Antoniuk, K. and Antoniuk, Dm. (2022), "Sustainable waste management: international experience for Ukraine regions", *Management and entrepreneurship: trends of development*, 2(20), pp. 59-67. Available at: https://doi.org/10.26661/2522-1566/2022-2/20-05

MANAGEMENT

RECEIVED:
6 April 2022
ACCEPTED:
10 May 2022
RELEASED:
14 June 2022

UDC 351.777:332.142.6

DOI 10.26661/2522-1566/2022-2/20-05

SUSTAINABLE WASTE MANAGEMENT: INTERNATIONAL EXPERIENCE FOR UKRAINE REGIONS

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Abstract. The article considers the key statistical indicators of waste management in the context of sustainable development of the EU and the regions of Ukraine, which allows to understand development trends, identify problems and suggest ways to solve them. Positive trends in waste generation, processing and utilization have been identified, which contributes to the increase in the circular use of materials (CMU) in the EU. It is demonstrated that the unsatisfactory state of waste management in the regions of Ukraine is associated with significant territorial disparities in their formation and accumulation and with the low level of their utilization. The necessity of introduction of responsible consumption and production as preconditions of rational waste management at the regional level in the context of sustainable development is substantiated. **The aim** of the study is to substantiate the areas of implementation of the experience of EU countries in waste management for the regions of Ukraine to ensure sustainable development and security of the state. **Methodology:** the theoretical and methodological basis of the research are the fundamental basics on sustainable development studies, ecology, consumption and the circular economy. To ensure the conceptual integrity of the study, the following methods were used: statistical analysis and systematization, grouping, desk research. **The scientific significance** of the work is that the European and domestic experience of waste management with a focus on sustainable development is studied, the tendencies of improving the environmental situation in the EU countries are analyzed (introduction of circular economy principles, reduction of accumulation and recycling); recommendations for improving the results of sustainable waste management for Ukraine have been developed. **The value** of the study lies in the analysis and substantiation of problematic areas of sustainable waste management in the regions of Ukraine based on the experience of EU member states.

Keywords: sustainable development, waste processing and utilization, circular use of materials, reduction of post-harvest losses, regions.
JEL Classification: R11, Q01, Q53.

INTRODUCTION

Despite the difficult and tragic situation in Ukraine at the moment, we are convinced that its restoration and development should take place as soon as possible on the basis of sustainability principles and their implementation in all spheres of socio-economic life. For our country, one of

the many tasks to achieve the goals of sustainable development is the establishment of waste generation and disposal processes, the indicators of successful solution of which are included in the 12th Sustainable Development Goals "Responsible production and consumption". Thus, in the industrial regions of Ukraine the ecological and, accordingly, demographic situation remains threatening, which is caused, among other things, by the excessive amount of accumulated industrial waste, the slowness of reforms regarding their storage and utilization. This, in turn, leads to increased social tensions due to increased risks to human health. Under such conditions, it is important to study the experience of developed countries in solving the problems of sustainable waste management, namely of the EU countries, which have significant achievements in this area.

LITERATURE REVIEW

According to the Sustainable Development Index (SDI) by the ISC WDS World Data Center for Geoinformatics and Sustainable Development [1], Ukraine ranked 76th out of 137 countries in 2020, with an index value in 2005–2013 fluctuated in approximately the same range (0.72–0.74), and since 2015 it has significantly decreased to 0.413 (in 2017). In 2018–2020, SDI rose to 0.694–0.697, but is low. This is primarily due to the low position in the index of economic measurement (0.374) and environmental measurement (0.538).

In the regional dimension, according to the Sustainable Development Index, the following regions are distinguished: with a high index – 1.04–1.29 (Zakarpattia, Ivano-Frankivsk, Lviv, Ternopil, Vinnytsia, Kharkiv regions); average – 0.9–1.03 (Volyn, Rivne, Zhytomyr, Kyiv, Poltava regions); low and very low – less than 0.9 (all other areas). Such a spatial structure is associated with the concentration of industrial enterprises in the regions of south-eastern Ukraine and the negative impact of environmental factors on the indicator of quality of life (Sustainable Development Modeling, 2021).

Effective waste management in production and consumption plays an important role in reducing environmental impact. According to the European Commission's report, waste will have a huge negative impact on the environment, causing pollution and greenhouse gas emissions that cause climate change (European Comission, 2010). That is why the effective model of waste management is their utilization and recycling, which return material resources to the economy.

An example to be followed in this direction is the experience of EU member states, which seek to create a circular economy in which the number of iterations of resource and material use is as high as possible and waste is minimized. An important aspect of this model is to reduce both material consumption and waste by reducing economic and environmental cycles of resource flows, which also can be made by popularization of sustainable consumption (Antoniuk K., 2021).

PAPER OBJECTIVE

The aim of the study is є substantiation of the directions of implementation of the experience of the EU countries in waste management for the regions of Ukraine in order to ensure its sustainable development and security.

METHODOLOGY

The theoretical and methodological basis of the study are the fundamentals of research on sustainable development, ecology, consumption and the circular economy. To ensure the conceptual integrity of the study, the following methods were used: statistical analysis and systematization, grouping, desk research.

RESULT AND DISCUSSION

During 2004–2018, the volume of waste generated in the EU countries increased from 775.9 tons to 812.0 tons (+4.2%) due to an increase in waste / water waste (+175.9%), construction (+20.1%) and households (+6.7%), with a significant reduction in waste generated by agriculture (-66.8%), manufacturing (-24.9%), mining and quarrying (-22.6%) (Table 1).

Table 1

Waste generation in EU countries (excluding basic mineral waste), 2004–2018, million tons

	2004	2006	2008	2010	2012	2014	2016	2018	2018/ 2004, %
Agriculture, forestry, fishing	62,3	56,7	45,5	20,2	20,4	17,7	19,7	19,5	-66,8
Mining and quarrying	10,4	7,1	10,0	7,9	7,5	7,7	6,9	8,1	-22,6
Manufacturing	239,9	225,8	216,8	190,5	176,4	175,9	178,9	180,1	-24,9
Energy	85,4	93,3	84,1	78,6	88,8	87,4	74,7	75,7	-11,4
Waste/water	75,2	83,3	98,9	129,9	155,0	180,7	196,9	207,6	175,9
Construction	34,4	33,4	34,8	42,5	39,8	38,6	37,8	41,3	20,1
Other sectors	97,7	111,12	88,8	102,3	88,9	85,1	88,5	94,0	-3,7
Households	174,1	179,2	181,6	186,0	180,7	175,8	181,4	185,7	6,7
Total	775,9	789,9	760,6	758,7	758,0	769,0	784,7	812,0	4,2

Source: Eurostat. Waste statistics (2018).

During 2004–2020, the rate of circular use of materials (CMU, the ratio of secondary raw materials to total material used for domestic use), which reflects the share of resources used from collected waste, increased from 8.3% to 12.8% (Fig. 1). In the short term (2014–2020), growth was lower than the annual average by 1.3%, and only in 2020 the CMU grew by 0.8%.

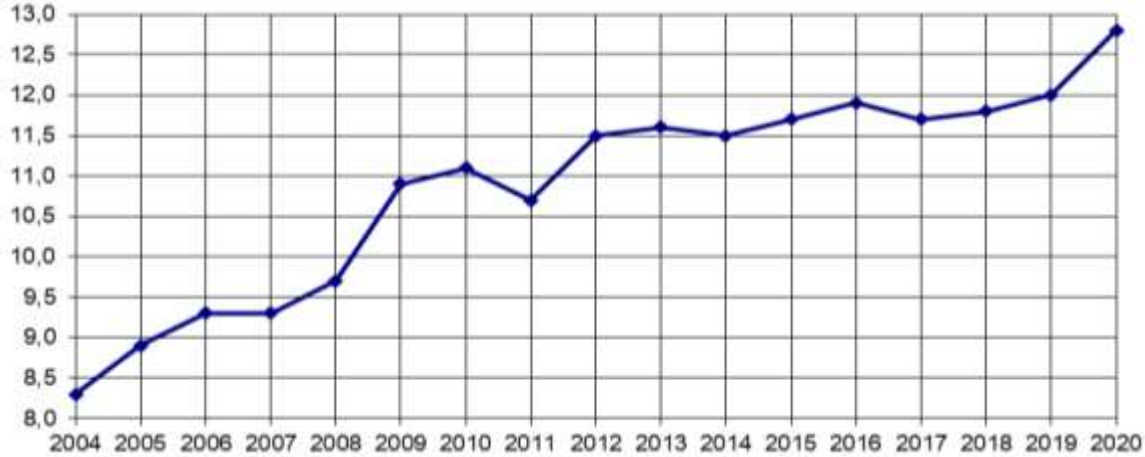

Figure 1. Dynamics of changes in the circular use of materials (CMU) in the EU (2004–2020), %

Source: Eurostat, (2021).

The highest CMU rates were observed in the Netherlands, Belgium, France, Italy, Estonia, and the lowest in Romania, Ireland, Portugal, Bulgaria, and Cyprus (Fig. 2).

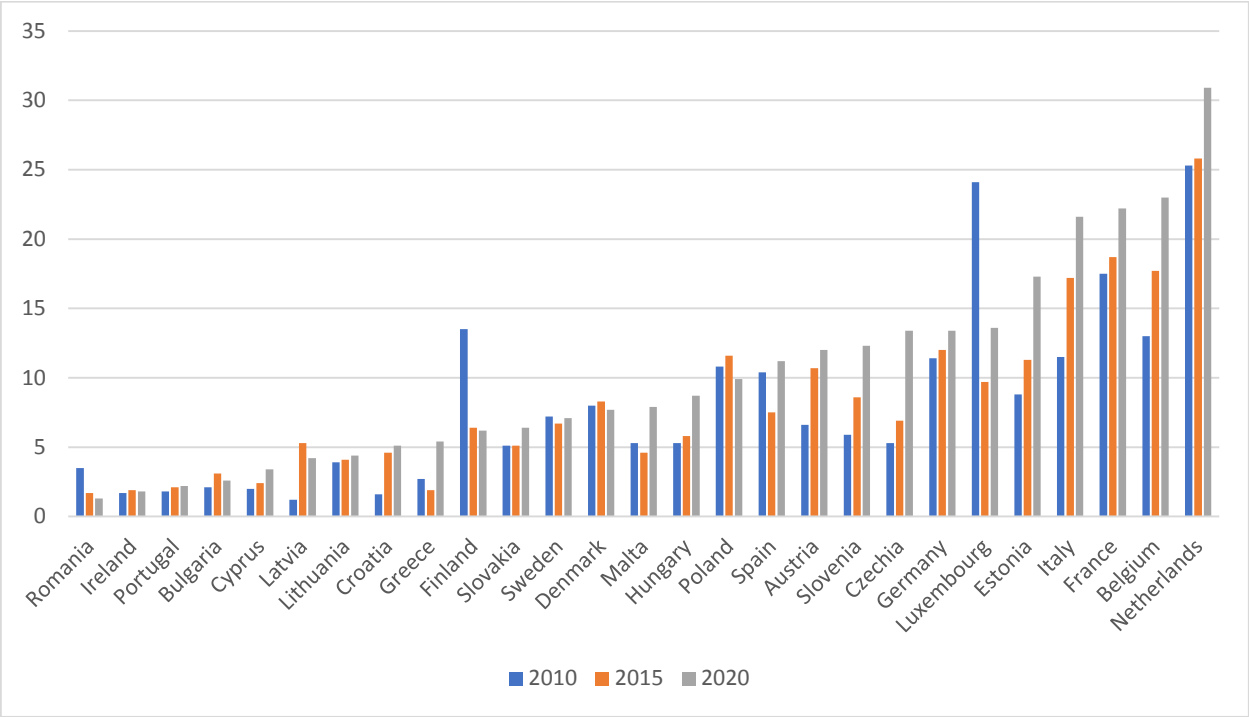

Figure 2. Dynamics of changes in the geographical structure of the circular use of materials (CMU) in EU member states (2010-2020),%

Source: *Eurostat, (2021).*

Unfortunately, statistics on waste disposal, which excludes the main mineral waste, have been available only since 2010 and show a slight increase. However, despite the much higher rate of recycling, the relatively low degree of circularity in the EU can be explained by two structural barriers. First, a significant part of the materials is used for the construction and maintenance of buildings, infrastructure and other goods (works, services) with a long service life and limited availability for recycling. Secondly, a significant amount of material resources is used for energy production, so the circularity rate is quite low (European Commission, 2015).

In 2018, out of 812.0 million tons of generated waste, the largest part came from waste / water (207.6 million tons), households (185.7 million tons) and Manufacturing (180.1 million tons) (see Table 1). One third of wastes, excluding basic mineral wastes, were mixed conventional wastes, including household wastes, mixed undifferentiated materials and waste sorting residues. Waste combined into "recyclable waste" (metal, glass, paper and plastic) accounted for about a quarter, combustion waste - 15%, animal and vegetable waste - 10%, chemical and medical waste - 6%, mineral waste from processing of stabilized waste - 5%. In 2016, the volume of slag and equipment was about 2%. In 2016, 48% of waste was recycled in the EU (Fig. 3).

Up to 25% of waste was accumulated in landfills, while the share of waste accumulated in garbage dumps decreased, recycling due to energy-saving incineration increased. The recycling rate is higher for general waste, except for basic mineral waste, than for household waste. Despite significant growth, the level of municipal waste disposal remained at 45.3% in 2018, which is due to the dominance of landfill technology for their disposal. However, there is a change in landfill disposal for combustion with energy recovery. Thus, if in 2011 34.4% of municipal waste was accumulated in landfills and 24.0% burned, and in 2018 the share of landfills was 24.4% against 27.6%.

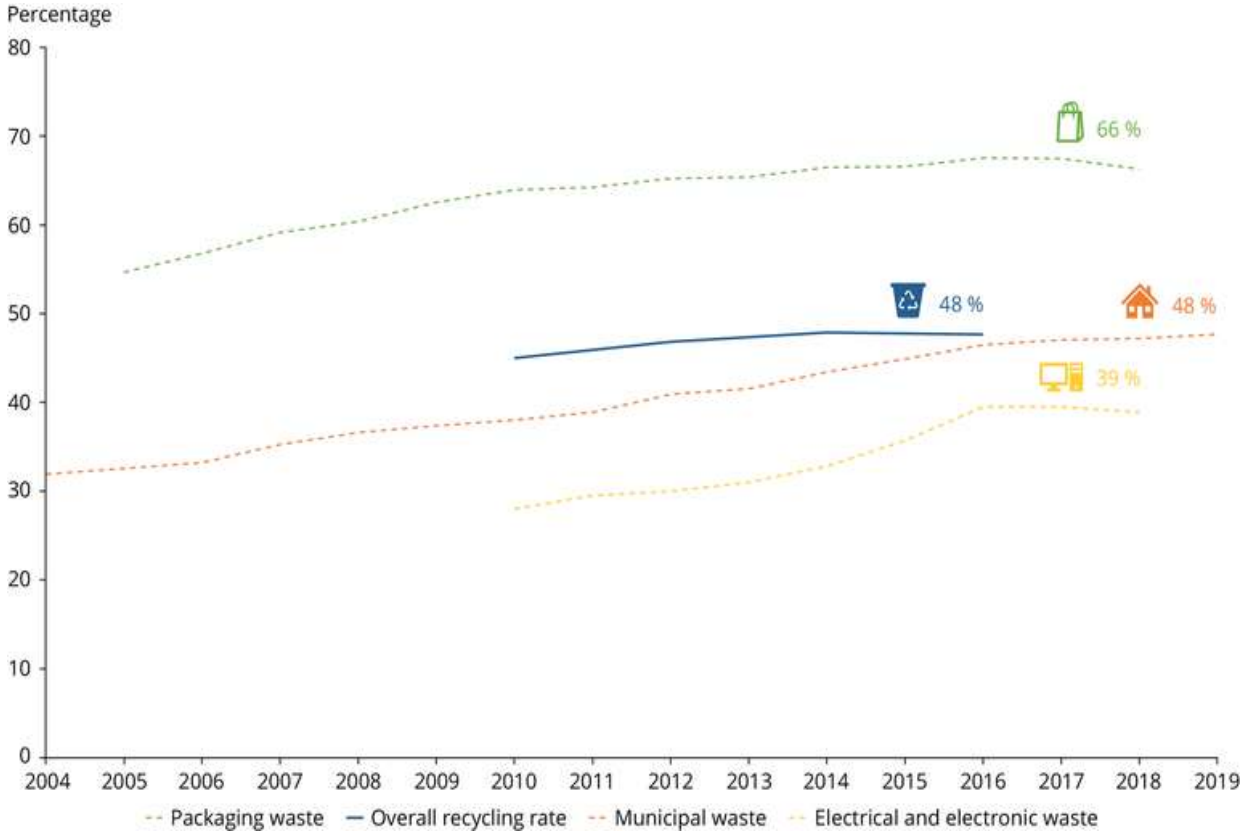

Fig. 3. Recycling rates in Europe by waste stream (2004–2019), %

Source: *Europian Environment Agency, (2019).*

In 2018, 7.5% of waste, excluding basic mineral waste, or 132 kg per capita, was assessed as hazardous to health or the environment.

In Ukraine, the emphasis of the implemented measures for achieving the 12th SDG ("Ensuring of responsible consumption and production") is made on reducing post-harvest losses in agricultural production and efficient waste management, while it should be much more wider (Antoniuk K., Antoniuk D., Mokiy A., 2020).

The importance of the first task can be explained by the priority of agricultural sector development as potentially competitive for the national economy in the medium term. But the constant increase in the load on agricultural land due to increased arable land, agricultural consumption, food prices causes negative consequences, which in the long run pose a significant threat to economic security of regions with reduced resource potential for stable agro-industrial production (Analytical report, 2018). To solve this problem, it is necessary to reduce food losses in the supply chain, the dynamics of which should be assessed using the following indicators: the share of post-harvest losses in total grain production (%); share of post-harvest losses in total production of vegetables and melons (%).

Recently, there has been a decrease in post-harvest losses in total grain production (Fig. 4), the share of which in the regions of Ukraine ranges from 0.1 to 3.4 %. It seems debatable to apply a methodological approach to account for this indicator (Analytical report, 2018), as its real value is much higher, and compared to 2011 has decreased significantly. The following average annual indicators are defined as target values for the national economy: 2020 – 1.8 %; 2025 – 1.0 %; 2030 – 0.5 %.

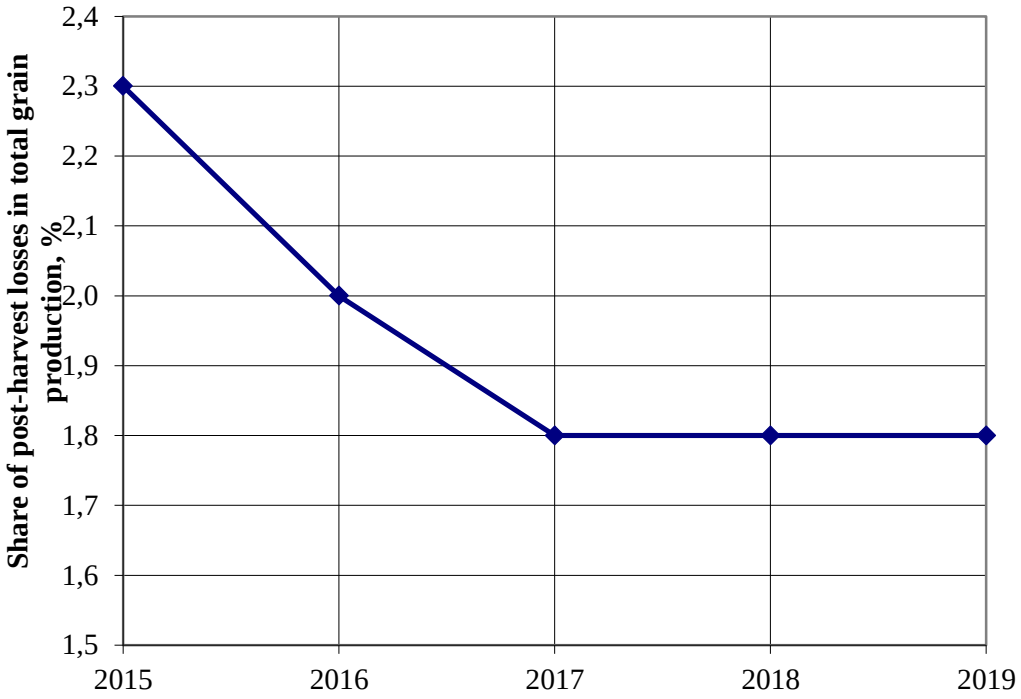

Figure 4. Dynamics of change in the share of post-harvest losses in total grain production,%

Source: Analytical report, 2018.

In Ukraine, the problem of waste management will become increasingly important, including the consumption safety context. The tasks of reducing the volume of waste generation and increasing the volume of their processing and reuse to minimize the negative impact on the environment, increase the efficiency of production and, consequently, the safety of consumption of goods (services) remain decisive.

During 2015–2019, there is a tendency to reduce the volume of waste of hazard classes I–III, but the share of waste of class IV is growing. To some extent, the economic crisis of 2008–2009 and the military-political conflict with the Russian Federation since 2013 have significantly affected the volume of hazardous waste of I–III classes. In 2015, there was a significant decrease of 44% (to the level of 2011), caused by the occupation of certain districts and cities of Donetsk and Luhansk regions, which housed a large part of the country's industrial enterprises. These trends also appeared due to the industry structural reorientation to less production waste.

At the same time, the total amount of waste in the economy is increasing (Fig. 5). In the regional dimension, the leaders are: Dnipropetrovsk region (206 million tons); Kirovohrad (35 million tons); Donetsk (20 million tons); Poltava and Zaporizhia regions (5 million tons each). This is due to the concentration of mining and processing enterprises – the main polluters, whose shares in 2011 were 75.0% and 18.0%, in 2016 – 74.0% and 18.2%, respectively.

The volume of waste disposal in the regions of Ukraine ranges from 3.8 to 67.3% of the total. In Zaporizhzhia, Poltava, Ivano-Frankivsk and Cherkasy region, the share of waste incinerated and utilized at landfills in the total amount of waste generated significantly exceeded the Ukrainian average (29%).

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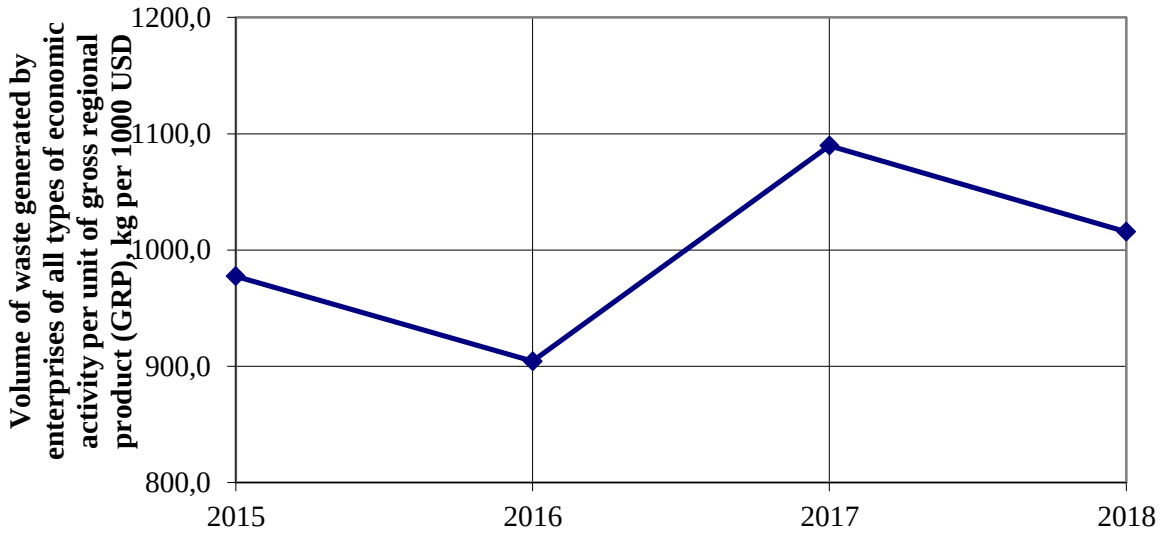

Figure 5. Dynamics of changes in the volume of waste generated by enterprises of all types of economic activity per unit of gross regional product (GRP) (2015-2018), kg per 1000 USD
Source: Analytical report, 2018.

Significant volumes of generated waste and low values of their utilization indicators lead to an increase in the volume of accumulated waste (Table 2). A threatening situation is observed in Dnipropetrovsk region, where 10 million tons of waste are stored, in Zaporizhzhia region (7.7 million tons of waste of I-III classes), in the Sumy region (2.2 million tons of waste of I-III classes) and in Luhansk region (860.4 thousand tons of waste of I-III classes). As for the total amount of waste accumulated during operation, Dnipropetrovsk and Donetsk regions are several times higher than other regions of Ukraine in terms of waste disposal per square kilometer (EEA report, 2016).

Table 2
The total amount of waste accumulated during operation, in places of utilization, per square km, in the most polluted regions of Ukraine, t

№	Region	Years				
		2010	2015	2016	2017	2018
1	Dnipropetrovsk	287151,1	318310,6	320717,2	323535,7	335571,1
2	Donetsk	95742,7	40200,1	32611,6	32587,0	33996,4
3	Kirovohrad	9557,8	13976,5	15274,9	16609,7	21011,1
4	Kyiv city	4442,3	14100,1	13903,3	14258,9	14818,7
5	Lviv	8006,6	10553,0	10617,9	10657,7	10513,4
6	Zaporizhzhia	5439,9	5883,6	5970,2	6082,8	6064,1

Source: EEA report, 2016.

The state of household waste management in Ukraine, according to scientists of the National Institute for Strategic Studies (Yakushenko L.M., Bugaychuk N.V., 2019), is characterized by:

- inconsistencies and imperfections of legislative regulation (52 legal acts, five of which are considered contradictory and eight more - irrelevant);
- low level of infrastructure development in the field of household waste management (as of 2018 in Ukraine 6107 garbage dumps and landfills with a total area of 9172.436 hectares, of which 984 units did not meet environmental safety standards and 256 units - overloaded; the need for new landfills - over 421 units);

- lack of economic incentives to expand the range of services in the field of household waste management;

- imperfect or no informational and educational work (Antoniuk K., Mokiy A. , Pikh M., Bukharina L., Antoniuk D., 2021) in the field of household waste management among the population (as of 2019, only 1462 settlements have introduced separate collection of household waste; in 28 settlements there are 34 waste sorting lines).

CONCLUSION

The critical situation with waste in Ukraine cannot be resolved in the short term, as it requires significant financial and intellectual resources. Implementation of EU environmental policy principles in the areas of "Waste Management", "Industrial pollution and man-made threats", "Climate change and protection of the ozone layer", implementation of investment projects to implement innovative waste management technologies involving European financial institutions will help to solve this problem, which directly affects the safety of consumption.

At present, there is a recognition of the importance of introducing responsible consumption and production, which can be further strengthened by consolidating the actions of the state, business and consumers in the following areas:

- gradual removal of hazardous chemicals from production processes through the introduction of a system of environmental labeling and European standards of production management;

- creation of legal and institutional preconditions for the formation of a green economy in Ukraine, implementation of the concept of a circular economy, the principles of resource-efficient and clean production;

- strengthening the role of united territorial communities, increasing their powers to impose sanctions on companies that pollute the environment;

- application of modern technologies and European practices of waste management of production and consumption of goods (works, services);

- implementation of programs of information, education and educational activities on sustainable production and consumption of goods (works, services).

This will be facilitated by improving the institutional framework for security and sustainable development of Ukraine.

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СТАЛЕ ПОВОДЖЕННЯ З ВІДХОДАМИ: МІЖНАРОДНИЙ ДОСВІД ДЛЯ РЕГІОНІВ УКРАЇНИ

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У статті розглянуто ключові статистичні показники поводження з відходами в контексті сталого розвитку країн ЄС та регіонів України, що дозволяє зрозуміти тенденції розвитку, виокремити проблеми та запропонувати шляхи їх вирішення. Виявлені позитивні тренди у генеруванні, переробці та утилізації відходів, що сприяє збільшенню показника циркулярного використання матеріалів (CMU) в країнах ЄС. Незадовільний стан поводження з відходами у регіонах України, пов'язаний із суттєвими територіальними диспропорціями в їх утворенні та накопиченні, низьким рівнем їх утилізації. Обґрунтовано необхідність впровадження відповідального споживання та виробництва як передумови раціонального поводження з відходами на регіональному рівні в контексті сталого розвитку. **Метою** дослідження є обґрунтування напрямів імплементації досвіду країн ЄС із поводження з відходами для регіонів України задля забезпечення сталого розвитку та безпеки держави. **Методологія:** теоретико-методологічною основою роботи є фундаментальні основи досліджень сталого розвитку, екології, споживання та циркулярної економіки. Для забезпечення концептуальної цілісності дослідження були використані такі методи: статистичний аналіз та систематизація, групування, кабінетні дослідження. **Наукове значення** роботи полягає в тому, що досліджено європейський та вітчизняний досвід поводження з відходами з орієнтацією на забезпечення сталого розвитку, проаналізовано тенденції покращення екологічної ситуації в країнах ЄС (впровадження принципів циркулярної економіки, зменшення обсягів нагромадження та переробки); розроблено рекомендації щодо покращення результатів поводження з відходами на засадах сталого розвитку для України. **Цінність** дослідження полягає в аналізі та обґрунтуванні проблемних напрямів забезпечення сталого поводження з відходами в регіонах України на основі досвіду країн-членів ЄС.

Ключові слова: сталий розвиток, переробка і утилізація відходів, циркулярне використання матеріалів, скорочення післязбиральних втрат, регіони.