

UDC 656.073.7:631.95

**Vasyl Kravtsiv**

D.Sc. (Economics), Professor,
 Director, State Institution
 «Institute of Regional Research named after
 M. I. Dolishnyi of the National Academy
 of Sciences of Ukraine»
 4 Kozelnytska Str., Lviv, 79026, Ukraine
kravciv@ukr.net
 ORCID ID:
<http://orcid.org/0000-0002-5618-0392>

**Volodymyr Kolodiichuk**

D.Sc. (Economics), Associate Professor,
 Head of Department,
 Professor of the Department of Management
 named after Prof. Ye. V. Khrapliviyi,
 Lviv National Agrarian University
 1 Volodymyr Velykyi Str., Dubliany,
 Zhovkva District, Lviv Region, 80381, Ukraine
V-A-K@ukr.net
 ORCID ID:
<http://orcid.org/0000-0003-2757-6299>

**Irina Kolodiichuk**

PhD (Economics), Senior Researcher,
 State Institution «Institute of Regional
 Research named after M. I. Dolishnyi of the
 National Academy of Sciences of Ukraine»
 4 Kozelnytska Str., Lviv, 79026, Ukraine
ira1166@ukr.net

The greening of transport and logistics systems of regional agricultural markets

Abstract

Introduction. An increase in the volume of agricultural markets forces intensification of the domestic and international traffic and aggravates anthropogenic burden on the environment. To solve the problem of greening of transport and logistics systems, it is necessary to make appropriate decisions at different levels.

The purpose of the research is to propose ways of greening of the transport and logistics systems that cause the heaviest anthropogenic burden.

Results. The work emphasises the necessity to apply a systemic approach to consideration of the transport component of regional agricultural markets. The authors of the article define the greening of transport and logistics systems as implementation of a set of organisational and technological safeguards concerning the process of optimisation of energy expenditures and safety of the forms of energy transformation on transition of material flows by logistics chains. The work examines experience of European transport and logistics companies concerning the implementation of the fundamentals of green logistics and the possible application of the relevant experience in domestic circumstances. It is stressed that organisational and managerial ways of greening of transport and logistics systems of regional agricultural markets in Ukraine expects a reduction in the randomness of transport flows, their optimisation and support of modality of shipping operations, as well as raising efficiency of the application of road traffic which is viewed to be the most environmentally dangerous. Technical and technological reserves of motor transport greening are seen in the implementation of the concept of sustainable truck transport, which includes technical and behavioural aspects. It is confirmed that principal changes require replacement of the existing vehicle fleet with modern vehicles of Euro 5 and Euro 6 standards, and, in the future, with hybrid cars running on electric motors. It is determined that in Ukraine there are violations of ecological norms due to their imperfection and loyalty of the institute of responsibility. However, the international liabilities require Ukraine to harmonise its ecological laws to the norms and standards of the EU, securing improvement of environmental conditions.

Conclusions. The greening of transport and logistics systems of regional agricultural markets requires setting the conditions, which can neutralise anthropogenic burden by the environmental capability to self-reproduction. To green transport and logistics systems of regional agricultural markets, it is reasonable to consider organisational, managerial, technical, technological, legal and regulatory aspects of development. The implementation of the mentioned directions should be based on the concept of green logistics. To apply the concept in Ukrainian realities, it is necessary to master the experience of European transport and logistics companies.

Keywords: Transport and Logistics System; Ecology; Region; Agricultural Market

JEL Classification: O13; Q42; R40

DOI: <https://doi.org/10.21003/ea.V171-06>

Кравців В. С.

доктор економічних наук, професор,
 директор ДУ «Інститут регіональних досліджень імені М. І. Долішнього НАН України», Львів, Україна

Колодійчук В. А.

доктор економічних наук, доцент, завідувач кафедри менеджменту ім. проф. Є. В. Храпливого,
 Львівський національний аграрний університет, Львів, Україна

Колодійчук І. А.

кандидат економічних наук, старший науковий співробітник,
 ДУ «Інститут регіональних досліджень імені М. І. Долішнього НАН України», Львів, Україна

Екологізація транспортно-логістичних систем регіональних сільськогосподарських ринків

Анотація. У статті розглянуто тенденції та екологічні наслідки функціонування транспортно-логістичних систем. Встановлено взаємозв'язок між зростанням масштабів сільськогосподарських ринків і посиленням антропогенного навантаження на оточуюче середовище. Представлено авторське визначення екологізації транспортно-логістичних систем. Проаналізовано досвід європейських транспортно-логістичних компаній щодо реалізації основних положень концепції «зеленої логістики» та можливості її використання у вітчизняних реаліях. Окреслено існуючі проблеми та запропоновано заходи організаційно-управлінського, техніко-технологічного та законодавчо-регулятивного характеру екологізації транспортно-логістичних систем регіональних сільськогосподарських ринків в Україні.

Ключові слова: транспортно-логістична система; екологія; регіон; сільськогосподарський ринок.

Кравців В. С.

доктор економічних наук, професор,

директор ГУ «Інститут регіональних досліджень імені М. І. Долишнього НАН України», Львів, Україна

Колодійчук В. А.

доктор економічних наук, доцент, заведуючий кафедрою менеджмента ім. проф. Е. В. Храпливого, Львівський національний аграрний університет, Львів, Україна

Колодійчук І. А.

кандидат економічних наук, старший науковий співробітник,

ГУ «Інститут регіональних досліджень імені М. І. Долишнього НАН України», Львів, Україна

Екологізація транспортно-логістичних систем регіональних сільськогосподарських ринків

Анотація. В статті розглянуті тенденції та екологічні наслідки функціонування транспортно-логістичних систем. Визначено системну взаємозв'язок між зростанням масштабів сільськогосподарських ринків і посиленням антропогенного навантаження на оточуюче середовище. Представлено авторське визначення екологізації транспортно-логістичних систем. Проаналізовано досвід європейських транспортно-логістичних компаній щодо реалізації основних положень концепції «зеленої логістики», так і можливості її використання у вітчизняних реаліях. Визначено існуючі проблеми та запропоновано заходи організаційно-управлінського, техніко-технологічного та законодавчо-регулятивного характеру екологізації транспортно-логістичних систем регіональних сільськогосподарських ринків в Україні.

Ключевые слова: транспортно-логістичная система; экология; регион; сельскохозяйственный рынок.

1. Introduction

Ukraine's path towards European integration, requires the performance relevant to the world market and corresponding global standards of logistics management. International labour distribution reinforces integration processes concerning the exchange of production results and complicates the management of material flows. Globalisation of the world economy increases the intensity of employment of the transport component in logistics systems. Along with economic effects, such phenomena cause negative impacts on ecosystems via exploiting transport vehicles. In its essence, logistics is a factor of ecologically balanced development of both the world and national economies.

The application of different kinds of vehicles depends on the parameters of material flows, shipped through the functional sphere of logistics (purchase, production, distribution). The tendency of growth of traffic is a particular concern for all branches of material production. Nevertheless, the largest share in the structure of material flows is taken by agricultural raw materials and processed products. Particularly, Ukraine occupied the second position by the volume of grain export among the countries of the world in 2014, giving up the leading position to the USA. The domestic agricultural sector took the first position by the amount of currency revenue to the state budget, thus outstripping metallurgical industry which was traditionally focused on export. In 2014, Ukraine exported 33.4 million tons of cereals and related processed; the figure was 38.3 million tons in 2015, while the volume of exports increased to 41.5 million tons in 2016 [1, 36]. However, the potential domestic grain production is estimated at the level of 90-100 million tons per year, in contrast to the harvested 66.1 million tons in 2016. Positive trends also feature the exports of sugar (from 40 thousand tons in 2014 to 505 thousand tons in 2016), oil (from 4.5 million tons in 2014 to 5.1 million tons in 2016), poultry products and other commodities [1, 38].

The inelasticity of the demand for agricultural raw materials and related processed products give grounds for the forecast of the amounts of their consumption in regional terms. However, the territorial discrepancy between the concentration of production areas and agricultural markets also increases the intensity of domestic material flows between the regions of Ukraine.

The increasing scale of agricultural markets and, consequently, domestic and international traffic, intensifies

anthropogenic burden on the environment, the protection of which requires appropriate decisions at different levels. According to the data by the State Statistics Service of Ukraine, out of 1 million 664 thousand tons of pollutants and greenhouse gases emitted into the atmosphere in 2015 from mobile sources of pollution, 1 million 475 thousand tons (88.7%) is due to road traffic (including 399.3 thousand tons resulting from the use of business entities' transport). A significantly lower amount of pollutants and greenhouse gases is emitted by railway transport (29.7 thousand tons), by air transport (8.5 thousand tons) and by sea transport (5.8 thousand tons) [2, 5]. The authors of the article consider that the problems of greening of transport and logistics systems can be solved by optimising cargo flows, reducing their randomness with regard to different kinds of transport, supporting traffic modality, as well as improving the efficiency of road traffic.

2. Brief Literature Review

Issues relating to transport and logistics systems are studied in the works by numerous domestic and foreign scientists. Particular aspects relevant to the problem discussed in this article have been studied by Ukrainian scientists such as V. V. Brahinskyi [3], O. P. Velychko [4], V. I. Perebyinis [5], O. V. Tkach [6], as well as by foreign researchers, among whom are D. J. Bowersox, D. J. Closs [7], J. R. Stock, D. Lambert [8], M. R. Linders [9] and others. Their works argue the notion of transport component in logistics, study structural and functional characteristics of transport and logistics systems and determine criteria of their efficiency and ways of their optimisation.

Ecological aspects of the performance of transport and logistics systems are examined in scientific publications by L. H. Melnyk [10], Ye. V. Mishenin [11], N. V. Popova and V. H. Shynkarenko [12], as well as in the works by foreign scientists such as D. Carslaw [13], G. Kummeterstein [14], J. Kusztal [15], R. S. Luijt [16] and others. The so-called green logistics is a methodological basis for the researches conducted by the abovementioned authors, which is founded on the international principles announced at the World Conference on the issues of environment and development in Rio de Janeiro in 1992 [17].

Thus, the issues relating to the logistical management of the recently increased flows in the agricultural sectors of Ukraine on the fundamentals of green logistics have not been

investigated by scientists yet. The peculiarities of agricultural markets require a balanced approach to the performance of transport and logistics systems. Meanwhile, the insufficient theoretical and methodical framework of the essence and specificity of the greening of transport and logistics systems considerably suppresses further scientific research, prevents the application of the full set of measures concerning the environmentally sustainable performance of transport and logistics systems in regional agricultural markets.

3. The purpose of the article is to determine ways of greening of the transport and logistics systems that cause the heaviest anthropogenic burden in regional agricultural markets.

4. Results

Current economic realities require a complex consideration of logistical activities in the relationship of its essential, institutional, structural and functional characteristics with concern of interim targets and the final goal. Such examination is possible under conditions of the existence of a systemic approach to logistics. The approach explains logistics as a system of interrelated notions and categories, which reveal the essence, particularities and principles of organisation of logistics activities. The relevant categories include «system», «logistics system», «logistics chain», «transport and logistics system», etc. Considering the above, the subject of logistics as a branch of the management theory is presented by investigation of the forms and means of organisational, economic, structural, functional and institutional impacts on the moves of material and associated informational, financial and servicing flows from primary sources of raw materials to the consumer of ready products in order to improve the mentioned process and enhance the performance of the target function of the logistics system, which is revealed in achieving synergies. The dynamics of material flows is secured by traffic, which, through the prism of a system approach, should be considered as a transport and logistics system (TLS) characterised by a number of peculiarities. The most essential features include complexity, hierarchy, integrity, structural character, operability, mobility, ultrastability, adaptability, uniqueness, unforeseen and undefined behaviour, as well as synergism and emergence, which determine its internal construction, principles of performance and relations with the external environment. The tendency of intensification of anthropogenic burden on the environment is one of the most threatening consequences of economic globalisation. Thus, transport should be considered as a transport and logistics system in the complex of all cause-effect relationships.

System principles of traffic performance are stressed by V. I. Perebyinis who notes that «a transport and logistics system is derived from the term «logistics system», yet, in contrast to the former, it emphasises the main integrating function of transport in logistics» [5, 20].

V. V. Brahinskyi defines a transport and logistics system as «an interaction of all participants of the transport and distribution process in terms of organisational, economic, technical, technological and informational aspects during cargo shipping» [3, 1]. O. V. Tkach and I. A. Voloshchuk consider a transport and logistics system as an «integrated complex of the subjects of transport and logistics activity and objects of transport and logistics infrastructure, interacting to optimise cargo shipping «from door to door» at minimum expenditures under maximum beneficial conditions» [6, 224]. The principles of a system approach in planning, supply chain management SCM [18] and SCOR-modelling in logistics of local shipping [4] are stressed by O. P. Velychko.

Most of the researchers drop the ecological constituent of performance of transport and logistics systems, emphasising only economic effects. However, N. V. Popova and V. H. Shynkarenko [12, 57] point that «the reduction of ecological

threats caused by traffic to the environment, is an important direction of the TLS development in Ukraine. It will not only improve the environmental situation in the regions, but also foster the creation of a positive image of transport enterprises».

Thus, the greening of transport and logistics systems is considered as performance of organisational and technological measures concerning the optimisation of energy expenditures of transport vehicles and safety of the forms of energy transformation for the purpose of transition of material flows by logistical chains according to the criteria determining the reduction of anthropogenic burden on the environment and implementation of the target function of the logistics system, which is focused on achieving synergies.

It is clear, that internal combustion engines (ICE) constitute a basis of modern transport vehicles. They transform thermal energy into mechanical work by using crude hydrocarbons. The main threat is caused by combustion products, as well as by noise and vibration impacting the environment. There are also environmental consequences of possible traffic accidents, as well as negative impacts on local flora and fauna.

At the current stage, the issue of greening of logistics systems requires conditions, under which anthropogenic burden is neutralised by the natural environment by means of self-reproduction. Otherwise, crossing the line will cause, and has already partially caused, inevitable natural and climatic changes. The development of scientific and technical progress will surely favour the use of alternative energy sources, as well as the expansion of hybrid and electric motors. However, the evolutionary process should not deteriorate of the existing situation. Accepting the actual situation as a reference point for essential changes of the «TLS - environmental protection» relationship, it is reasonable to plan three directions of the development of transport and logistics systems in regional agricultural markets, in particular with regard to organisational and managerial, technical and technological, legal and regulatory aspects (Figure 1).

The implementation of the mentioned directions should be based on the concept of green logistics, which is based on system relationship of all elements of TLS in agricultural markets to secure ecological safety of the regions.

In Ukraine, the fundamentals of the concept of green logistics can be performed with the application of the experience

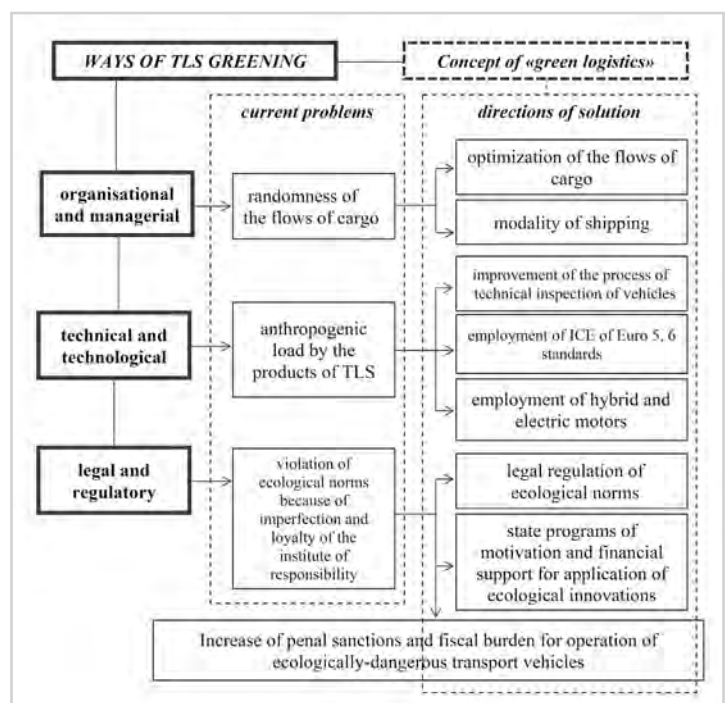


Fig. 1: Directions of development of transport and logistics systems of regional agricultural markets
Source: Compiled by the authors

of European transport and logistics companies such as Schenker-BTL, Geodis Group, F. M. Logistic, TNT Express, Kuehne+Nagel and others.

The activity of the largest European transport and logistics company Schenker-BTL established in 1999, resulting from the amalgamation of the German company Schenker (founded by H. Schenker in 1873) and Swedish BTL (Billspedition, Transport & Logistics) is an illustrative example. Nowadays, the logistics operator takes the leading position in Europe by the amount of shipping by road traffic and is the second by sea shipping and the fourth by air carriage. The company has a global information system of control for the freight traffic and successfully embodies the environmental program of green logistics [19].

The concept of green logistics of the company Schenker-BTL expects a symbiosis of environmental and economic constituents in its traffic products. The environmental sustainability is grounded on keeping to rigid environmental standards of shipping and informing cargo owners about the impact of traffic on the environment. Computer software of green logistics to determine possible volumes and chemical content of harmful exhausts, as well as permanent control for ecological parameters of the logistics system aimed at making environmentally adopted logistical decisions, is an innovative development in the world logistics practice. Reducing the duration of shipping by means of freight consolidation and employment of more environmentally friendly transportations lies in modal traffic schemes, as well as continuous renovation of the company's vehicle fleet. Schenker-BTL sets the goal to cut down the emissions of carbon dioxide (CO₂) by 30% in the period of 2006-2020 in all chains of supply. Green logistics software is able to measure the amount of harmful emission of five main pollutants: carbon dioxide, nitrogen oxides, hydrocarbon compounds, dispersive particles and sulphur dioxide on a definite area of the route for a certain period with consideration of the weight of freight, kind and class of transport vehicles and type of fuel. Thus, the company clients can estimate ecological value, i.e. costs of environmental losses (in Swedish crowns and Euros) due to the substances, as well as the total amount of traffic work (ton-kilometre) and consumption of energy (kilowatts) and, thus, choose the best-possible conditions of shipping, as it is a typical behaviour of socially responsible businesses [20].

The concept of green logistics is successfully applied by Geodis Group, a French transport and logistics company, emphasising exploitation of environmental advantages of engines of auto trucks running on gas (NGV - Natural Gas Vehicle).

Consolidating the experience of the performance of the European logistics operators, one can see the correspondence of their green logistics programs to the international principles announced at the World conference on the issues of environment and development in Rio de Janeiro [17]. In the context of organisational and managerial way of greening TLS of regional agricultural markets in Ukraine (see Figure 1), it is reasonable to reduce the randomness of transport flows of raw materials and ready products causing negative environmental consequences and intensifying the burden on motorways with a subsequent increase in their exploitation expenditures.

The territorial irregularity of areas of growing of agricultural crops, the location of processing enterprises and consumption markets of agricultural products are the objective reasons for inter-regional shipping of agricultural products. Regional specialisation of the agricultural sector is forced by soil-climatic, historical, demographic, geographical and other aspects of Ukraine's territorial development. Assessment of the main territorial elements of the Ukrainian agricultural sector should provide for the application of the regional typology, presented in [21]: Polissia, Forest-Steppe, Steppe, Crimean-Carpathian, subtropical and suburban types. Along with the estimation of the parameters of all areas of the agricultural sector, they supply an estimation of the potential material flows.

The Ukrainian grain market is an illustrative example of randomness of cargo shipping. Forming a basis for the performance of a logistics system, material flows create materials stocks, transferring from dynamic conditions into static ones. Having eliminated the total complexity of the logistics system and specified the elements of grain storage, the performance of domestic elevating enterprises is revealed in their functionality, which is limited by the «receive the grain - deliver the grain» function. It means that both the seller and the buyer of grain, being in different regions of Ukraine, perform an inter-regional physical transfer of the defined lot of grain from the place of its storage.

The conceptually new approach to the organisation and performance of the logistics systems in the grain-product sub-complex of the agricultural sector [23], proposed in [22], will contribute to the maximum reduction of the transport component in the structure of expenditures by means of some «virtualisation» of material flows between the certified elevating capacities. As of 1 June 2018, there are 761 enterprises with simultaneous introduction of the system of monitoring and security of inter-regional balances of grain in Ukraine. Grain is produced in all regions of Ukraine, and it is a standardised product. According to the list of features, it is positioned as an exchange commodity. Thus, the authors of the article ground the idea of the maximum reduction of inter-regional grain flows by mutual substitution of impersonalised lots of grain. This means that the seller, storing some amount of grain in an appropriate certified stock-house, transfers the property to the buyer in the form of an appropriate document (a storage certificate), and the buyer gets the grain with the relevant parameters of quality and quantity in the certified stock-house of grain in his/her region.

The reduction of transport expenditures and the corresponding anthropogenic burden is one of the advantages of the proposed scheme of optimisation of the logistics system under conditions of permanent or increasing number of completed commercial agreements by refusing from random shipping of small lots of grain and their substitution with centralised shipping of consolidated lots (railway traffic instead of carload shipping and auto traffic shipping at inter-regional distances).

The efficiency of TLS performance can be supported by traffic modalities, particularly by using a combination of different kinds of traffic with consideration of their logistics characteristics and shipping routes. Auto traffic cannot be substituted in the «field-stock-house» system, yet it is inefficient for inter-regional shipping of agricultural raw materials. Multi- and inter-modal combinations with water (sea and river) and railway transportation will contribute to greening of TLS.

Technical and technological reserves of TLS greening is seen in the reduction of anthropogenic burden resulting from combustion products, noise, vibration impacts of technical means and accidental consequences of their exploitation on the environment. The greatest environmental threat is caused by the products of combustion of hydrocarbon raw materials (mainly products of oil processing), which are the results of operation of internal combustion engines. ICEs exhausts contain about 200 components, and their decay period lasts from some minutes to five years. Chemical contents of the exhausts depend on the type and quality of fuel, ways of combustion in the engine and its technical conditions. Constructive improvements of engines can substantially reduce the negative impact on the environment. One should note that the tendency to obtain a positive impact of scientific and technical progress on the environment is relevant not only in terms of mobile sources of pollution in Ukraine (motor, railway, air, water transport and production machinery), but also with regard to industries in general (Table 1).

Formal and corrupt practices of the process of technical inspection of transportation means in Ukraine are a sufficient ecological threat, which requires a comprehensive solution. Methods of diagnostics and control for technical means should be based on the use of modern equipment, rigid regulations and liability for the violation of environmental laws.

It is also necessary to support environmental approaches in the process of exploitation of vehicles. This can be achieved by promoting of the so-called concept of sustainable logistics (Table 2). The concept includes technical and behavioural aspects.

The technical aspect includes basic constructive parameters of automobiles, auxiliary units and innovative consumable products, which indirectly reduce anthropogenic burden on the environment by means of lesser expenses on fuel (Table 2).

consider that there is a growing share of the generating capacities in the world, which apply solar energy and wind energy, in contrast to electric power plants, which burn coal, natural gas, etc. Electric vehicles will become the so-called containers for storage of energy from alternative sources, reducing expenses for electric current accumulation. According to the calculations of Bloomberg New Energy Finance (BNEF) [27], the global vehicle fleet will annually consume 1,900 terawatt of electric energy until 2040, which is equal to 10% of the world production of energy in 2015.

The efficiency of electric motors is equal to 85-95%, while the maximum efficiency of modern ICE (petrol or diesel) without auxiliary systems is hardly 45%. The current problem of electric vehicles employment is a high cost of traction power banks, which approximately constitutes one third of the vehicle value. According to the analysis of the market of electric vehicles, carried by BNEF [27], production of accumulators for electric vehicles will need less than 1% of the explored reserves of lithium, nickel, manganese and copper, as well as 4% of the world reserves of cobalt until 2030. Probably, after 2030, there will be new technologies of batteries production of other raw material, and it will make them cheaper, more compact and more durable. However, nowadays one can already see impressive findings in electric vehicle production. Particularly, in November 2017, there was a presentation of a prototype of an auto truck with electric motor, named Tesla Semi, by Ilon Mask. It is planned to be commercialised in 2019. The vehicle capacity, announced by the producer, makes 1 million miles

(~ 1.6 million kilometres). This is equal to 40 round the world trips. The maximum mileage on one charge of power banks, under full loading of the vehicle (36 tons) and maximum permitted speed, constitutes 500 miles (~ 800 km).

In many countries, the development of electric vehicles is stimulated by privileges and grants. It confirms the fact that greening of TLS is impossible without state support. In Ukraine, the government has already made the first steps in that direction. In particular, from 1 January 2018 to 31 December 2018, customs clearance of electric vehicles (VAT, excise, duty) is at zero rate. An analysis of the domestic ecological laws showed rather strict environmental standards. However, extreme regulation of some spheres of environmental management, the lack of appropriate environmental monitoring and the ecological effect is hardly observed. Some environmental standards are either too rigid, or not relevant, because they come from Soviet standards, while some other norms are so loyal that they do not stand up to criticism either. According to the Tax Code of Ukraine, the tax rate for the emission of one ton of carbon dioxide (CO₂) into atmosphere by stationary sources of pollution is only UAH 0.41 as of 1 January 2018. In other countries of the world, the tax constitutes above EUR 1 per ton:

- Poland and Mexico - EUR 1;
- Sweden - EUR 118;
- Finland - EUR 48-54;
- Norway - EUR 3-47;
- Denmark - EUR 23;
- the United Kingdom - EUR 22;
- Ireland - EUR 20 [29].

Basing on the Transportation strategy of Ukraine for the period until 2020, which was approved at the meeting of the

Tab. 1: Emission of the main pollutants into the atmosphere in Ukraine, 1000 ton/year

Pollutants	Years						2015 as compared to 2010, in %
	2010	2011	2012	2013	2014	2015	
Sulphur dioxide (SO ₂)	1,206.3	1,333.1	1,399.2	1,381.8	1,133.3	830.3	68.8
<i>including mobile sources</i>	28.9	30.3	31.1	31.5	27.3	23.7	82.0
Nitrogen oxides (NO _x)	603.7	633.0	634.6	633.4	541.4	453.0	75.0
<i>including mobile sources</i>	293.2	300.0	302.1	300.1	253.3	219.2	74.8
NM VOC (non-methane volatile organic compounds)	359.3	350.8	338.1	325.7	270.1	225.8	62.8
<i>including mobile sources</i>	293.3	285.6	280.6	271.2	220.1	178.5	60.9
Ammonia (NH ₃)	25.1	25.9	24.0	22.6	21.3	18.8	74.9
<i>including mobile sources</i>	0.022	0.021	0.020	0.019	0.014	0.011	50.0
Carbon oxide (CO)	2,951.9	2,908.2	2,830.5	2,782.1	2,283.4	1,971.9	66.8
<i>including mobile sources</i>	1,888.1	1,842.1	1,825.9	1,774.9	1,455.0	1,207.8	64.0
Total amount of particles	594.5	641.0	609.6	553.8	434.1	377.4	63.5
<i>including mobile sources</i>	32.4	34.4	35.9	37.0	32.3	27.8	85.8

Source: Compiled by the authors based on [24]

Tab. 2: Example of Germany concerning possible saving due to technical aspects of sustainable logistics

Measure	Expenses (Euros)	Reduction of fuel expenses (cut down of CO ₂ emissions)	Payback period
Automatic transmission	3,000	3.0%	3.2 years
Lubricant with a low friction coefficient	400 (a year)	2.5%	6 months
Aerodynamic set (auto truck + trailer)	8,500	5.0%	2.4 years
Tires with low rolling resistance	500 (a year)	3.0%	5 months
Control for air pressure in tires	1,000	3.0%	10 months

Source: Compiled by the authors based on [25]

The behavioural aspect anticipates the so-called ecological driving (eco-driving), which is mastered by drivers during the period of theoretical training and improved by practical driving of a vehicle. Investigation by the scientists, headed by R. S. Luijt [16] proves that for the period of 2010-2015, an annual saving of fuel in the Netherlands equalled 5% due to ecological driving. The so-called ecological approach «Energie Zuinig Rijden» (EZR) is a method to change drivers' behaviour concerning ecological driving and further coaching of middle and top managers as to keeping to the realistic targets of energy saving. The EZR approach has appeared to be successful in the implementation of the required changes for initiation of a new approach to management (bottom-up), which stimulated and controlled energy saving in Train Operation Company (TOC), which is the largest Dutch company.

According to the data by the Ministry of Infrastructure [26], the total number of trucks was 1.95 million vehicles in Ukraine in 2016. Among them, three fourths are above 10 years old, and more than 50% of them are low-technology vehicles of either Russian or Ukrainian production. Considering the number of new registrations by the territorial service centres of the MIA of Ukraine in 2016, a complete vehicle fleet renovation takes from 13 to 25 years.

The greening of road traffic in Ukraine needs renovation of the country's vehicle fleet corresponding to Euro 5 and Euro 6 standards, as well as hybrid exploitation of hybrid cars with complete transfer to electric motors in the future. However, the issue of production of electric energy for charging electric motors is also discussed in the context of the anthropogenic impact of power stations. Yet, it is much safer than the actual volume of exhausts of hydrocarbon raw materials by transport vehicles. Nevertheless, one should

Cabinet of Ministers of Ukraine on 20 October 2010 [30], it is planned to reduce the amount of emission of harmful substance into atmosphere by 30%. Energy consumption by vehicles is going to be reduced by 15-20%, particularly road traffic - from 43.6 to 34.8 grams of conditional fuel per ton-kilometre, railway - from 10.32 to 8.75 grams of conditional fuel per ton-kilometre, and all the changes happen under conditions of integration of the domestic traffic system into the European and global space with the maximum possible use of transit potential of Ukraine. An impetus in the field of the state regulation is meant by the Association Agreement between Ukraine and the European Union [31], which requires adaptation of the Ukrainian ecological laws to the norms and standards of the EU, thus, introducing the modern world approaches, norms and rules. Such a step will support the improvement of environmental conditions and health of Ukrainian citizens.

5. Conclusions

When examining performance of agricultural markets through the prism of logistics, it is necessary to concern the inevitable negative impact of the processes of shipping

of material flows on the environment via pollution of the environment with the products of energy transformation. The greening of transport and logistics requires organizational and technological measures concerning optimisation of energy expenses and security of the forms of energy transformation for shipping of material flows by logistics chains according to the criteria aimed at reducing anthropogenic burden on the environment and implementing of the target function of the logistics system. Currently, the issue of greening of transport and logistics systems requires conditions under which anthropogenic burden can be neutralised by the environmental self-reproduction. Accepting the present situation as a reference point for essential changes in the «TLS - environmental protection» relationship, it is reasonable to take organisational, managerial, technical, technological, legal and regulatory steps towards the development of transport and logistics systems in regional agricultural markets. They should be based on the concept of green logistics and its implementation in the domestic realities needs mastering of the progressive experience the leading European transport and logistics companies.

References

1. State Statistics Service of Ukraine (2017). *Balances and consumption of the main food products by population of Ukraine*. Official web-site. Retrieved from http://www.ukrstat.gov.ua/druk/publicat/Arhiv_u/07/Arch_spor_zb.htm (in Ukr.)
2. State Statistics Service of Ukraine (2015). *Emissions of pollutants and greenhouse gases into the atmosphere from mobile sources of pollution in 2015: statistical bulletin*. Official web-site. Retrieved from http://www.ukrstat.gov.ua/druk/publicat/kat_u/publnav_ser_u.htm
3. Brahinskyi, V. V. (2011). Development of a transport and logistics system as a form to translate the transit potential of Ukraine into action. *Public Administration: Theory and Practice*, 2, 9 (in Ukr.).
4. Velychko, O. (2015). Integration of SCOR-modeling and logistical concept of management in the system of internal transportation of milk cooperative. *Mediterranean Journal of Social Sciences*, 6(1S2), 14-24. doi: <https://doi.org/10.5901/mjss.2015.v6n1s2p14> (in Ukr.)
5. Perebyinis, V. I., & Perebyinis, O. V. (2005). *Transport and logistics systems of enterprises: establishment and performance*. Monograph. Poltava: RVV PUSKU (in Ukr.).
6. Tkach, O. V., & Voloshchuk, I. A. (2013). Transport and logistics systems: theoretical fundamentals of establishment and directions of development. *Science and economics*, 3, 221-226 (in Ukr.).
7. Bowersox, D. J., & Closs, D. J., & Cooper, M. B. (2007). *Supply Chain Logistics Management*. Boston, MA: McGraw-Hill.
8. Stock, J. R., & Lambert, D. M. (2000). *Strategic Logistics Management* (4th edition). The McGraw-Hill/Irwin Series in Marketing.
9. Linders, M. R., & Firon, H. E. (1999). *Management of shipment and storage*. Logistics. Saint Petersburg: Polygon.
10. Melnyk, L. H. (2016). Innovative prospects of the Third industrial revolution: economics, power engineering, ecology. *Marketing and management of innovations*, 4, 342-352 (in Ukr.).
11. Mishenin, Ye. V., Kobyljanska, I. I., Ustik, T. V., & Yarova, I. Ye. (2013). *Environmentally focused logistical management of production*. Monograph. Sumy: LLC PH «Papyrus» (in Ukr.).
12. Popova, N. V., & Shynkarenko, V. H. (2016). Modern tendencies of development of transport and logistics systems. *Journal of Economics of Transportation and Industry*, 53, 54-60 (in Ukr.).
13. Carslaw, D. C. (2005). Evidence of an increasing NO₂/NO_x emissions ratio from road traffic emissions. *Atmospheric Environment*, 39(26), 4793-4802. doi: <https://doi.org/10.1016/j.atmosenv.2005.06.023>
14. Kummetersteiner, G. (2011). *Handbook «Ecological»*. Amberg-Weiden University. Retrieved from https://www.oth-aw.de/files/oth-aw/Professoren/Kummetersteiner/OEKL-Teil_1-Grundlagen_2011.03.31.pdf
15. Kusztal, J. (2002). Importance of logistics in ecological activity of enterprises. In *Marketing and logistic of management system: thesis of the reports of the IV International scientific and practical conference* (pp. 206-207). Lviv: Lviv Polytechnic National University.
16. Luijt, R. S., van den Berge, M. P. F., Willeboordse, H. Y., & Hoogenraad, J. H. (2017). 5 years of Dutch eco-driving: Managing behavioural change. *Transportation Research Part A: Policy and Practice*, 98, 46-63. doi: <https://doi.org/10.1016/j.tra.2017.01.019>
17. United Nations (1992). The Rio Declaration on Environment and Development. *The United Nations Conference on Environment and Development, Rio de Janeiro, June 3-14*. Retrieved from http://www.unesco.org/education/pdf/RIO_E.PDF
18. Velychko, O. (2014). Fundamental basis and connection of modern business logistics and SCM. *Review of European Studies*, 6(4), 135-146. doi: <https://doi.org/10.5539/res.v6n4p135> (in Ukr.)
19. StudLib (n.d.). *Eco-logistical policy in the performance of international companies*. Retrieved from <https://studlib.info/ekologiya/1228806-ekologichna-politika-v-diyalnosti-mizhnarodnikh-kompani> (in Ukr.)
20. Yatsiv, I., & Kolodiichuk, V. (2017). Formation of social responsibility of large agricultural land users in Ukraine. *Economic Annals-XXI*, 168(11-12), 48-52. doi: <https://doi.org/10.21003/ea.V168-10>
21. Ishchuk, S. I., & Hladkyi, O. V. (2013). *Regional economics: Theory. Methods. Practice: Manual*. Kyiv: Znannia (in Ukr.).
22. Kolodiichuk, V. A. (2016). Conceptual model of optimization of the logistics system in grain product subcomplex of AIC of Ukraine. *Economics of AIC*, 5, 60-65 (in Ukr.).
23. Kolodiichuk V. A. (2014). Branch positioning of grain product subcomplex of AIC of Ukraine. *Economic annals-XXI*, 9-10(1), 45-48. Retrieved from http://soskin.info/userfiles/file/2014/9-10_2014/1/Kolodiichuk.pdf (in Ukr.)
24. State Statistics Service of Ukraine (2018). *Emissions of pollutants into the atmosphere of Ukraine for the period of 1990-2017*. Retrieved from <http://www.ks.ukrstat.gov.ua/ekonomichna-statistika/ekonomichna-diyalnist/1743-2-1-6-navkolishne-seredovishche/1319-dinamika-vikidiv-zabrudnjuchih-rechovin-i.html>
25. Roth, J.-J., Bernecker, T., Lohre, D., Grandjot, H.-H., & Poerschke, V. (2015). *Sustainable Logistics - An Introduction to the Concept and Case Studies from Germany*. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Retrieved from <https://www.german-sustainable-mobility.de/wp-content/uploads/2015/01/gpsm-logistics-GRUEN-5.compressed.pdf>
26. Ministry of Infrastructure of Ukraine, World Bank Group (2017). *Strategy of sustainable logistics and Scenario for Ukraine*. Project Reviewing. Kyiv. Retrieved from <https://mtu.gov.ua/files/Logistics.pdf>
27. Ranball, T. (2016, February 25). *Here's How Electric Cars Will Cause the Next Oil Crisis*. Retrieved from <https://www.bloomberg.com/features/2016-ev-oil-crisis>
28. The Verkhovna Rada of Ukraine (2010). *Tax Code Ukraine in edition as of October 04, 2018, No. 2530-VIII*. Retrieved from <http://zakon2.rada.gov.ua/laws/show/2755-17/page>
29. Unian (2017, October 15). *It is necessary to raise the ecological tax in Ukraine. - Semerak*. Retrieved from <https://ecology.unian.net/2189116-v-ukraine-neobhodimo-znachitelno-povyisit-ekologicheskij-nalog-seme-rak.html> (in Ukr.)
30. The Cabinet of Ministers of Ukraine (2010, October 20). *About approval of the Transportation strategy of Ukraine for the period until 2020*. Resolution No. 2174-p. Retrieved from <http://zakon.rada.gov.ua/laws/show/2174-2010-%D1%80> (in Ukr.)
31. The Verkhovna Rada of Ukraine (2014). *Association Agreement between Ukraine, as one party, and the European Union, the European Atomic Energy Community and their member-countries, as the other party No. 984_011 in edition as of November 30, 2015*. Retrieved from http://zakon.rada.gov.ua/laws/show/984_011 (in Ukr.)

Received 5.08.2018