission reduction goals is the reference point. In the previous solution, the reference point was the emission levels from 2005. However, the policy revision and setting new goals, along with regulation (EU) 2019/1242 (concerning heavy-duty vehicles, encompassing all heavy and light transport vehicles, as well as passenger vehicles with more than 8 seats) changed the reference point to data for the period June 2019 – July 2020, gathered in the form of data from CO2 emission monitoring systems, which are the basis for calculation, in accordance with provisions contained in the discussed regulation.

For the purposes of the conducted considerations and analyses, it is assumed that the data for the year 2019 are the basis. According to Eurostat data, the total CO2 emission for transport and storage in Poland in 2019 amounted to 22,143,751 tons of CO2. This value will be treated as the reference point.

Returning to the issue of legal regulations concerning CO2 emissions for heavy-duty vehicles at the EU level, it should be noted that the legal environment is still evolving. New regulatory initiatives appear, or emission goals are revised. In the context of standards for new heavy-duty vehicles homologated and sold within the EU, the leading and most crucial regulation is regulation 2017/2400, introducing the VECTO tool, used for simulating CO2 emissions for specific vehicles. Starting from 2019, many vehicles from several groups have already received official CO2 emission values set as standard, using the VECTO tool.

In terms of monitoring and reporting obligations, regulation 2018/956 is crucial. It is associated with the obligation to calculate CO2 emissions for each newly registered heavy-duty vehicle using the VECTO tool and gathering this information by their manufacturers. This data will then be periodically reported to the EEA.

Regarding emission standards, it is worth mentioning regulation 2019/1242, which is related to the obligation imposed on heavy-duty vehicle manufacturers to reduce the average emissions for the vehicles (fleet of vehicles) they produce in the groups covered by the regulation. So, the goal is to achieve a reduction of 15% by 2025 and 30% by 2030. In this context, it is worth citing data from the TE report (Suzan, 2021) showing that almost all heavy-duty vehicle manufacturers are already prepared to achieve the goal set for 2025.

5. CO2 Emission Targets for the Transport Sector

Assuming the starting point is the emission value from 2019 reported by Eurostat for the transport and storage sector, it amounts to a total of 22,143,751 tons of CO2. In the same year, according to GUS statistics, commercial road transport performed transport work equal to 346,992 million Tkm, and the entire road transport sector performed work equal to 395,311 million Tkm. Using these two values, the CO2 reduction goals can be translated into specific numerical values. In this case, the starting point will be the values from 2019 mentioned above and their relation (table below).

Table 11. *Determination of the average emission for the road transport sector for 2019 [g/Tkm] - reference point*

Tkm mln	Tons (t) CO2	g/Tkm
Transport work performed	Total sector emissions	Average sector emission
395 311	22 143 751	56,01603

Source: *Own calculations based on GUS and Eurostat data*.

From the calculations, it appears that in 2019, the average CO2 emission, in relation to the transport work performed, was 56.02 g/Tkm. Taking this value as a baseline, targets were set for this value for the next time horizons (Table 12).

Table 12. *Targets for the average emission for the road transport sector in the 2025-2050 horizon [g/Tkm] – in relation to the reference value*

Horizon / year	Target [%]	Total sector emissions [t] CO2	Target [g /Tkm]**
2025	25%*	16 607 813	42,01
2030	50%	11 071 876	28,01
2035	65%*	7 750 313	19,61
2040	75%*	5 535 938	14,00
2045	85%*	3 321 563	8,40

2050	90%	2 214 375	5,60

Note: ** Estimated target levels for the next horizons, not yet announced by the EU.*
*** Assuming an unchanged level of transport work performed.*
Source: *Own calculations based on information from the EP and EC websites.*

The above table and the interim targets listed therein take into account the step-by-step progress in emission reduction in the sector, allowing for the consideration of the exploitation cycle of heavy vehicles lasting about 15-20 years. Consequently, the reduction occurs as the oldest (most emissive) vehicles are replaced with newer ones. Therefore, there's no need to replace the entire fleet in a short period, which would be very difficult to achieve for various reasons.

6. State Transport Policy

The State Transport Policy, as a strategic document, serves as a framework that sets future directions for the development of legal regulations concerning the shaping of many aspects of the administrative and legal environment of transport within the country. The current State Transport Policy for the years 2006-2025 was developed in 2005.

Among the objectives of this document, the improvement of the quality of the transport system (Objective 1) was identified. Economically, this was meant to provide the right conditions for the country's economic development, while ecologically (Objective 6) it aimed to support the balance between satisfying human needs and preserving environmental values, safeguarding the interests of future generations (Krystek, 2005).

In section 6 of the described STP, the main directions for transport development were defined. In the context of road transport (section 6.2), the focus was primarily on road infrastructure. Meanwhile, in section 6.9, one of the state's actions regarding transport means was identified as: "the use of legal and fiscal tools creating incentives for the purchase and operation of modern transport means (road vehicles, railway rolling stock, aircraft, ships, etc.) with desired operational characteristics".

Section 7 focused on the natural environment, identifying greenhouse gas emissions as one of the threats to this environment. In this context, a trend of tightening the EU's climate policy was noticed, and consequently, the need to limit the rate of increase in pollution emissions from transport. In the context of limiting CO2 emissions from road transport, nothing specific was practically recorded in the currently valid STP. At this level, national regulations do not directly enforce any changes in the emission of transport means, apart from those resulting from other regulations – mainly emission standards for cars.

The next perspective for the STP is probably the years 2026-2050. In 2017, the Strategy for Responsible Development until 2020 (with a perspective until 2030) was adopted, serving as a kind of update to the medium-term Country Development Strategy 2020. Within the II strategic area titled "competitive economy", objectives 6.4-6.5 addressed the need to protect and improve the state of the environment and adapt to climate changes. In this document, transport is pointed out as one of the areas influencing the achievement of these strategy's goals. Much attention was once again devoted to issues related to infrastructure (SOR, 2017).

The Sustainable Transport Development Strategy until 2030 is one of the nine integrated strategies aiming to implement the assumptions of SOR. This document, under intervention direction 5, "Reducing the negative impact of transport on the environment", indicates the need to meet the EU requirements in terms of, among other things, allowable emission levels for road transport.

By 2030, there's also the recorded need to support electromobility initiatives. The "Clean Air" program was also mentioned in the context of creating clean transport zones or the general reduction of CO2 emissions by transport (Cichosz, Nowicka, Ocicka, and Pluta-Zaremba, 2019). Thus, it can be assumed that the goals set by EU initiatives and regulations will be transferred and adopted into national legislation.

7. Directions of Challenges for Enterprises from the Polish Road Transport Sector

Challenges for the road transport sector in the context of the Green Deal or Fit For 55 largely revolve around achieving emission reduction targets. In the short-term perspective for new vehicles, this seems achievable without much effort. The only condition is, of course, having the appropriate financial resources to deploy new heavy-duty vehicles to a company's fleet. However, it should be noted that vehicles meeting stricter emission standards will be more expensive due to the application of new technological solutions.

Another challenge related to the need for fleet modernization is the problem of restructuring the owned fleet of heavy-duty vehicles. This issue is universal for the entire sector and will remain so for many years. In practice, it comes down to deciding "when and which" new type of truck to replace the currently operated ones.

A combination of several factors will dictate this decision at the level of individual companies. Besides the obvious – economic factor (availability of funds for fleet modernization), regulations (legal environment) will have a significant impact. In this case, beyond the general regulations applicable throughout the EU, national regulations introducing stricter emission requirements for vehicles or the entire fleet may play a greater role.

At the moment, this does not seem realistic for Poland, but the situation might be different in other EU countries. It should be remembered that road transport carried out by Polish companies largely consists of transit transport or long-distance transport.

Requirements for the emissions of heavy-duty vehicles moving in countries other than Poland may play a significant role in the near future. An example could be "clean transport zones", which are becoming increasingly popular in the centers of major Western European cities. Today, this poses a real limitation for Polish companies carrying out, for example, express transport with vehicles with a GVW up to 3.5t within the framework of last-mile transport or export transport. In the future, these zones may be expanded, which will limit the access of certain places for vehicles with worse CO2 emission parameters.

Another issue is the limitations (and related challenges) generated from the infrastructure side. Acquiring a low-emission or even zero-emission (electric or hydrogen) means of transport introduces new aspects to company processes concerning route planning or freight forwarding service. The development of infrastructure for charging electric vehicles or hydrogen refueling, especially in so-called MOPs on expressways and highways, is of great importance.

Electric vehicles require longer charging times than traditional refueling with gasoline or diesel fuel or hydrogen. Therefore, the role and size of MOPs serving trucks will be a significant limitation for the popularization of, for example, electric trucks.

New vehicles equipped with zero or low emission propulsion will, due to their construction and additional components, have some limitations related to payload, resulting from the vehicle's own weight (without cargo). This will affect the economic efficiency of operating such vehicles, transport cost calculations, and the overall efficiency and effectiveness of transport companies. Over time, this will result in a change in the market standard for specific vehicle groups.

Another issue that is a source of challenge for the entire road transport sector is the so-called mobility package, promoting rail transport instead of road. Introducing solutions that promote rail or intermodal transport for longer distances, at the expense of road transport, may be the reason for the decline in the previously good growth dynamics of the entire sector.

If legal regulations force a greater share of rail transport (e.g., "trucks on tracks") in long-distance transport previously carried out by road vehicles, the so-called "last-mile transport" will gain importance. This transport will be carried out by road vehicles, but the distances will be much shorter. In this context, electric vehicles of various sizes and payloads may prove to be very efficiently used.

Another challenge for the entire transport sector is digitization. Digitization is ultimately intended to allow better management of transport resources, and consequently, more efficient use of them. This is expected to result in lower emissions due to better fleet management. Digitization also concerns the obligations of recording and reporting actual emissions, fuel consumption, or mileage within the framework of common systems for collecting this data at the EU level.

Moreover, digitization has become a standard today, in the context of logistics operations and customer logistics service. In the context of reducing vehicle pollution, digitization supports such an essential issue as the current vehicle condition monitoring during operation. This will allow for faster vehicle repairs and improve the effectiveness and efficiency of ongoing maintenance of technical conditions. The technical condition of vehicles directly affects the pollution they emit.

Current political events in the world, especially the ongoing war in Ukraine, have created a series of new and previously unnoticed challenges related to the need to ensure a more fluid flow of goods from eastern directions. Currently, the EU supports Ukraine in the ongoing conflict, which also means economic support. In the future, it is expected that economic ties between the EU and Ukraine (and the entire Eastern Europe) will strengthen.

This means greater trade. In this context, discussions are being held on the expansion of the European Transport Network TEN-T to meet the increased flow of goods from the East in the future. Another issue is increasing the resilience of the TEN-T network to disturbances, especially military ones. In the future, initiatives will certainly be implemented at the EU level aimed at implementing actions to increase efficiency and expand the TEN-T (Weenen, Burgess, Francke, 2016).

Poland's participation in these actions will be critical due to its geographical location. This will create some significant changes in the legal and organizational environment of Polish transport sector entrepreneurs.

The COVID-19 pandemic has profoundly affected the transportation market. Beyond the challenges during lockdown periods and related movement restrictions (including transport between EU countries), a shift in purchasing habits was observed. E-commerce has flourished, necessitating efficient and effective logistical solutions within e-logistics (Carvalho, Ishikura, Silva, Arruda, Santos, Cutait, 2023).

As a result, transportation and courier companies faced numerous requirements and challenges. Many of these trends will remain active in the short term - for instance, the need for rapid delivery of purchases (shorter delivery times), an increase in demand for courier services, and the significant popularity of dropshipping, etc.

Maintaining e-commerce-related transport at pandemic levels is not feasible in the long term without implementing certain structural and organizational changes.

The most significant challenge, not directly related to the Green Deal and its associated legislative initiatives, is the difficulty in acquiring workers – specifically, drivers. On one hand, this issue became acutely problematic in the context of the war in Ukraine and the exodus of Ukrainian nationals, as well as visa issues for many workers from the East. On the other hand, this problem has been escalating for several years.

Many of the challenges mentioned above also apply to passenger transport, especially urban transport. Aiming to build more efficient, sustainable, and modern urban transportation systems, which include automotive transport (both collective and individual), entails a range of challenges in areas such as pollution emission reduction, decreasing urban traffic congestion, enhancing the safety and efficiency of public transport in cities, digitization, and integration with smart city solutions and concepts (Celikyay, Celikyay, 2022).

8. Conclusions

The article focuses on the analysis of the newly adopted climate and transport policy goals of the European Union and attempts to identify the most pressing challenges faced by companies from the Polish road transport sector in relation to these objectives. The authors reviewed key EU documents and strategies related to climate and transport, and presented their potential impact on the road transport sector in Poland.

As a result of the analysis, it was found that the new EU policy imposes a series of requirements on companies from the transport sector, which can affect their competitiveness. Particularly important are the requirements related to CO2 emissions reduction, promotion of low-emission transport, and infrastructure adaptation to new technologies.

Companies from the Polish road transport sector face the need to invest in modern means of transport, reconstruction of the fleet structure of heavy-duty vehicles, training, and adapting to changing legal regulations. The challenges also include the necessity for proper adaptation in rapidly changing socio-economic conditions and an increasingly digital reality. The authors also emphasize that for Polish companies, it will be crucial to find a balance between meeting environmental requirements and maintaining market competitiveness.

In summary, the analysis of the new climate and transport policy objectives of the European Union highlights a series of challenges that companies from the Polish road transport sector will have to face. These challenges include, but are not limited to, energy transformation, energy efficiency, CO2 emissions regulation, and adaptation to new technological and regulatory standards. On the one hand, ambitious goals related to emission reduction and increased energy efficiency provide new opportunities for innovation and modernization.

On the other hand, the implementation of these objectives requires significant capital and time investments, which may pose a barrier, especially for small and medium-sized enterprises.

Ultimately, the new climate and transport policy of the EU is not only a challenge but also an opportunity for the road transport sector in Poland. Through effective planning and implementation of adaptive strategies, Polish companies will not only be able to meet EU standards but also gain a competitive advantage in an increasingly globalized and environmentally conscious market.

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