

2.2 Complex approach to the formation of a regional logistics infrastructure for industrial waste management in Ukraine in the context of a circular economy

In modern conditions, the established regional industrial waste management systems in Ukraine are not effective enough. This is due, first of all, to the imperfection of the institutional support for the implementation of the waste management mechanism (processes of collection, transportation, storage, processing, disposal, removal, disposal and burial), which leads to an increase in the volume of their accumulation; lack of means of waste management; low level of implementation of low-waste technologies and creation of logistics infrastructure and corresponding cluster structures for waste management; insufficient volume of investments in industrial waste recycling.

At the same time, it should be noted that there is a lack of theoretical and methodological foundations for the formation of regional waste management systems in Ukraine in the conditions of European integration and decentralization of power, methods of analysis of the process of generation and utilization of industrial waste in regional ecosystems, methodical approaches to determining the factors influencing the functioning of the logistics infrastructure of waste recycling and criteria for its improvement creates problems in the formation of scientifically based development of regional industrial waste management plans. All this has a negative impact on the current state of the natural environment and leads to an increase in environmental load, possible environmental risks, and thereby reduces the level of environmental safety in the regions of Ukraine.

Therefore, it is expedient to change the modern paradigm of environmental thinking and environmental policy, search for innovative tools, “green” and logistical solutions, substantiate the theoretical and methodological foundations and develop scientific and applied proposals, as well as introduce fundamentally new organizational, economic and management approaches and “green” technologies to improve the functioning of the regional industrial waste management system in the

context of the concepts of circular economy and balanced sustainable development. Let's consider it on the example of Kyiv region (Ukraine).

At present, the implementation of an ecologically balanced system of nature management and preservation of natural ecosystems, the development of a regional Concept and Strategy for the management of industrial waste, the introduction of innovative waste recycling technologies, the use of public-private partnership as an effective mechanism for the functioning of logistics infrastructure are recognized as priority tasks for the effective implementation of environmental policy in the Kyiv region. levelling of environmental risks from the negative impact of logistics activities on the environment, etc. This corresponds to the main provisions of the National Waste Management Strategy in Ukraine until 2030, the State Regional Development Strategy for 2021-2027, the National Waste Management Plan until 2030 within the framework of the implementation of the Framework Directive 2008/98/EC “On Waste”, Directive 1999/31 /EC “On waste disposal”, 2000/53/EC (End-of-life vehicles, ELV) Recycling, 2006/21/EC “On waste management of mining enterprises”, 2012/19/EC “On electrical and electronic equipment waste (WEEE)” and the Association Agreement between Ukraine and the European Union.

The author's scientific developments (personally and in co-authorship) on environmental problems of regional industrial waste management using logistic approaches in the conditions of a green and circular economy are carried out within the framework of research works of the Institute of Industrial Economics of the National Academy of Sciences of Ukraine: “Circular smart-specialization of old industrial mining regions of Ukraine” [80-83]; “Justification of circular economy elements in metallurgical production” [84]; “Strategic directions of smart specialization of industrial regions of Ukraine” [85-99].

The issues of modernization of the industrial waste management system and the corresponding logistics infrastructure are regulated by a number of legislative and regulatory acts (with amendments), among them: the Law of Ukraine “On Environmental Protection”; Law of Ukraine “On Radioactive Waste Management”; Law of Ukraine “On Waste”; The Law of Ukraine “On the Nationwide Targeted

Environmental Program for the Management of Radioactive Waste”; Law of Ukraine “On Public-Private Partnership”; Law of Ukraine “On Environmental Impact Assessment”; Decree of the Cabinet of Ministers of Ukraine “On the approval of the National Waste Management Strategy in Ukraine until 2030”; Decree of the Cabinet of Ministers of Ukraine “On approval of the National Waste Management Plan until 2030”; Resolution of the Cabinet of Ministers of Ukraine “On Approval of the State Strategy for Regional Development for 2021-2027”; Order of the Ministry of Environmental Protection and Natural Resources of Ukraine “On Approval of Methodological Recommendations for the Development of Regional Waste Management Plans”; Regional development strategies for the period until 2027, etc.

Problems of transformation of regional industrial waste management systems using the principles of green and circular economy are of constant interest to scientists and practitioners. As the analysis of literary sources shows, a significant number of scientific works of foreign and Ukrainian scientists are devoted to the justification of scientific and methodological approaches to waste recycling and the improvement of regulatory, legal, institutional, organizational, economic, financial and information support for industrial waste management; conceptual provisions for the development of reverse logistics in the circular economy system, the formation and functioning of the logistics infrastructure in the context of ensuring the sustainable development of the regional economy of Ukraine.

However, despite the wide range of scientific developments on the chosen topic, further research on the formation of the logistics infrastructure of industrial waste management, taking into account the regional characteristics of the Kyiv region, is timely and relevant. For quality monitoring of the environment, finding ways to solve the problem of increasing the level of environmental safety, it is advisable to perform an analytical assessment of the current state of development of the industrial waste management system in the Kyiv region. And this problem acquires special importance in the modern conditions of the transformation of the regional logistics system and the creation of appropriate infrastructure (for example, cluster formations) in the context of the European Green Course.

In view of this, the *purpose of this study* is to justify the feasibility of applying a comprehensive approach to the formation of the regional logistics infrastructure of industrial waste management in Ukraine on the basis of the green and circular economy.

The methodological basis of the research is the provisions of the theories of sustainable and regional development. The study of modern processes of formation of waste management systems is based on the use of methods: economic-statistical analysis, balance, modelling, analogies and synthesis, system approach, comparisons and observations, classification, structural-logical generalization, etc. The basis of the study was the achievements of modern economic science, scientific works of leading domestic and foreign scientists and practitioners in the field of waste recycling, nature management, problems of ensuring sustainable development of territories and finding new ways to achieve it, in particular, through waste management.

The information base of the study was: legislative and regulatory acts of Ukraine, Development Strategy of the Kyiv Region for 2021-2027, Regional Waste Management Plan of the Kyiv Region until 2030, official materials of the State Statistics Service of Ukraine and the Main Department of Statistics in the Kyiv Region, Ministry of Environmental Protection and natural resources of Ukraine, the Ministry of Development of Communities and Territories of Ukraine, publications of foreign and domestic scientists.

Statistical analysis shows that the total volume of emissions of pollutants and greenhouse gases into the atmospheric air in the Kyiv region increased by 33.3% (from 167.5 to 223.3 thousand tons) during 2000-2020 due to an increase in emissions by mobile sources by 80.9% (from 86.7 to 156.8 thousand tons). However, the volume of emissions of pollutants and greenhouse gases into the atmosphere by stationary sources decreased by 17.7% (from 80.8 to 66.5 thousand tons).

Investigating the development of the regional industrial waste recycling system, it was established that the amount of generated waste decreased in 2020 compared to 2010 by 26.6% (from 2932.2 to 2153.6 thousand tons), and that disposed of by 98.6% (from 1296.9 up to 18.2 thousand tons). It is worth noting that in the Kyiv region there

is a trend of significant growth in the ratio between the volumes of generated and disposed waste. Thus, the value of this indicator increased in the region for 2010-2020 from 2.3 to 118.3 times. The volumes of removed industrial waste to specially designated places or objects decreased by 2.2% or from 1715.6 to 1677.7 thousand tons. The volumes of waste accumulated during operation in specially designated places or objects in the region increased by 2.6 times or from 37042 to 95588.2 thousand tons.

According to the analysis of information and analytical materials, the amount of waste generated from the economic activity of enterprises in the Kyiv region increased by 3.4 times in 2017-2020 (from 593.1 to 1990.1 thousand tons), and their specific weight in the total amount of generated of waste – by 45.5 percentage points or from 46.9 to 92.4%.

It should be noted that the situation with investing in the development of the waste management system in the Kyiv region is significantly deteriorating. This is evidenced by the low share of capital investments for waste management in the entire region. This was especially observed in 2011, 2012, 2014, 2015. Only in 2019 did the situation improve somewhat – the value of this indicator was 65.7%, which is 49.8 percentage points higher compared to 2010. The share of capital investments for waste management decreased by 11.3% in 2010-2020 or from 15.9 to 4.7% of the total amount of capital investments for environmental protection for all types of environmental protection activities. However, during this period, the specific weight of capital investments for atmospheric air protection and climate change problems increased by 5 percentage points.

Statistical analysis shows that the share of current costs for waste management in 2020 was 35.8% of current costs for environmental protection for all types of environmental protection measures, or 10.6 percentage points more compared to 2010. The specific weight of current costs for protection atmospheric air and the problem of climate change decreased during this period by 2.7 percentage points.

Based on the analysis of the approved Development Strategy of the Kyiv region for 2021-2027, it was established that the program document does not pay enough

attention to the formation of the regional logistics infrastructure of industrial waste management, which would meet the modern requirements of management. At the same time, the main weaknesses of the Kyiv region include: 1) technologically and morally outdated industrial waste management system, insufficient level of their disposal; 2) low indicators of the use of industrial waste as secondary raw materials in the context of the circular economy; 3) insufficiently effective implementation of measures aimed at preventing the formation, utilization, disposal and removal of waste; 4) lack of a comprehensive approach to the management of industrial production waste recycling through the creation of an appropriate logistics infrastructure based on the principles of the green economy.

However, as a result of the research, strengths were also revealed. So, currently active work is being done in the Kyiv region to increase the level of environmental safety. For this purpose, the Regional Waste Management Plan until 2030 is being developed, which provides for the implementation of the waste management system on an innovative basis. The main activities for the creation of waste management infrastructure include: development of project documentation for the construction and reconstruction of waste management facilities (funding amount: 55 million UAH); construction of regional waste management facilities (1050 million UAH); reclamation of landfills and landfills (funding volumes will be determined in two years after their inventory).

So, as the comparative analysis of strategic documents showed, environmental safety and protection of the natural environment are among the priority directions. At the same time, it should be emphasized that only in the Regional Development Strategy until 2027 are defined tasks for waste management, among which are: support for innovative developments and the introduction of the latest technologies in the field of waste processing and the return of resource-valuable materials to economic circulation; environmental monitoring and informing the population about the state of the environment; creation and development of eco-networks.

For the effective functioning of the logistics infrastructure of industrial waste management in the Kyiv region in the context of the paradigms of “green” growth,

circular economy and sustainable development, it is advisable to apply a complex approach, the essence of which is the integration and implementation of:

- principles of transformation of the industrial waste management system (compliance with the principles of a closed cycle economy; implementation of the waste management hierarchy (waste prevention → preparation for reuse → recycling → other recovery operations → disposal); implementation of an integrated information system for waste management; systematic approach and planning; application of extended producer responsibility, integration into the EU waste market and implementation of the European industrial waste management system);

- algorithm of reverse logistics (determination of the potential volume and characteristics of return flows; grouping of return flows of waste by characteristics; calculation of costs for returning products; selection of a return mechanism (according to the highest level of profitability, lowest costs, outsourcing); operational stage of return; design of a system for managing the return flow of waste; information provision; monitoring and control over the implementation of the system of management of the reverse flow of production waste);

- organizational and economic mechanism (functions, methods, management tools, information systems, digital, “green” and innovative technologies);

- financial instruments of green investment for the implementation of the regional industrial waste management strategy (green loans, green bonds, crowdfunding, crowdsourcing, grants from European and international financial organizations, technical assistance from international financial organizations, resources of “green” investment funds).

The implementation of the proposed integrated approach will contribute to the adoption of justified innovative decisions on the greening of logistics activities and environmental management; timely solution of problems of management of return flows of production waste using the principles of reverse logistics; minimization of the negative impact on the environment by increasing the amount of processing and reuse of industrial waste; effective implementation of circular economy models, transition to

expanding producer responsibility; increasing the level of environmental security of the region; achieving the goals of sustainable development.

In modern conditions, waste should be considered as an economic category, which should be based on the fact that waste is an economic object, the management of which depends on regional development. Therefore, at present, the regional and local authorities of the Kyiv region need to pay attention to the development of the Comprehensive Waste Management Program and the finalization of the Regional Industrial Waste Management Plan until 2030 with the involvement of various categories of stakeholders.

However, it should be noted that the concepts of “industrial waste” and “production waste” are not clearly defined by the current legislation of Ukraine. In this regard, it would be appropriate to introduce these concepts into national legal documents. This, in turn, would make it easier to distinguish them from other types of waste and would ensure more effective implementation of legislation in the field of industrial waste management, including as a recycling of secondary resources. In addition, the terms “waste management”, “waste management hierarchy”, “waste recycling”, “green investments”, “mechanism of “green” financing” should be included in the current legal acts that regulate the issue of waste management. For this purpose, it is expedient to introduce amendments and additions to the Laws of Ukraine “On Waste”, “On Environmental Protection”, “On Environmental Impact Assessment”, National Waste Management Strategy in Ukraine until 2030, National Waste Management Plan until 2030, Strategy development of the Kyiv region for 2021-2027, Regional waste management plan in the Kyiv region until 2030. It is also necessary to finalize and adopt the draft law “On waste management”, which will define the classification of waste depending on the types of economic activity, the principles and the mechanism for implementing the five-level hierarchy of waste management.

In order to improve the industrial waste management system in the Kyiv region, it is expedient to: 1) implementation of the latest technologies and equipment for collection, sorting, transportation, processing and disposal of waste taking into account

advanced European practices; 2) promoting the use of waste recycling as secondary raw materials on the basis of “green” investment; 3) development of a financial mechanism for the application of public-private partnership based on attracting private investments and other off-budget sources of financing in the field of industrial waste management; 4) creation of an appropriate cluster structure as an organizational form of partnership in the field of industrial waste management; 5) development and implementation of tools for economic stimulation of industrial waste utilization; 6) implementation of the concept of reverse logistics in the context of the green and circular economy.

Prospects for further research in this area are based on the justification and development of conceptual provisions for the formation of regional industrial waste management cluster structures in the economic regions of Ukraine, taking into account the specifics of their functioning.