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## OCENA ZGODNOŚCI KRAJOWEGO SYSTEMU TRANSPORTOWEGO DLA ZRÓWNOWAŻONEGO ROZWOJU<sup>1</sup>

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**Adnotacja.** Artykuł zawiera wyniki badania dotyczącego utworzenia systemu monitorowania służącego do oceny stanu zgodności i procedur funkcjonowania krajowego sektora transportu w celu spełnienia wymogów i celów zielonej gospodarki. W artykule przeanalizowano stopień rozwoju infrastruktury transportowej i taboru pod względem ich jakości, niezawodności, trwałości i zgodności z krajowymi celami zrównoważonego rozwoju, w tym infrastruktury regionalnej i transgranicznej; monitorowanie procedur przekazywania wszystkich rodzajów transportu do trakcji elektrycznej i dostępności odpowiedniej sieci infrastruktury.

Utworzono system wskaźników zgodności infrastruktury transportowej i taboru z celami dziewiątego celu zrównoważonego rozwoju, przeprowadzono analizę sektora transportu i systemu wskaźników określających poziom bezpieczeństwa innowacyjnej infrastruktury drogowej i transportowej gospodarki narodowej. Wprowadzono monitorowanie zakresu stosowania ICT w transporcie i zbudowano system wskaźników ich zgodności z ustalonym krajowym CSR.

Rzeczywistość i celowość przeprowadzonych badań są określone przez zobowiązania Ukrainy do osiągnięcia Celów Zrównoważonego Rozwoju (CSR) zatwierdzonych na Szczycie ONZ w sprawie zgodności z globalnymi celami stworzenia przyjaznego dla środowiska, bezpiecznego i atrakcyjnego gospodarczo kompleksu transportowego;

Praktyczna orientacja uzyskanych wyników wynika z celowości ich wykorzystania przez władze państwowe w tworzeniu skuteczności legislacyjnej i programowej funkcjonowania przemysłu transportowego i dziedzin pokrewnych w zakresie zasad i zasad «zielonej» gospodarki oraz zgodnie z krajowym CSR.

**Słowa kluczowe:** «Zielona» gospodarka, kompleks transportowy, wskaźniki jakości, cele zrównoważonego rozwoju.

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<sup>1</sup> Publikacja została przygotowana w ramach NRD Gospodarczych i Środowiskowych Priorytetów Zielonej Gospodarki w kontekście zrównoważonego rozwoju Ukrainy kosztem programu budżetowego „Wsparcie rozwoju priorytetowych obszarów badań naukowych” (KPKVK 6541230).

The publication was prepared within the framework of the SRW Economic and Environmental Priorities of the Green Economy in the Context of Sustainable Development of Ukraine at the expense of the budget program "Support for the Development of Priority Areas of Scientific Research" (KPKVK 6541230).

Публікацію підготовлено в межах НДР «Економіко-екологічні пріоритети «зеленої економіки» у контексті сталого розвитку України» за рахунок коштів бюджетної програми «Підтримка розвитку пріоритетних напрямів наукових досліджень» (КПКВК 6541230).

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## ASSESSMENT OF THE CONFORMITY OF THE NATIONAL TRANSPORT SYSTEM FOR SUSTAINABLE DEVELOPMENT

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**Abstract.** The article contains the results of the study on the formation of a monitoring system for assessing the state of compliance and procedures for the functioning of the national transport sector to meet the requirements and objectives of the green economy. The paper analyzes the degree of development of transport infrastructure and rolling stock in terms of their quality, reliability, sustainability and compliance with the national goals of sustainable development, including regional and cross-border infrastructure; monitoring of the provision of procedures for the transfer of all modes of transport to electric traction and the availability of the appropriate infrastructure network.

The system of indicators of the correspondence of transport infrastructure and rolling stock with the objectives of the Ninth Sustainable Development Goal has been formed, an analysis of the transport sector and a system of indicators for determining the level of security of the innovative road and transport infrastructure of the national economy have been carried out. The monitoring of the extent of the use of ICTs in transport was introduced, and the system of indicators for their compliance with the established national CSR was constructed.

Actuality and expediency of the conducted research are stipulated by Ukraine's obligations to achieve the Objectives of Sustainable Development (CSR) approved at the UN Summit on compliance with the global goals of creating an environmentally friendly, safe and economically attractive national transport complex;

The practical orientation of the results obtained is due to the expediency of their use by the state authorities in the formation of legislative and software effectiveness of the functioning of the transport industry and related fields on the principles and principles of the "green" economy and in accordance with the national CSR.

**Keywords.** «Green» economy, transport complex, indicators of quality, goals of sustainable development

### **Problem solving in general and its connection with important scientific or practical tasks.**

Urbanization of the country, which leads to an accumulation of a large number of residents in cities, an increase in the number of personal vehicles from the population, an increase in cargo and passenger traffic in the traditional way of operating the transport system, will lead to uncontrolled deterioration of the state of the environment and, consequently, the quality of life of the population.

Today, the level of energy consumption and CO<sub>2</sub> emissions tend to increase, in spite of repeated warnings by the Intergovernmental Panel on Climate Change (IPCC) that concluded (1) that in order to maintain a long-term increase in average temperature in the range of 2.0<sup>0</sup> C to 2.4<sup>0</sup>C, global emissions of CO<sub>2</sub> to 2050 should decrease by at least 50% compared with 2000. Recent studies show that climate change is even faster than anticipated, and even the goal of "50% by 2050" may not be sufficient to prevent dangerous climatic changes.

In recent years, much attention has been paid to the importance of policy measures that focus on the mechanism of carbon emissions as a way to stimulate the development and dissemination of clean technologies necessary for the energy revolution. The

Copenhagen Climate Treaty, which has been signed by many countries, recognizes market approaches as a way of improving economic efficiency, but such measures (for example, the sale of carbon emission quotas) are most likely not necessarily the most effective for short-term investments in more expensive technologies that will benefit from long-term emission reductions. Moreover, a truly low-carbon world market is likely to be created only after many years. And so far, it is advisable to use a wide range of other tools that will help to create markets for advanced technologies that are consistent with national policy goals and which are supported, including by regulatory enactments, tax incentives, private programs, subsidies and information public shares. However, it is necessary to provide for a gradual reduction of state support, until its complete elimination after the technologies become competitive, or vice versa, if it turns out that they are unlikely to be able to become such. According to the IEA (2), conducted in 2010, to achieve 50% CO<sub>2</sub> emission reduction, state funding for low-carbon technologies should be two to five times the current level. The identified problems are a priority for many scholars - domestic and foreign (3-6), but the dynamics of change demonstrate the urgent need for research that should take into account the pace of degradation and unpredictable consequences. Moreover, the objectives set for the Sustainable Development Goals include the need to develop a high-quality, reliable and sustainable infrastructure, increased use of electric vehicles and the availability of an appropriate infrastructure network for it, and the provision of innovative road infrastructure development through, among other things, the expansion of state participation in various infrastructure projects, application of information and innovation technologies, etc. The fulfillment of these tasks requires the development of a system for assessing the quality of their achievement and ability for the long-term use in practice.

**The purpose of the work** is to create a monitoring system for assessing the level of compliance of the state and procedures of the functioning of the national transport sector with the requirements and objectives of the green economy in the directions defined by the goals of sustainable development for Ukraine.

#### **Presenting main material.**

**Formation of indicators for developing a high-quality, reliable, sustainable infrastructure, including regional and cross-border infrastructure.** The construction of any estimation system should be in line with the set objectives and the ultimate goal of the study, which may be complicated by the limited statistical data and factual material for performing qualitative work. In order to determine the state of development of the Ukrainian transport system within the objectives of the Sustainable Development Goals, the formation of indicators for the quality of its functioning, a number of indicators of the transport sector's activity in dynamics over the course of 5 years were analyzed with correlation both to the base period (2007) and to the values of the indicators established The United Nations as a guide for the desired level of development of national economies individual sectors. Separate the most significant indicators of transport activity, which are crucial for a general, holistic view of the state and problems associated with the transport complex of Ukraine for the period under study.

The determination of fluctuations in the number of cargos carried by all modes of transport in 2017, which amounted to 1582 million tons, led to the conclusion that the decrease compared to 2007 was 20.5%. However, despite such a worsening of volumes of transportation, in relation to the target indicators set for the UN 2020, 2025 and 2030, the value of 2017 differs from those set at 4.1%, 9.6% and 16.8%, respectively, which is

not is a critically different indicator of activity. The number of passengers carried for 2010-2017 in comparison with 2007, decreased by 43.4%, reaching 4,648 million people. Comparison with established target indicators shows a shortage of 10%, 15.5% and 22%, respectively, for years.

The dynamics of the chain indexes indicates a slight change in the indicators for 2010-2017 in Ukraine. Nevertheless, the largest drop in the volumes of cargo transportation was observed in 2014 – by 11.6%, and the number of passengers carried in the next, 2015, by 12.5%, which is due primarily to military actions on the Ukrainian territory and its consequences for all segments of the population and national economy. During the investigated period, 2010-2017, the most effective in both the volume of cargo transportation and the number of passengers carried is 2011, an increase of 6.9% and 2.0%, respectively. In subsequent years, the dynamics of changes are insignificant.

Against the background of the established changes, the degree of fixed assets wear for the "Transport, warehousing, postal and courier activities" in Ukraine remains rather high. So, in 2017, the share of wear was more than 50.0% of the total number of major. The worst situation with the available main means of transport, postal and courier activities was in 2014, when the total depreciation of assets reached 97.9%. Due to the decrease in fixed assets in 2015, when their share in total fixed assets at the initial (revalued) value decreased by 85.5%, an increase in the residual value of fixed assets in more than 3 times and a reduction in the percentage of their depreciation 97.9% to 51.7%, followed by a downward trend. Contrary to this improvement, the overall level of competitiveness of Ukraine is steadily deteriorating, and in 2017 it is 88th among 140 countries, in terms of infrastructure quality and its level of competitiveness - 81st place (primarily due to unsatisfactory state of highways). The analysis of the change in indicators shows a steady positive dynamics with regard to the degree of depreciation of fixed assets, starting in 2014, all other types of investigated variables changed without significant fluctuations.

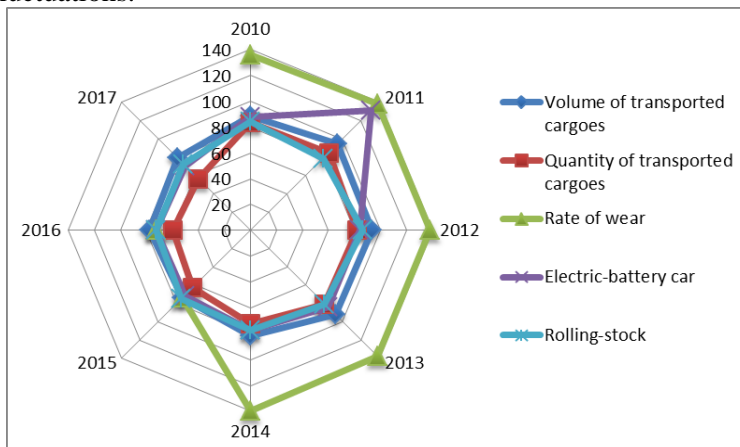


Fig. 1. Dynamics of indexes of indicators of transport products, rolling stock and fixed assets to base year

Monitoring of the state of ensuring the expansion of the use of electric transport and the corresponding network of infrastructure was carried out through the analysis of the indices of rolling stock of electric vehicles for the study period, which showed a general reduction by 29.4%, and in the case of electric-battery cars of internal communication, the dynamics is – the number of trolleybus cars decreased by 39.3%,

tram cars - by 30.1% and metro cars increased by 15.7%

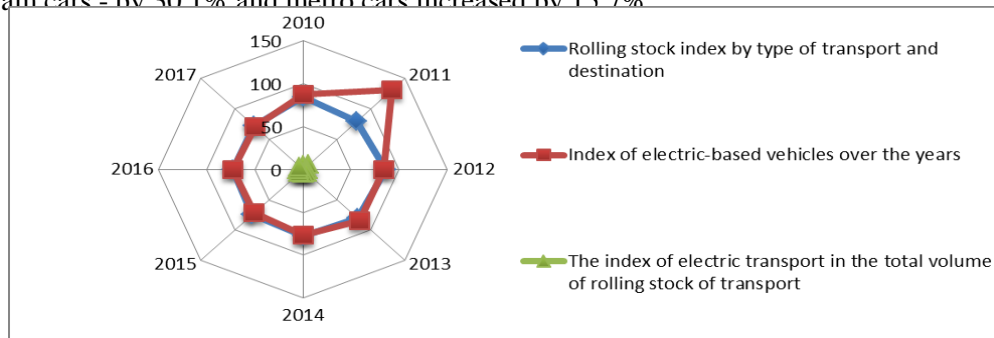


Fig. 2. Dynamics of rolling stock indices

With regard to the growth rate of movable property of all types of electric-battery cars, there is a slight annual fluctuation with the largest drop in trolleybus cars in 2014 by 25.1%, and the largest increase in subway carriages in the same year by 2.6%. The calculation of the indices of the number of rolling stock of electric-battery cars to the volumes of 2007 and the values of the UN target indicators identified a significant shortage of resources to achieve the established goals of sustainable development.

The amount of property for the analyzed years amounted to only 8.2% of the total number of all types of electric vehicles from the total rolling stock of the transport complex in 2011, and in its least value - 4.7% in 2014. With the set goal, the achievement of 65.0% of the rolling stock of electric-battery cars from the total volume to 2020 (70.0% and 75.0% in 2025-2030 respectively), the deficit is 60.2, 65.2 and 70.2 points from the values of 2017, respectively.

In connection with the lack of statistics on the total number of units of electric transport of domestic consumption (taking into account the number of private and public electric-based vehicles), absence of indicators of the total mileage of various types of electric vehicles in statistical data, indicators of the indirect determination, namely calculation of indices and rates of growth of total mileage of trucks and passenger buses indicators, performed on gasoline and diesel fuel. The use of such an approach will make it possible to form an idea about the scope of the use of innovative approaches to the introduction of principles and methods of the "green" economy into the work of the transport complex of Ukraine.

For the years studied, the volumes of freight cars and bus passenger transportation, which are performed on fossil fuels - gasoline and diesel fuel, despite the slight fluctuations, have a steady tendency to preserve the environmentally sensitive type of transportation both for goods and passengers. The growth rates of these indicators were the largest in 2011 by 11.5% of the mileage of trucks, which was performed on diesel fuel, and by 25.3% of the mileage of passenger buses, also performed on diesel fuel. The lowest figures are recorded in 2014, a 25% drop in gas mileage, and a drop of 37.4% of passenger buses, also performed on gasoline in the same year.

Against the background of the general reduction of traffic volumes in 2014, which was the result, first of all, of fighting in eastern Ukraine: by goods – only by 9.1%, by passengers – by 25%, data on volumes performed on fossil fuels, indicate the predominance of this type of transportation in industrialized regions of Ukraine, which exacerbates the extremely threatening condition of these regions in terms of environmental quality and insufficiency of environmental protection measures.

Even worse, the situation was in 2007, when the deviation from the indicators shows a drop in the volumes of transportation of goods in cars with gasoline engines by 41.2 points, with the growth of volumes of transportation on diesel fuel by 19 points (the overall deviation is a fall of 5.9 points).

In passenger traffic, in comparison with 2007 and 2017, the total volume drop was 10.1 points, gas transportation by 40 points, but the use of diesel fuel increased by 12.9 points.

The trend towards the transition to using diesel fuel as "dirty" fuel will form an extremely difficult environment, a threat to public health, which will result in the irreversibility of destructive processes and huge amounts of recovery funds in cases of expediency of implementing environmental protection procedures.

An analysis of the availability of road transport infrastructure based on the use of innovative technologies has been carried out by assessing and developing a system of indicators for such a level of security. The dynamics of changes in the rate of growth of indicators for the availability and quality of public utilities is practically stable, but the largest decrease was observed in 2014, by 4%, due primarily to the loss of territory of Ukraine, military actions in the country, slowdown of support and updating of the current infrastructure, deterioration of the general state of the national economy of Ukraine. Nevertheless, in comparison with 2007 and 2017, the share of hard-coated roads increased from 97.76% (2007) to 97.9% (2017) and amounted to 165.6 thousand km and 159, 6 thousand km respectively. One of the goals of sustainable development is the increase in the number of transport units, whose movement should be provided with renewable energy sources, instead of fossil fuels and lubricants. The precondition for this task is to provide a sufficient number of kilometers of roads of the requisite quality equipped with the necessary means of support - power stations of general use, points of car service with the relevant specialists, etc. Operating length of electric transport lines in comparison with 2007 decreased by 23,1% and in total it was only 5 thousand km - 3.4 thousand km of trolleybus lines, 1.6 thousand km of tram tracks and 113.4 km of tracks underground respectively. The analysis of the operational length indices did not reveal significant fluctuations in either or the other side. In terms of electric transport, the largest decline was observed in 2014, 2015 and 2016 in terms of the length of trolleybus electric lines (by 36.7% compared to the base year) with a gradual increase of 2.3% in 2017. The dynamics of the change in the length of the electric lines for trolleybuses practically repeats the overall trend (trolling and tram), namely a decline of 24.6% in 2015-2016 and a gradual increase in 2017 to 76.9%.

Another dynamics is observed with respect to the length of the metro tracks. During all studied years, kilometrage gradually increased from 5.2% in 2010 to 10.0% in 2017. The cross-sectional analysis with the number of rolling stock for these types of transportation showed: - an increase in the number of subway cars by 15.9 points, which logically forms a positive trend for the desired level of development of this type of transport. Concerns are caused by indicators of other modes of transport of domestic use - trams and trolleybuses, which show both the fall in the length of electric lines and the number of rolling stock - by 29.4 points in general compared with the base year, and even worse - by 60.2, 65.2 and 70.2 points respectively of the target.

The stopping of the development of domestic electric transport in Ukraine does not correspond to the obligations assumed by the government of Ukraine with the conclusion of international agreements and the approval of the Transport Strategy of



Ukraine until 2030 and may have consequences in the form of deterioration of the environment, lowering the quality of life of the population (in including increasing the incidence rate, especially through the most vulnerable sectors of the population - the elderly and children), the loss of the country's ability to consider the country as a reliable and investment but attractive partner. One of the important quantitative indicators of the trends taking place in the country is the availability of the infrastructure for ensuring the tasks defined by the main framework documents of the sectors of the country's economy. With regard to the transport sector, such a document is the Transport Strategy of Ukraine until 2030. The objectives laid down in it, declare a gradual, but irreversible, departure from the use of vehicles that are moving due to the work of their internal combustion engines (ICEs) – by 50.0% Until 2030, unfortunately, statistics on the number of cars on privately owned domestic vehicles from 2011 are absent, but the data for previous years are as follows: in 2007 – 5630.9 thousand units, in 2008 – 6090.4 thousand units, 2009 – 6216,7 thousand., In 2010 – 6470,5 thousand units, in 2011 – 6514,5 thousand units. Official statistical collections do not offer data on the registration of electric vehicles in Ukraine, while independent automobile associations offer the following data: by 2017, the number of registered cars has more than doubled and amounted to 3818 units. (+ 251%) (2016 – 1521 units (+ 364%), till 2016 – 418 units). Providing infrastructure - electric stations, including stations free of charge within the Tesla Club Ukraine program, are developing at the same pace: by 2016 – 62 units, 2016 – 144 units. (+ 232%), in 2017 – 577 units. (+ 400,7%), with practically increasing geometric progression in the development of this trend.

At the same time, these trends do not show any impact on the use of traditional methods of transfer and, accordingly, the use of the provisioning infrastructure for this. The number of petrol stations for fossil fuels has a steady tendency to increase, with the largest figures in 2013 by 17.5% and the lowest in 2017 – 2.4% in the base year. However, the rapid increase in the number of power stations to provide electric vehicles in recent years and the consolidation of the world trend for a massive transition to the use of electric vehicles, primarily private users, the refusal of many countries – primarily Norway (by 2015 100% switch to electric-based transport, now 24% of the automotive market is the niche of electric vehicles), France (from 2040 complete suspension of the sale of gasoline and diesel cars), Great Britain (zero emission of exhaust gases by 2050), Germany plans to 2030, although there are certain obstacles from the major automobile corporations, India (refusal to 2030), China – the leader of the sale of electric vehicles – 351 thousand units. for 2017, Israel, etc., on the use of internal combustion engines, on the one hand, sets the direction of development of the road transport market for Ukraine, on the other hand, increases the risk of forming the market for the sale of vehicles with internal combustion engine.

In this sense, the legislative conditions that need to be formed as a support for the expansion of the use of electric-based vehicles in Ukraine and the prevention of the introduction of obsolete models into its territory are important.

To date, the Verkhovna Rada has 2 Draft Laws "On Amendments to the Tax Code of Ukraine" that deal with the development of this area. This is the bill No. 5494-1 dated December 20, 2016, which proposes the introduction of cardinal preferences to support the processes of electromobility - the abolition of import duties for electric vehicles (today it amounts to 109,129 euros per unit), the abolition of value added tax - 1) operations importation into the customs territory of Ukraine and the subsequent delivery

on the customs territory of Ukraine of vehicles equipped exclusively with electric motors; 2) operations on the supply of services for the carriage of passengers by taxi, equipped exclusively with an electric motor (one or more); 3) operations on the provision of passenger transport for lease (leasing, hire, transportation to order). In addition, it is proposed temporarily, until January 1, 2025, to exempt from payment of the cost of parking services persons who place vehicles equipped with electric motors, on platforms for parking vehicles of state and communal forms of ownership, and to amend the rules of the road, which allow vehicles equipped with electric motors and vehicles equipped with internal combustion engines other than electric motors (hybrids), stroke, intended for the use of route transmissions sports facilities. At the meeting of the Transport Committee of the Verkhovna Rada of Ukraine on September 5, 2018, nine draft laws were considered that are directly related to the development of the electric vehicle market in Ukraine and the provision of infrastructure for it. These are: draft Law No. 4033 of 07.19.2016, No. 5494 of 06.12.2016, 5494-1 of 20.12.2016, 7156 of 10.03.2017, 7156-1 of 17.10.2017, 7156-2 dated 17.10.2017, 7177 entry 05.10.2017, 8159 dated March 19, 2018, 8160 dated March 19, 2013. Such a rapid increase in the significance of issues of preservation of the natural environment and health of citizens should form and support the image of Ukraine as a modern social state. However, despite all the positive trends, there are a number of issues to be solved in the near future. The benchmark for these processes may be the number of petrol stations on fossil fuels, the largest share in 2012 – an increase of 2.4%, and a gradual decline in 2016 – by 0.8%, and in 2017 – by 3.8 % (as compared to the previous year). In addition, the index of the number of petrol stations in the base year was the largest in 2012 – 11.5% and the lowest – in 2017 – 2.4% with a gradual decline: in 2016 it is 106.5%, in 2017 – 102.4%.

It is expedient to use the index of expenses of fossil fuels – gasoline and diesel fuel for operation of trucks and passenger buses of enterprises and organizations of Ukraine, which we consider in dynamics, and in comparison with the base year. Unfortunately, these indicators are derived from the form of state statistical reporting, starting from 2016, so we can investigate the changes we have only this year. Nevertheless, there are certain trends, namely, the fall in the consumption of gasoline and cargo and passenger transport – the highest in 2013, by 26.9% (freight traffic) and in 2014 – by 39.0% (passenger transportation); the largest increase – in 2015, by 5.4% (passenger transportation). Regarding the consumption of diesel fuel: the largest drop, compared to the previous year, amounted to 22.3% (passenger traffic) in 2014 and – 14.1% (freight traffic) in the same year. The largest increase in 2011 is 25.0% of passenger buses and 13.6% of cargo vehicles.

Visually see the trend of change in the longer time range of the study and by comparison to the year chosen for the base. In this case, there is clearly a steady decline in the volume of fossil fuel use during the years under study: in 2014, the fall in gasoline use by 73.8% by passenger buses and by 2013 by 52.2% by trucks; a decline of 15.2% in diesel fuel used in trucks by 2015 and a 39.4% increase in passenger buses by 2015. Nevertheless, there is a general steady tendency to reduce the use of fossil fuels on Carriage: In 2015, the fall in gasoline volumes – by 69.2% (freight transport) and 73.8% (passenger transportation); diesel fuel – by 15.2% (freight transport) and by 9.7% (pass. transportation). Below is a visual representation of the obtained values ( Fig. 3)

It is important to draw attention to the fact that the use of diesel fuel in the internal combustion engine leads, on the one hand, to a significant drop in carbon



dioxide emissions, on the other hand, the amount of emissions of combustion products in the form of fine particulate matter, as the most vulnerable fraction of harmful substances to human health and the environment, is quite large, which relates this type of fuel to extremely "dirty" and harmful energy sources. However, this type of fuel is both the most energy-intensive and the one that makes sense to be used in heavy work (careers, construction sites, processing of large sown areas, etc.), therefore, international practices have formed certain mechanisms for reducing the level of this fuel's hazard or completely preventing undesirable consequences. First of all, it is the use of high quality cleaning fuel, minimum Euro-5, and secondly, the equipment of internal combustion engines with special filters of multi-stage cleaning. These measures minimize the damage (ecological, social, and, consequently, economic) from the use of diesel fuel.

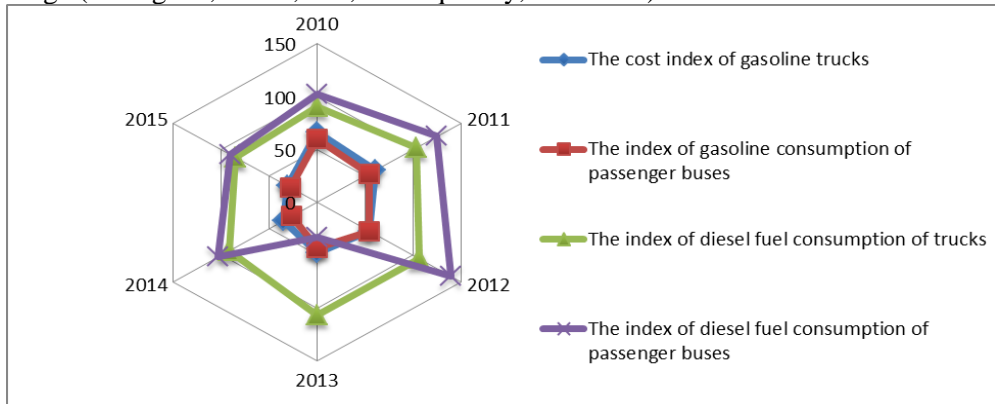


Fig. 3. Costs of fossil fuel for carriage of goods by car and passengers by bus

As indicators that are markers of compliance with the processes of providing environmental protection measures, we suggest the use of indicators of the number of protective plantings on Ukrainian highways. Taking into account the fact that road transport is the most "dirty" mode of transport, at least for today, those trends that show developed countries in transition to environmentally friendly modes of transport (marine, river, electric), and the volumes of use in this particular mode of transport in Ukraine (the share of road transport in the total volume of transport was: 66% in 2010, 70% in 2014, 71% in 2017, for comparison – 2 million tons of cargo was transported by sea, 4 million tons – by river in 2017, which is the indicator of the specific gravity of the partly small, so that the statistical analysis, unfortunately, not included) important environmental protection reduce the degree of adverse effects on the environment and population. In this sense, indicators can be used as a criterion: the number of protective plantings on public roads along the length of roads with protective stripes, the length of decorative protective strips, the number and area of green nurseries

The monitoring of the degree of application of ICTs in transport and the indicator proposed for determining the level of informatization of the transport complex of Ukraine (7–9) is an indicator of the share of value added at the cost of production of enterprises belonging to the medium-high technology sector of the processing industry, namely motor vehicles, trailers and semitrailers; other vehicles according to the CRED, in the total added value of production costs. Due to the fact that the proposed values of the target indicators are based on the various types of enterprises in the medium-tech industry sector of Ukraine, without separating the enterprises of production of means of transport, we have adopted these indicators only as such without the use of specific

quantitative values. The analysis of the dynamics of the share of value added shows steady tendencies to reduce the share of added value of innovations in the activities of vehicle manufacturers – from 21.6% (the largest value) to the total volume of innovative results in industrial enterprises of Ukraine, to 5.7% (the smallest value in 2011) compared to the previous year. Taking 2007 as a base, a negative trend is being made in reducing the innovation component in the volume of sales and in the amount of value added from this type of activity. Namely, the smallest indicator in 2011 is a fall of 15.9 points, the most positive results, with a decline of only 1.6 points in 2013 (Fig. 4).

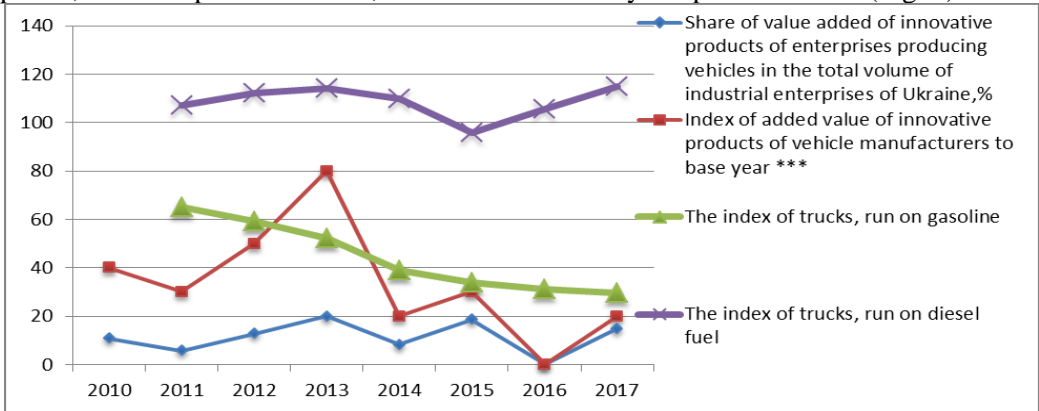


Fig. 4. Dynamics of added value of innovative products at transport industry enterprises Make according to data: (10, 14-16)

The indicator proposed by us in addition is an indicator of the number of traffic counters - means for determining the intensity of traffic and the composition of the traffic flow on public highways. Analysis of the availability of the required number of meters as technical means of transport processes is appropriate in the case of studying the dynamics of intellectualization of transport flows and the determination of emissions of harmful substances, based on indicators of traffic intensity.

**Qualitative assessment of the dynamics of changes in indicators for achieving Ukraine's sustainable development goals**

Indicators for monitoring Sustainable Development Goals "Creating Sustainable Infrastructure" included an expanded set of indicators for the development of a high-quality, reliable, sustainable and sustainable infrastructure, including regional and cross-border infrastructure; ensuring the expansion of the use of electric transport and the corresponding infrastructure network; accessibility of road transport infrastructure based on the use of innovative technologies, in particular through expanding the forms of state participation in various infrastructure projects; application of information and communication technologies in transport.

Table 1

**Indicators of achievement Sustainable development goals**

The goal of sustainable development	Indicators adapted to Ukraine (basic)	Indicators using the OECD methodology	Author's indicators	Total
« Creating a Sustainable Infrastructure »	5	-	18	23

The analysis led to the conclusion that there is a steady tendency to increase the number of rolling stock on the electric traction, which indicates the need for appropriate measures to form the infrastructure of these processes, support of rolling stock users and investors involved in the development of this area, institutional procedures for their settlement. In 2017, the number of registered electric vehicles increased more than 2 times and amounted to 3818 units. (+ 251%) (2016 – 1521 units (+ 364%), till 2016 – 418 units). Providing infrastructure - electric stations, including stations free of charge within the Tesla Club Ukraine program, are developing at the same pace: by 2016 - 62 units, 2016 – 144 units. (+ 232%), in 2017 – 577 units. (+ 400,7%), with practically increasing geometric progression in the development of this trend.

In terms of electric public transport, the largest decline was observed in 2014, 2015, and 2016 in terms of the length of trolleybus electric lines (by 36.7% compared to the base year) with a gradual increase of 2.3% in 2017. Dynamics of change in the length of electric lines for trolley buses practically repeats the general trend (trolleybuses and trams), namely a decline of 24.6% in 2015-16 and a gradual increase in 2017 to 76.9%.

The dynamics of changes in the number of rolling stock of electric transport of domestic use is also negative, in 2017 this figure amounted to 4.8% of the total number of rolling stock, and compared with the base year showed a drop of 29.4%.

In comparison with the target indicators of the installed relative amount of electric transport of domestic use, the shortage is: compared with 2020 – 60.2 points, from 2025 – 65.2 points, and from 2030 – 70.2 points. This tendency is extremely negative, and in the absence of any cardinally directed development strategies for this type of transport, it indirectly contributes to supporting the increase of vehicles on internal combustion engines and raising the level of pollution of residential areas.

The tendency is a tendency to decrease the wear and tear of vehicles, warehousing, postal and courier activities, where the indicator amounted to 50.8% in 2017, which practically reaches the value of 2020 set by the goals of sustainable development by 49% and only by 5 points does not correspond to the indicator set for 2030. This tendency forms a steady basis for improving the state of the air due to the reduction of the chemical, noise load on it, updating the rolling stock on modern environmentally friendly means of transport.

Negative is the dynamics of the number of goods and passengers transported by all types of transport. But if the value of freight rates increased by 4.7% in 2016, then passenger traffic showed a 4.2% decrease compared to 2017, as well as a general drop in comparison with the base year and cargo, and by passengers by 20.5% and 43.4% respectively. That is, the problems of raising the level of mobility of the population remain unresolved, especially through the use of an environmentally-protected transportation method. The study of the dynamics of output by the index of industrial output shows a decline in industrial production. This is indirectly confirmed by an analysis of the dynamics of transport product indicators through volumes of transported cargoes (falling by 20.5%), since transport is closely linked to inter-branch links with all other industries and is largely inclined to influence these industries on the results of their activities. In comparison with the targets for 2020, 2025 and 2030, the national transport system has a shortage of goods in transportation of 4.5%, 9.6% and 16.8% respectively, and for transported passengers – 10.6%, 15.5% and 22.5% respectively. Nevertheless, the tendency of increase of indexes of freight and passenger transportation carried out on

fossil fuel is negative. Although the total volume of such freight transport in Ukraine decreased by 17.4% in 2017 and by 70.4% in gasoline, during this period the volume of transport carried out on diesel fuel increased by 15.1% compared to the previous year. The analysis of indicators in accordance with the base year also showed a drop in the total volume of freight transport in fossil fuels by 5.9%, of which gasoline transportation was carried out by 41.2% less, but the use of diesel fuel increased by 19.0%. Regarding passenger transportation, the analysis of data for 2017 in comparison with the previous one shows the following: a fall in the total volume of fossil fuel transportation by 18.0%, of which 76.7% is lower in gasoline and 21.1% increased volumes of transportation on diesel fuel. Data on the base year looks more encouraging: a drop of 10.1% of the total volume, or 40.0% on gasoline. However, in relation to diesel fuel, the same happened as in the transport of goods, and the growth in passenger traffic by 12.9%. The analysis of fuel consumption volumes has the same trend (relative to the base year): with a maximum drop in 2015 by 69.2% of freight traffic, and a drop of 72.4% of passenger traffic carried out on gasoline. An important component of the tracking of traffic flows, the formation of ideas about the state of roads, tensions, volumes of transportation, is the availability of traffic counting counters. Reducing their number deprives the opportunity to conduct high-quality monitoring of traffic flows, to take necessary corrective measures. Such tendencies should be constantly investigated at the state level not only in terms of the impact on the state of the environment, but also on the quality of life of the population and its health. First of all, this concerns the necessity of taking protective measures in the settlements, in places of the greatest concentration of citizens, production and transport routes, and the necessity to use the fuel of the necessary quality, it is expedient to form and implement programs of ecologization of cities and villages, to design new transport systems quality and safety, to implement state policy in the field of interaction with investors by creating attractive mutually beneficial conditions for attraction of investments on the development of modern transports systems.

One of the most important conditions for the implementation of the above is the increase of the share of enterprises in the total volume of production, which will receive added value from the sale of innovative products. Analysis of the dynamics of the share of value added of such products at the cost of production of vehicle manufacturers shows that, contrary to the growth of this indicator by 10.4% in 2015, the value in comparison with the base year decreased by 70.0%, first of all, due to a steep drop in the share of innovative products in the total value added in 2011 to 5.7%

That is, the tasks set out in the program document on achieving Ukraine's Sustainable Development Goals for the next decade can be achieved through the introduction of a national Strategy for the Development of Environmental, "Green" Transport, which should include radical transformations in this area, reinforcing its intentions with institutional provision, economic and financial implementation mechanisms, tools for implementing state supervision and monitoring the fulfillment of the established requirements.

Contrary to the positive trend of growth of some indicators, such as the length of operation length of electric transport lines of domestic use and the number of traffic meters in the total flow, all the latest survey data showed a general fall in the calculation as in previous years, even more in comparison with the base year. In fact, the analysis of the results of the transport sector, which was the subject of this study, reflects the

national vulnerability of infrastructure provision and the lack of modern rolling stock. Requirements for observance of environmental measures defined by the Transport Strategy of Ukraine until 2030 do not have practical support for any assets, their system modernization, growth of use of innovative transport products, etc.

Among the positive trends, we must emphasize the decline in vehicle wear, starting from 2015 (from 97.9% to 50.8% in 2016), reducing the run of trucks and passenger buses, which are performed on gasoline, and the total cost of fossil fuels, gasoline and diesel fuel, for the transport of trucks and passenger buses.

**Conclusions.** Among the areas for improvement of the situation in Ukraine in relation to the goal of "Creating a Sustainable Infrastructure" in the direction of the goals and objectives of the "green" economy, the following should be highlighted:

- road equipment with a sufficient number of traffic counters, which will lead to an examination not only of the average daily and hourly traffic volume, but also the composition of the traffic flow through the use of vehicle classifiers. That is, the distribution of vehicles by their types is an essential element of the procedures for regulating and coordinating the environmental tension of the studied areas. Although there is a certain trend in the growth of the number of traffic counters for the period from 2007 to 2017, which is positive, unfortunately, it is burdened by a decrease in the index of value added of innovative products at the expense of enterprises – the production of vehicles for the same period, which does not have the necessary cumulative positive environmental protection effect from the impact of transport flows on the state of the environment and public health. As the traffic flow is not only a source of chemical and noise pollution, but also the largest user of fossil fuels and a source of agricultural land degradation from mobile vehicles and stationary equipment, the source of environmental overheating from the operation of ICEs and stationary installations on fossil fuels, sources of electromagnetic radiation and vibration, large volumes of carbon in the form of soot, ash elements, etc., the combined negative effect of transport on the environment and health I people is a serious threat to national scale.

- the transition of rolling stock moving on the territory of Ukraine to Euro 4 - Euro 6 fuel by introducing preferential schemes for encouraging rolling stock owners to use fuel of this type. However, the general tasks set by the Articles of the National Transport Strategy until 2030 with a radical reduction of emissions of pollutants, carbon dioxide, nitrogen oxide, sulfur dioxide, etc. can not be solved without the introduction of innovative technologies in the production of vehicles, in the equipment of stationary devices, environmental protection measures, use of fuel type, not less than Euro 4–Euro 6 for vehicles with ICE, increase in the volume of use of vehicles on electric traction, etc., therefore

- institutional support to support the use of rolling stock on an electrical traction through the adoption of the Draft Law "On Amendments to the Tax Code of Ukraine", which will promote the creation of attractive conditions for owners of such rolling stock and investors in the development of infrastructure maintenance of electric vehicles;

- increase of the share of public electric transport in the total amount of travel by the population by: – bridgement of route cars, major transport polluters of settlements; – increasing number of units of modern rolling stock of public transport, including taking into account the needs of people with disabilities; – implementation of the policy of encouraging the population to use public transport; – forming a flexible, convenient fare

system ("single" flowers, electronic flowers, fixed-flowered flowers, provided that they are used within a certain period of time, etc.);

– creation of preferential conditions for enterprises in which the share of innovative products in the total value added demonstrates positive changes in the dynamics;

– an increase in the length of the roads with hard cover and the total area (and the number) of protective strips, which will ensure that the level of air pollution will be reduced due to mechanical, chemical and noise pollution of the environment, will stop the rapid degradation of rural lands. Negative are the tendencies of reducing the length of roads with hard cover, the number, area and length of green plantations along the roads of general use, against the background of the growth of total volumes of use of fossil fuels and increase of mileage of motor transport on diesel fuel (10-19), reduction of rolling stock of electric transport of internal use. It is possible to consider the positive dynamics as the rapid growth over the last years under study, 2016-2017, the number of mobile vehicles by electric traction and the number of infrastructure objects that ensure their movement.

Results in the area of formation the indicators of achievement The goals of sustainable development allow us to determine the overall dynamics of changes (growth, decrease) of key indicators for 2007-2017 in Ukraine, and provide a qualitative assessment of such changes (positive – P, negative – H, without significant changes – BZ, the target indicator has not been reached – TNR, evaluation needs additional research – AR). A qualitative assessment of the direction and nature of changes in the indicators for achieving the goals of sustainable development is presented in Annex 1.

### Appendix 1

Table 1

#### Qualitative assessment of the dynamics of changes in the indicators of achievement of the Goal of Sustainable Development

Index	Dynamics of changes: increase ↑ decrease ↓	Estimation of dynamics: P; H; BZ; TNR; AR*
<i>I</i>	2	3
<b><i>1.1. Develop a high-quality, reliable, sustainable and sustainable infrastructure, including regional and cross-border infrastructure.</i></b>		
1.1.1. Volume of transported cargoes, million tons	↓	H, TNR
1.1.2. Number of passengers transported, million people	↓	H, TNR
1.1.3. Degree of depreciation of fixed assets for the NED "Transport, warehousing, postal and courier activities", %	↓	P, TNR, AR
<i>1.1.4. Indices of carriage of goods and passengers, % in 2007, target indicators 2020-2025-2030</i>	↓; ↓	H, AR
<i>1.1.5. Indices of the degree of wear and tear of fixed assets in % to 2007, target indicators 2020-2025-2030</i>	↓	P, AR
<b><i>1.2. Ensure the expansion of the use of electric vehicles and the corresponding infrastructure network</i></b>		
1.2.1. The share of rolling stock of electric vehicles, %	↓	BZ, AR
<i>1.2.2. Dynamics of the share of rolling stock of electric vehicles, %</i>	↓	H, TNR, AR



<i>1.2.3. Indices of indicators of rolling stock of electric vehicles in % to 2007, target indicators 2020-2025-2030</i>	↓	H, TNR, AR
<i>1.2.4. Total mileage of trucks of enterprises and organizations of Ukraine, and those performed on gasoline and diesel fuel, thousand km</i>	↓ ↓ ↑	BZ, AR P, AR H, AR
<i>1.2.5. The dynamics of the growth rate of the total run of trucks and passenger buses of enterprises and organizations of Ukraine, and those performed on gasoline and diesel fuel points</i>	↓ ↓ ↑	BZ, AR P, AR H, AR
<i>1.2.6. The total mileage of passenger buses of enterprises and organizations of Ukraine, and those performed on gasoline and diesel fuel, thousand km</i>	↓ ↓ ↑	BZ, AR P, AR H, AR
<i>1.2.7. The index of total mileage of trucks of enterprises and organizations of Ukraine, and those performed on gasoline and diesel fuel, %</i>	↓ ↓ ↑	Π, AR Π, AR H, AR
<i>1.2.8. The index of the total mileage of passenger buses of enterprises and organizations of Ukraine, and those performed on gasoline and diesel fuel, % to 2007</i>	↓ ↓ ↑	P, AR P, AR H, AR
<b><i>1.3. Ensure accessibility of road transport infrastructure based on the use of innovative technologies, in particular through expanding the forms of state participation in various infrastructure projects</i></b>		
<i>1.3.1. The share of public use roads of national importance with a rigid covering that meet the regulatory requirements, %</i>	↓	H
<i>1.3.2. The dynamics of the share of public use roads of national importance with a hard covering that meet the regulatory requirements, (+, - to previous year)</i>	↓	BZ
<i>1.3.3. The index of length of public roads with hard cover (+, - compared with 2007)</i>	↓	H, AR
<i>1.3.4. Length of operating length of lines of electric transport of internal use, km</i>	↑	P
<i>1.3.5. Dynamics of the growth rate of lines of electric transport over the years</i>	↑	P
<i>1.3.6. Index of length of operation length of lines of electric transport to base year</i>	↓	H, AR
<i>1.3.7. The length of the transport routes, which are equipped with protective stripes, thousand km</i>	↓	BZ
<i>1.3.8. The index of the length of the traffic routes, which are equipped with protective bands, to the base year</i>	↓	H
<i>1.3.9. The length of decorative plantations, km number of green nurseries, units. area of green nurseries, units.</i>	↓ ↓ ↓	BZ, AR BZ, AR BZ, AR

1.3.10. <i>The index of the length of the decorative plantations, km</i>	↓	H, AR
<i>number of green nurseries, units.</i>	↓	H, AR
<i>area of green nurseries, units.</i>	↓	H, AR
1.3.11. <i>Number of petrol stations, units.</i>	↑	H, AR
1.3.12. <i>The number of petrol stations to the base year</i>	↑	H
1.3.13. <i>Gasoline consumption index to base year:</i>	↓	P, AR
<i>- trucks</i>	↓	P, AR
<i>- by passenger buses</i>	↓	P, AR
1.3.14. <i>The index of diesel fuel consumption to the base year:</i>	↓	P, AR
<i>- trucks</i>	↓	P, AR
<i>- by passenger buses</i>	↓	BZ, AR
<b><i>1.4. Ensure accessibility of road transport infrastructure based on the use of innovative technologies, in particular through expanding the forms of state participation in various infrastructure projects</i></b>		
1.4.1. <i>Share of value added at the cost of production of enterprises belonging to the medium-high-tech manufacturing sector, namely motor vehicles, trailers and semitrailers; other vehicles according to the CRED, in the total added value of production costs,%</i>	↓	H
1.4.2. <i>Dynamics of the share of added value of innovative products at the cost of production of enterprises producing vehicles</i>	↓	H
1.4.3. <i>The dynamics of the index of added value of innovative products at the cost of production of enterprises producing vehicles</i>	↓	H
1.4.4. <i>Counters of traffic accounting, units.</i>	↑	P
1.4.5. <i>Index of traffic count meters,% to base year</i>	↑	P

\*Prepare by autor (10-20)

\*\* Legend: **P** – positive dynamics; **H** – negative dynamics; **BZ** – without significant changes; **TNR** – the target indicator has not been reached; **AR** – evaluation needs additional research.

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