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**Kostiuchenko L.V.** PhD in Economics, Associate Professor, Associate Professor of logistics  
Department of National Aviation University (Ukraine)

**ORCID** – 0000-0002-7635-5153

**Researcher ID** – S-7795-2018

**Scopus author id:** –

**Marchuk V.Ye.** Doctor of Engineering, Associate Professor, Professor of Logistics  
Department National Aviation University (Ukraine)

**ORCID** – 0000-0003-0140-5416

**Researcher ID** – S-6514-2018

**Scopus author id:** – 56246790900

**Harmash O.M.** PhD (Economics), Associate Professor, Associate Professor of Logistics  
Department National Aviation University (Ukraine)

**ORCID** – 0000-0003-4324-4411

**Researcher ID** – I-4542-2018

**Scopus author id:** – 57218381499

## DEVELOPMENT OF RECYCLING INFRASTRUCTURE IN UKRAINE

**Lesia Kostiuchenko, Volodymyr Marchuk, Oleg Harmash.** *“Development of recycling infrastructure in Ukraine”.* Today, household waste occupies a large area of legal and illegal landfills, and existing recycling plants are not operating at full capacity due to lack of recyclables. Responsible waste management is a key issue for the entire recycling industry in Ukraine. The study of trends in the development of solid waste recycling infrastructure in developed countries is the basis for the formation of its own recycling system in Ukraine. This explains the fact that in a difficult environmental situation on a global scale, the issue of recycling is gaining priority today.

Modern enterprises that provide services for the removal of household waste, their sorting and further processing today especially need the participation of the state to create market conditions for the development of a competitive environment. After all, in addition to the processing of waste into secondary raw materials, biogas extraction systems are installed at landfills in Ukraine and installations for electricity production are operated. So in parallel with solving the problem of pollution, we have an additional source of alternative energy.

At the legislative level, the executive bodies of village, settlement and city councils have the right to address the issues of collection, transportation, utilization and disposal of household waste, setting tariffs for the service of household waste management, organization of separate collection of useful components of this waste. In order to create a proper system and build infrastructure for efficient waste management, it is important to unite local communities. In addition, it is critical to apply a systematic approach to the organization of the execution chain of all stages of recycling by forming the interaction of all infrastructure elements.

**Keywords:** recycling, recycling infrastructure, waste management, solid waste recycling, secondary resources, household waste management.

**Леся Костюченко, Володимир Марчук, Олег Гармаш. «Розвиток інфраструктури рециклінгу в Україні».** Побутові відходи сьогодні займають чималу територію на законних та незаконних полігонах, а наявні заводи з переробки працюють не на повну потужність через брак вторсировини. Відповідальне поводження з відходами – ключове питання для всієї рециклінгової галузі в Україні. Дослідження тенденцій розвитку інфраструктури рециклінгу твердих побутових відходів розвинених країн є базою для формування власної системи рециклінгу в Україні. Це пояснює той факт, що в умовах складної екологічної ситуації в глобальному масштабі питання рециклінгу сьогодні набуває пріоритетності.

Сучасні підприємства які надають послуги з вивезення побутових відходів, їх сортування та подальшої переробки сьогодні особливо потребують участі держави щодо створення ринкових умов для розвитку конкурентного середовища. Адже, окрім переробки відходів на вторинну сировину, на полігонах України облаштовано системи вилучення біогазу та експлуатуються установки для виробництва електроенергії. Отже паралельно з вирішенням питання забруднення, маємо додаткове джерело альтернативної енергії.

На законодавчому рівні вирішення питань збирання, транспортування, утилізації та знешкодження побутових відходів, встановлення тарифів на послугу з поводження з побутовими відходами, організація роздільного збирання корисних компонентів цих відходів мають право виконавчі органи сільських, селищних та міських рад. З метою створення належної системи та будівництва інфраструктури для ефективного поводження з відходами важливим кроком доцільно виконати об'єднання територіальних громад. Крім того, критично необхідним є застосування системного підходу до організації ланцюга виконання усіх етапів рециклінгу шляхом формування взаємодії роботи усіх інфраструктурних елементів.

**Ключові слова:** рециклінг, інфраструктура рециклінгу, управління відходами, рециклінг твердих побутових відходів, вторинні ресурси, поводження з побутовими відходами.

**Леся Костюченко, Владимир Марчук, Олег Гармаш. «Развитие инфраструктуры рециклинга в Украине».** Бытовые отходы сегодня занимают немалую территорию на законных и незаконных полигонах, а имеющиеся заводы по переработке работают не в полную мощность из-за нехватки вторсырья. Ответственное обращение с отходами – ключевой вопрос всей рециклинговой отрасли в Украине. Исследование тенденций развития инфраструктуры рециклинга твердых бытовых отходов в развитых странах является базой для формирования собственной системы рециклинга в Украине. Это объясняет тот факт, что в условиях сложной экологической ситуации в глобальном масштабе вопрос рециклинга сегодня приобретает приоритетность.

Современные предприятия, предоставляющие услуги по вывозу бытовых отходов, их сортировке и последующей переработке сегодня особенно нуждаются в участии государства в создании рыночных условий для развития конкурентной среды. Ведь кроме переработки отходов на вторичное сырье, полигоны Украины обустроены системами извлечения биогаза, а также эксплуатируются установки для производства электроэнергии. Таким образом, параллельно с решением вопроса загрязнения, имеем дополнительный источник альтернативной энергии.

На законодательном уровне решение вопросов касательно сбора, транспортировки, утилизации и обезвреживания бытовых отходов, установление тарифов на услугу обращения с бытовыми отходами, организация раздельного сбора полезных компонентов этих отходов имеют полномочия исполнительные органы сельских, поселковых и городских советов. С целью создания надлежащей системы и строительства инфраструктуры для эффективного обращения с отходами важным шагом рекомендуется объединение территориальных общин. Кроме того, критически необходимым является применение системного подхода к организации цепочки выполнения всех этапов рециклинга путем формирования взаимодействия работы всех инфраструктурных элементов.

**Ключевые слова:** рециклинг, инфраструктура рециклинга, управление отходами, переработка твердых отходов, вторичные ресурсы, управление бытовыми отходами.



**Introduction.** In a difficult environmental situation on a global scale, the issue of recycling is becoming a priority. Today, environmental issues fill the agenda of many international meetings of various levels and areas: political, scientific, industrial, medical, economic, narrowly specialized, and so on. The study of trends in the development of solid waste recycling infrastructure in developed countries is the basis for the formation of its own recycling system in Ukraine

**Analysis of recent researches and publications.** Leading countries around the world have developed a five-step hierarchy of waste management, which is based on the priority of waste prevention. And if it cannot be prevented, efforts are made to reuse, if not possible as a recycling (recycling of waste into products, materials or substances) [3]. In the general, recycling is the phenomenon of returning to industrial production of some materials contained in industrial, construction and household waste [4, c. 103].

According to the Ministry of Community and Territorial Development of Ukraine, recycling includes the recycling of organic material, but does not include energy recovery or recycling into materials to be used as fuel or backfill materials. In the event that recycling is not possible, energy recovery or recycling operations are used to be used as fuel or backfill materials. In this case, backfilling is a recovery procedure, when suitable waste (except hazardous) is used to fill voids or for engineering purposes in landscape work, where waste replaces materials that are not waste. If all these operations have already been performed or cannot be performed - waste can be removed (including buried, placed in special landfills, incinerated, dissolved, etc.). Ukraine has also adopted such a hierarchy, approving the

National Waste Management Strategy in 2017[3].

Today, household waste occupies a large area of legal and illegal landfills, and existing recycling plants are not operating at full capacity due to lack of recyclables. Responsible waste management is a key issue for the entire recycling industry in Ukraine. As a result, during 2020, Ukraine generated more than 54 million m<sup>2</sup> of household waste, or more than 10 million tons, which are disposed of in 6,000 landfills and landfills with a total area of almost 9,000 hectares [5]. In addition, there are uncontrolled illegal accumulations of garbage in Ukraine. At the same time, the periodic shortage of high-quality sorted raw materials at processing enterprises leads to the need to purchase it abroad.

**The purpose and objectives of the study.** Analysis of the publications of the above authors shows that views on the nature and content of recycling practitioners and academic experts do not differ. However, the researched publications do not have enough information on the formation of infrastructure for a recycling system within the country. That is why the purpose of this study is to study current trends in the development of recycling infrastructure in Ukraine.

**Basic material and results.** Studies have shown that in 2019 in Ukraine separate collection of solid waste is carried out in 1462 settlements (except for the territories of the Autonomous Republic of Crimea, Sevastopol), which is 281 settlements more than in 2018. The largest share of settlements in which separate collection of solid household waste is introduced (see Table 1), in the total number of settlements in the region - in the Zakarpattian region (19.7%), the second place went to Ternopil (18.7%), third - Kharkiv region (12.3%), in fourth place - Chernivtsi (8.4%), Volyn (8.3%), Ivano-Frankivsk region (8.1%). [6]

Table 1. – Share of settlements in which separate collection of solid household waste is introduced, from the total number of settlements of the region, %.

Name of the region	2018	2019	Deviations until 2018,+/-
Vinnitsia	4,9	7,9	+3
Volyn	1,2	8,3	+7,1
Dnepropetrovsk	3,1	3,3	+0,2
Donetsk	1,5	4	+2,5
Zhytomyr	1,2	1,2	0
Zakarpattia	29,6	19,7	-9,9
Zaporozhye	1,7	1,7	0
Ivano-Frankivsk	12,6	8,1	-4,5
Kyiv	3,6	2,2	-1,4
Kirovograd	0,8	1,6	+0,8
Luhansk	1,3	1,1	-0,2
Lviv	5	7,3	+2,3
Mykolayiv	1,9	1,9	0
Odessa	1,6	2,6	+1
Poltava	1,2	2	+0,8
Rivne	3,8	6,9	+3,1
Sumy	0,5	3	+2,5
Ternopil	14,7	18,7	+4
Kharkiv	10,9	12,3	+1,4
Kherson	2,4	3,9	+1,5
Khmelnitsky	1	1,2	+0,2
Cherkasy	0,9	1,3	+0,4
Chernivtsi	7,4	8,4	+1
Chernihiv	1,9	2,2	+0,3
In general, in Ukraine	4,1	5,1	+1

Source: [6]

The change in the dynamics of the share of settlements in which separate collection of

solid household waste has been introduced in recent years is shown in Fig. 1.



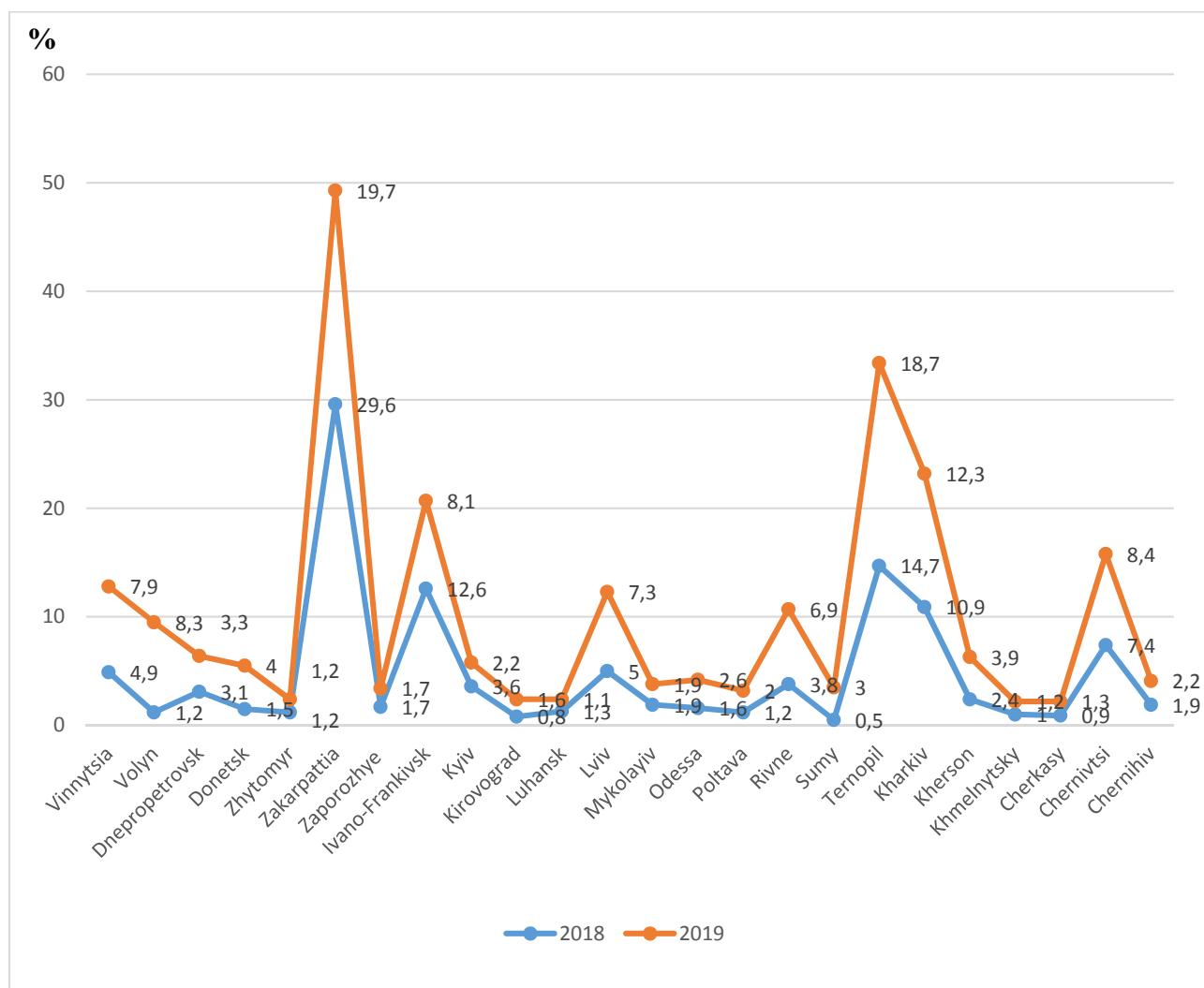


Figure 1. The dynamics of the share of settlements in which separate collection of solid household waste has been introduced

Source: [6]

The Law of Ukraine "On Housing and Communal Services" dated 09.11.2017 № 2189-VIII (entered into force on 01.05.2019) powers on the processing and disposal of household waste, as well as the establishment of tariffs for household waste management transferred to local governments, which caused demonopolization of the market of services for processing and disposal of household waste. However, the non-adoption at the legislative level of the introduction of extended liability of producers and importers of goods currently hinders the development of the field of household waste management.

According to the Ministry of Development of Communities and Territories of Ukraine [3], today in about 1,200

settlements separate collection of household waste is being introduced, which is one and a half times more than last year. There are 26 garbage sorting lines in 21 settlements, garbage sorting complexes are being built in 18 settlements. Annually, 700 thousand tons of cardboard and paper products, 120 thousand tons of polymers, 50 thousand tons of PET bottles, 460 thousand tons of cullet get to the waste processing enterprises of Ukraine. As of today, there are 91 processing enterprises in Ukraine, namely 17 waste paper processing enterprises, 39 polymer processing enterprises, 19 plastic bottle processing enterprises, and 16 cullet processing plants. They are loaded at 50-70% of their capacity (see Fig. 2).

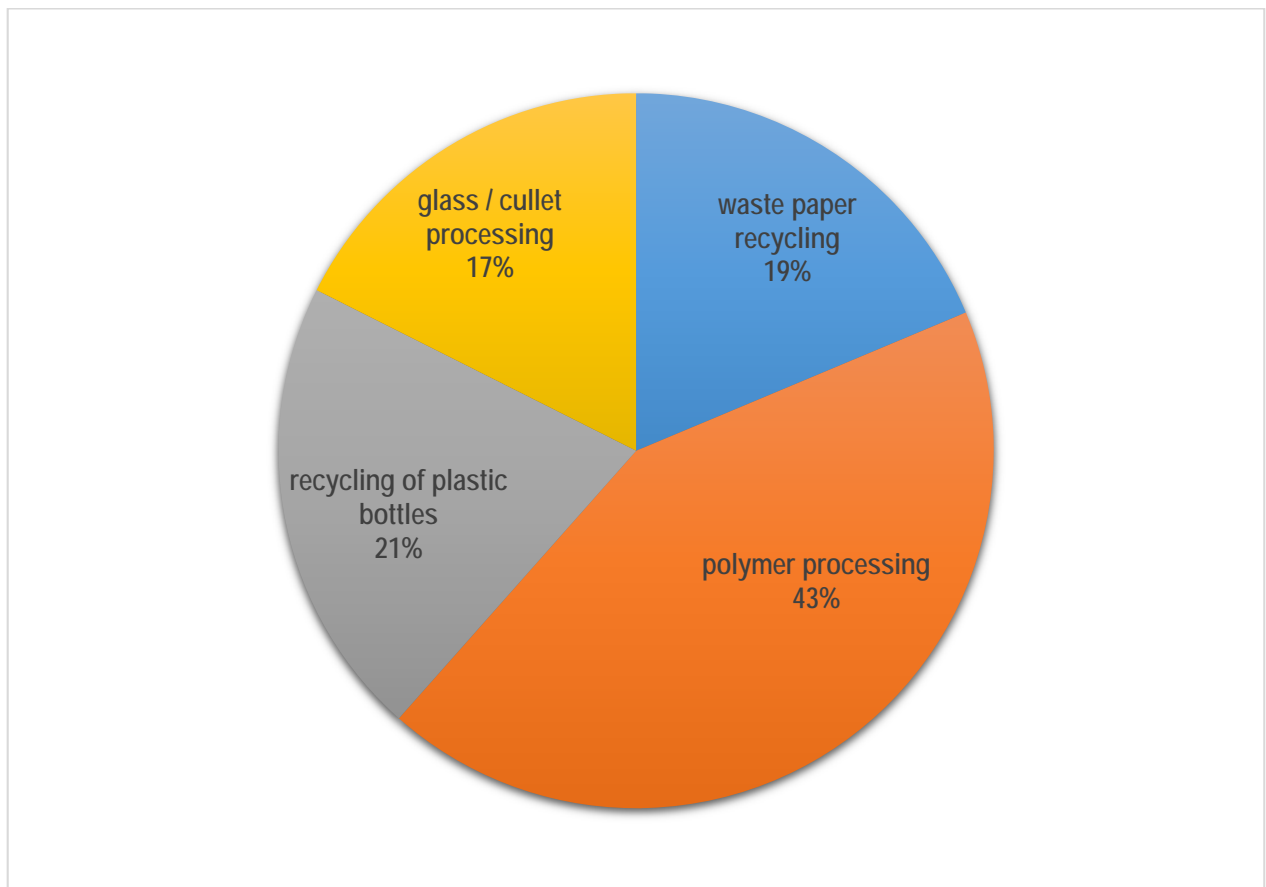


Figure 1 Structure of solid waste processing in Ukraine

Source: [3; 5]

Due to the separate collection of household waste by the population, the operation of sorting lines at landfills and collection points for secondary raw materials, the amount of collected valuable resource components is only 40% of the capacity of waste processing plants. As a result, the volume of forced imports of secondary raw materials for the operation of existing processing enterprises amounted to 400 thousand tons. It should be noted that in 2018, in order to provide quality services for the removal of household waste and cover the entire population, this service provided for the purchase of more than 172 million hryvnias more than 36 thousand containers for household waste, including more than 7 thousand containers for separate collection of household waste, and 181 specially equipped vehicles worth UAH 400 million. The purchase of containers and garbage trucks was carried out at the expense of local budgets, from the

funds of regional development and environmental protection and at the expense of private enterprises. In addition, a biogas extraction system has been installed at 28 landfills and cogeneration units with a capacity of 45.2 MW are in operation. The amount of electricity produced according to the NCRECP for 2018 as of November 1, 2018 is more than 144 million kWh. [5]

Among the recycling complexes a special place is occupied by waste incineration plants. This is the most common type of waste processing plant in developed countries. The first such manufactory was built in Nottingham near London in 1874 using the simplest technology as a waste disposal by incineration. Today's incinerators are a classic example of alternative energy. There are more than 2,500 of them in the world. In the USA, for example, there are about 500 productions, in Germany and France more than 100 in each. Among the world's megacities, the

largest number of such plants in Beijing – 32. There were 5 incinerators in Ukraine at different times (Kyiv, Dnipro, Kharkiv, Rivne and Sevastopol (is occupied today)), of which only the Energia plant in Kyiv operates. Today, the issue of chemical flue gas cleaning is acute at the enterprise. Similar problems are common to all incinerators. The products of waste combustion contain almost all the elements of the periodic table, the most dangerous heavy metals, acids and sulfur dioxide. Modern flue gas cleaning technologies can completely neutralize the negative effects of these substances. Therefore, in developed countries there are no restrictions on the location of incinerators. There are many examples of such companies located even in the city center, for example Tokyo, Zurich, or Lyon. The most textbook example is the Spittelau plant in Vienna, located in the center of the Austrian capital. Of course, ensuring the environmental safety of incinerators and the introduction of modern methods of purification of exhaust gases significantly increase the cost of construction of such enterprises. In the structure of the total construction cost, such costs can be up to 50%. The cost of building a new plant for processing 500 thousand tons of waste per year ranges from 300 to 400 million dollars. Concentrating such funds is a daunting task for most local governments. Therefore, many of them are actively looking for investors to build incinerators. [2]

In 2020, Ukraine generated more than 54 million m<sup>3</sup> of household waste, or more than 10 million tons, which are disposed of in 6,000 landfills and landfills with a total area of almost 9 thousand hectares. Almost 79% of the population of Ukraine is covered by household waste disposal services. The worst rate of coverage of the population with services for the removal of household waste in Kirovohrad region (64.8%) and in Zhytomyr region (65.3%). Due to the introduction, in 1725 settlements of separate household waste collection, operation of 34 waste sorting lines, 1 incinerator and 3 incinerators recycled and disposed of about 6.3% of

household waste, of which: 1.7% incinerated and 4.6% household waste got to the procurement points of secondary raw materials and waste processing lines. [7]

According to expert estimates, biogas extraction systems have been installed at 26 landfills in Ukraine, and installations for the production of electricity with a capacity of 30 MW are in operation. The amount of utilized biogas in 2020 amounted to 64.0 million m<sup>3</sup> (50% methane). The amount of electricity produced in 2020 is 112.3 GWh. However, the number of overloaded landfills is 261 units. (4.3%), and 868 units. (14%) do not meet environmental safety standards. Improper work on certification and reclamation of landfills. Of the 1,542 landfills that need certification, in 2020, 93 units were actually certified (23.9% of the total number of landfills need certification). The largest number of landfills that require certification is in Zhytomyr oblast - 243 units, in Dnipropetrovsk oblast - 147 units and in Chernihiv oblast - 132 units. [7]

According to data [7], out of 424 landfills in need of reclamation, 24 were actually reclaimed. The largest number of landfills in need of reclamation is in Odesa oblast - 82 units and in Zakarpattia oblast - 59 units. The need for construction of new landfills is 318 units. The greatest need for construction of new landfills in Dnipropetrovsk region is 42 units. Due to the improper system of solid waste management in settlements, usually in the private sector, in the reporting year 22.6 thousand unauthorized landfills covering an area of 0.56 thousand hectares were identified, of which 21.7 thousand were liquidated in 2020. unauthorized landfills with an area of 0.53 thousand hectares [7].

Businesses that provide household waste disposal services, which include companies that provide sanitation services, today especially need the participation of the state to create market conditions for the development of a competitive environment. According to [7], in 2020, 1190 organizations provided sanitation services including 264 privately owned (22%). The largest number of

privately owned enterprises in this area is in Kyiv (94%) and Zakarpattia region (55%). The number of employees in the field of household waste management is more than 18.4 thousand people. The total number of specially equipped vehicles is almost 3.9 thousand units. The average wear of special vehicles in 2020 is 62%. The lowest percentage of worn-out garbage trucks in Poltava and Rivne regions is 45% [7].

In 2020, almost UAH 1 billion was allocated for subsidized financing of the development and maintenance of sanitation. The largest amounts of financing in the field of household waste management were

observed in Kharkiv region (over UAH 378 million) and in Kyiv (over UAH 292 million). In general, the statistics of financing the field of household waste management in 2020 are given in table. 2.

The largest accounts payable in the field of household waste management were recorded in Donetsk region and Kyiv. The main factor hindering the introduction of modern methods and technologies in this area is insufficient funding, which is carried out in general at the expense of consumers of services and costs from local budgets for the elimination of unauthorized landfills. [7]

Table 2. – Financing of household waste management in 2020

Indicator	Value / amount	Units of measurement
The average tariff for household waste management in the country	130	UAH./M <sup>3</sup>
- including for burial	42	UAH./M <sup>3</sup>
Average tariff for household waste management for the population	111,7	UAH./M <sup>3</sup>
- including for burial	37,8	UAH./M <sup>3</sup>
The volume of sales of services for the removal of household waste	5,2	billion UAH.
The volume of paid services for the removal of household waste	4,9	billion UAH.
The amount of benefits to the population in the provision of services for the removal of household waste according to the calculations of enterprises	55,3	Million UAH
The amount of reimbursement of benefits	52,7	Million UAH
Accounts payable in the field of household waste management	563	Million UAH
including wages	44	Million UAH
Receivables	1,79	billion UAH.
including debt:		
- people	1,6	billion UAH.
- budget organizations	0,035	billion UAH.

Source: [7]

**Conclusions.** At the legislative level, the executive bodies of village, settlement and city councils have the right to address the issues of collection, transportation, utilization and disposal of household waste, setting tariffs for the service of household waste management, organization of separate collection of useful components of this waste.

In order to create a proper system and build infrastructure for efficient waste management, it is important to unite local communities. In addition, it is critical to apply a systematic approach to the organization of the execution chain of all stages of recycling by forming the interaction of all infrastructure elements

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