INNOVATIONS IN THE FIELD OF WASTE MANAGEMENT: UKRAINE AND INTERNATIONAL EXPERIENCE

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Every day the world's population throws away thousands of tons of used and unnecessary materials. Some of them pose a threat to human and animal health. Garbage is thrown away in various ways. These can be precious metals, glass cans and containers, bags, waste paper, plastic, food waste, etc.

People's lives are characterized by the emergence of a large number of different wastes. The significant increase in the needs of the population in recent years on the planet has led to a rapid increase in the amount of various types of waste, including solid waste, which pollutes the environment. They also serve as a source of harmful biological, chemical and biochemical substances into the environment. These substances cause significant damage to human life and health, as well as to future generations. In addition, solid waste must be presented as a source of a number of valuable substances needed for use in the most developed industries. It is impossible to make production waste-free, just as any consumption carries waste. Due to the improvement of production processes, increased market services, changes in living standards, significantly changes the quantitative and qualitative composition of garbage. Also, with a significant decline in production in Ukraine in general, increasing stocks of illiquid waste, which worsens the environmental situation of districts and cities, and therefore our chosen topic, is relevant.

Waste has accompanied mankind since the beginning of civilization. But it is only now that the world community has begun to realize the negative role that garbage plays in their lives. In just ten years, there has been a significant increase in awareness of this issue, although some issues, such as waste recycling, are still unclear. What is waste disposal?

In the traditional sense, waste disposal involves the disposal of waste, for example in kilns. In fact, some waste is disposed of by incineration, but recycling is a much more complex process that begins with the stages of recovery, collection and sorting. All these activities are aimed at using waste as a secondary raw material. It should be noted that this is a way to give waste a second life, because waste cannot be destroyed and disposed of without a trace. However, they can be used to minimize the negative impact on the environment.

Disposal and recycling

Disposal is a broader term than recycling, which applies only to a certain group of waste. As the name implies, recycling is a method of removing secondary raw materials from reuse in a certain cycle. For example, metals used in the manufacture of electronic devices can be removed from them and reused. This allows you to extend the production cycle indefinitely, because metals do not lose their properties during processing, which distinguishes recycling from recycling - in the process, many wastes lose their properties permanently.

Recycling is important for the whole world. With its help the following problems are solved: there are resources which stock is limited and it will not be possible to replenish them in the near future. By using recyclable materials, you can reduce costs. Most discarded waste can be reused for a cheaper way to produce most goods, so recycling industrial waste for further use is becoming increasingly important around the world. On the territory of Ukraine this direction is considered new and is only being mastered. The relevance of the technology increases the potential for savings that can be achieved through the use of secondary raw materials instead of primary sources.

It should also be noted that such methods of waste management as landfills, incineration - have a negative impact on the ecological situation of the country and adversely affect the life of not only humans but also flora and fauna.

Research on how landfills have an impact on the health of people living nearby has been going on since the 1970s. Their results are contradictory. Although many scientific studies have linked airborne substances to human health problems, there are a number of studies that do not. On the one hand, experts note that landfills around the world are not located in the richest areas. Their inhabitants tend to eat less and are generally less able to take care of their health. On the other hand, even in the circumstances listed above, the accumulated data are sufficient to raise serious concerns about landfills.

In the autumn of 2015, a conference of 24 experts from the World Health Organization from 11 countries was held in Bonn, Germany. Finally, the report "Waste and human health: Evidence and needs" was published, which deals with the long-term effects of hydrogen sulfide (H2S) and other harmful substances emitted by landfills on health. I am people who live within a radius of 2 km from landfills with hazardous waste. The authors of the report an increased risk of cancer (pancreas, larynx, liver, kidney), lymphoma, which is noted in a number of studies, discussing, however, that the data obtained need further verification. Also, living near the landfill can contribute to respiratory diseases.

The issue of the health of people living near landfills has been raised by Italian scientists. In 2009–2011, they studied risks in areas where landfills were poorly controlled by government agencies. In the Campaign, for example, they found a statistically significant increase in mortality compared to the population of remote areas, as well as higher risks of liver cancer (both sexes), stomach and lung cancer (men). In addition, among congenital defects infants in these populations significantly exceeded the average level of urogenital tract abnormalities. The researchers included 242,409 people living within a 5 km radius of nine different landfills. The study participants settled in this area at different times, from January 1, 1996 to the end of 2008. Scientists monitored their health until December 31, 2012. Researchers have observed a clear correlation between elevated levels of hydrogen sulfide in the air and mortality from lung cancer and respiratory diseases, as well as the frequency of hospitalizations for respiratory diseases, especially acute respiratory infections in children under 14 years of age.

The authors consider the link between landfill and respiratory disease proven (as it has been demonstrated repeatedly in previous studies), and the causal link between toxic emissions and lung cancer, they believe, needs further confirmation.

So they write in the conclusion of the study in full accordance with the criteria of evidence in medical science, which for the final conclusion requires repeated reproduction of the results by different scientists. But even if the conclusion about lung cancer is considered inconclusive, it is still clear: landfills are a very serious risk factor for people living in the immediate vicinity, for adults and children, for pregnant women.

The solution to the problem of landfills is to create a cyclical economy, where waste is disposed of as raw material for industry. In some countries around the world, such an economy has already been established, such as in Germany, where the last landfill ceased to exist in 2005. Unfortunately, this is not a close path for us, but I would very much like the problem to be at least formulated and the first steps to be taken.

Given these facts, many are also wondering how to use waste wisely. Mankind needs a system that can preserve the environment, the health of citizens and earn extra income. Given all these issues, the state has supported the development of recycling in the country. Businesses have to pay additional taxes if their shops do not have an individual disposal system.

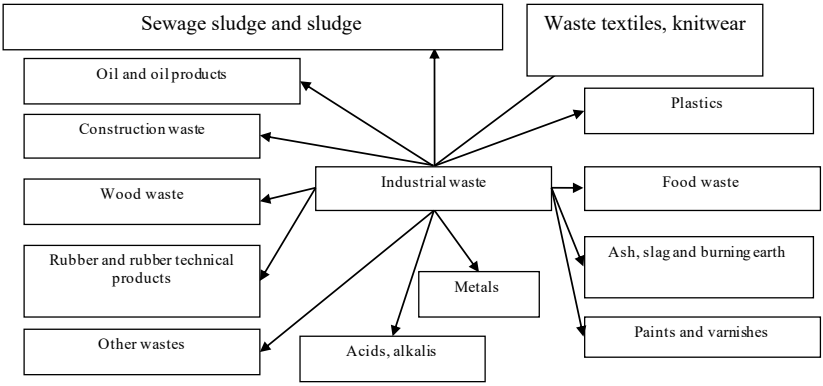

Fig. 1 – Classification of industrial waste

What waste can be disposed of? You can dispose of different types of waste that are not normally associated with recyclable materials, such as plastic, paper or glass. The best example of waste disposal is the use of livestock waste in the production of industrial fats, adhesives, gelatin or feed flour. Other examples are the production of animal feed from agricultural waste. On the other hand, construction waste, such as demolition and repair, can be used in the production of aggregates. It

happens that part of the waste is incinerated - this should also be considered as recycling, because incineration produces heat energy that goes to heating homes or hot water. As you can see, many wastes can find new life and useful uses.

Industrial waste can be divided into the following categories, which are presented in Figure 1.

On average, 28% of waste in the European Union is recycled, 49% is recycled and only 23% is recyclable [5].

According to the Ministry of Environmental Protection, Ukraine generates half a billion tons of waste annually, more than 90% of which is sent to landfills. At the same time, waste processing plants currently exist only at the project stage. «Word and deed» offers to see how much waste are generated in Ukraine, how much is disposed of, and how much is stored in landfills [10].

In 2010, 422.5 million tons of wastes were generated in Ukraine, 144.9 million tons were disposed of, and 311.6 million tons were sent for storage to specially designated places (Figure 2). Thus, the total amount of accumulated waste amounted to 13 billion 220 million tons. In 2020, 462.4 million tons of wastes were generated: 100.5 million tons were disposed of, 276 million tons were sent for storage. A small amount of waste in Ukraine is incinerated - an average of 1-1.1 million tons per year [10].

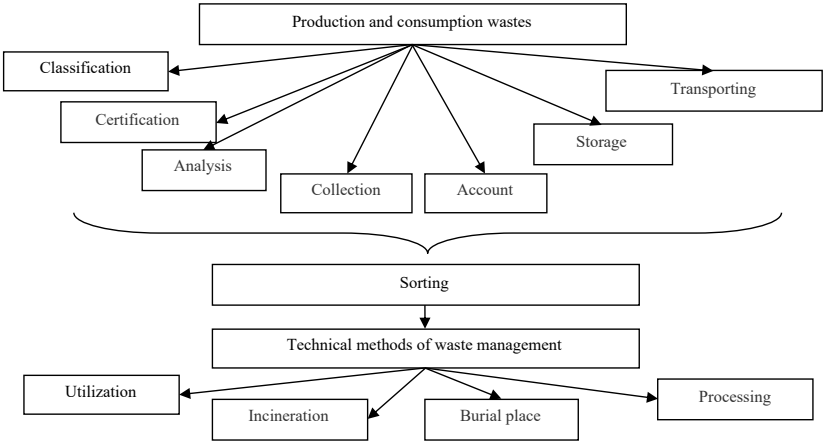

Fig. 2 – Scheme of the mechanism of household waste management

In Ukraine, landfills and landfills occupy about 9,000 hectares. Therefore, the issue of construction of waste processing plants is acute for every region of Ukraine. A lot of money needs to be invested in these projects, so this is still a question at the stage of promises. In August 2018, the mayor of Kyiv said that it is possible to build such a plant in 2-3 years, but they are still looking for an investor. The mayor of Sumy in 2019 also announced its intention to build, and therefore the land was allocated [9].

From this we can conclude that the Ukrainian waste disposal system is far from perfect, because the developed mechanism of full or partial recycling, energy distribution and energy supply has no alternative means of obtaining energy from garbage, many wastes emit harmful substances that affect public health, which lives nearby.

It should be noted that the authorities can influence such a difficult situation. Thus, in the area of North Rhine-Westphalia in Germany, local authorities spend about 7 million euros annually. Most importantly, the Germans have large penalties. For garbage along the road – up to 500 euros, for trying to throw household appliances in the woods – up to 300 euros, and if the garbage contains hazardous substances – up to 2.5 thousand euros. Against this background, Ukrainian sanctions for such violations – up to UAH 1,300 - seem ridiculous. [5].

Taxes on landfills, waste disposal and / or transportation are usually calculated at fixed rates: they vary from country to country. The highest taxes in this category are in the Scandinavian countries and the Netherlands: here they reach 150 euros per tonne; in other countries such a tax may be in the range of 5-20 euros per tonne. In practice, there is a widespread correlation: the higher the taxes on landfills, the less they are exported here. This is the mechanism in which there is a movement from the bottom up – from landfills ("landfill") to higher levels in the "hierarchy of waste management" (Figure 3). This is facilitated by tools such as forms of direct support for recycling and composting, as well as the dissemination of various "prevention" or "prevention" practices.

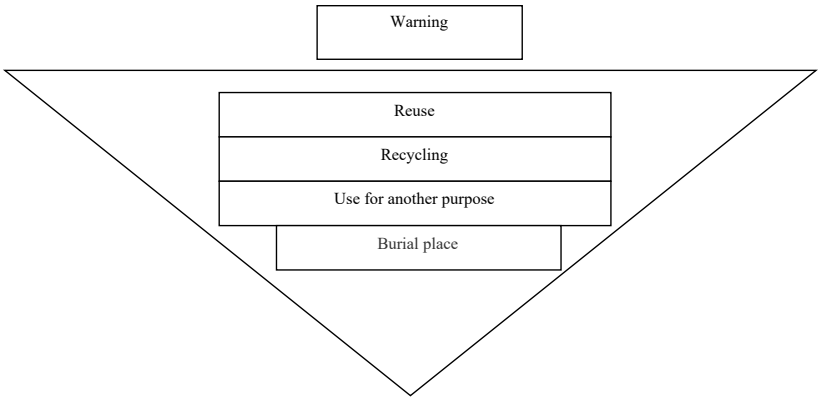

Fig. 3 – Waste management hierarchy in the EU

It should be noted that back in 1975, in order to converge the various national practices of the EU, the so-called Waste Framework Directive (75/442 / EEC) was adopted, which established general requirements and basic definitions (concepts and terms) in in this area. The Directive was republished and "codified" in 2006 (cited in a text repealing previous versions), and is currently in its latest version of 2008 under Directive 2008/98 / EC. Directive 2008/98 / EC emphasized the issue of the

waste management hierarchy, a concept that shows a sequence of best practices that ultimately reduces waste. Visually, the concept is represented in the form of an inverted pyramid.

It should be noted that the Ukrainian experience in waste management today does not coincide with the Western European experience in waste management: the differences, as we see, begin at the level of basic and source terminology. It is clear that "waste management" is ultimately focused on "landfill", while "management" involves a large number of possible activities. In the domestic literature there is no definition of a number of other concepts: yes, sometimes arbitrarily interpreted "reuse" and "recycling". Therefore, it is necessary to define the main definitions in the EU and in Ukraine. Without full conceptual and terminological clarity on all sides, the problem of Ukraine's rapprochement with the European Union's waste policy will obviously not be achieved. In France, Eco-Emballages provides training and advice to anyone, but mostly engineering students, on minimizing packaging waste.

Belgium is implementing a regional program (Flanders) to significantly reduce household waste; while part of the waste after grinding is used for energy. In parallel, the so-called reuse centers are being developed, which collect, sort, repair and sell "household waste" - clothing, household appliances, furniture, utensils, books and bicycles. The centers are tasked, among other things, with: 1) collecting at least five kilograms of items to be restored per person per year; 2) provide employment to a certain number of people; 3) serve at least 4 million consumers.

In Austria, the Law on Waste Management provides for the initial eco-design of products, the appropriate organization of production and distribution processes and work with consumers. Among other things, the following have been developed here: 1) the "flea market" based on the Internet, through which consumer goods, construction and garden tools are sold; 2) repair and maintenance centers - dozens of small centers where you can cheaply repair household appliances; 3) programs such as "change your lifestyle" that focus on services instead of buying goods.

In Italy, one of the regional initiatives (Piedmont) provides training and other services to households on composting food waste.

Various ways of using plastic recycling for road construction are being discussed today. The main asphalt road lasts for a maximum of 50 years and is in constant need of repair - the Dutch company VolkerWessels today promotes the concept of a plastic "eternal road", which does not take long to build, which requires minimal care and is safe. The basis of the project is modular plastic plates with empty internal space for rainwater drainage and placement of communication cables. PlasticRoad, as the project is called, predicts that such roads can be built 80% faster than usual and will last three times longer. The developed modules are resistant to temperature changes from minus 40 to plus 80, they can withstand the same load as traditional asphalt, they are easy to transport, and the soil under such highways is less prone to subsidence. At the end of their service life, such coatings can be recycled and reused.

These are just a few of the many possible examples of how waste prevention is carried out.

In Ukraine, some companies servicing the housing stock are beginning to implement modern waste collection systems, including selective collection. At the same time, the conscious participation of the population in the process of preliminary waste sorting is the most important problem in the implementation of selective waste collection. To do this, cities need to install modern containers for solid waste (hereinafter solid waste) of deep type, which have a large capacity and can be installed in close proximity to buildings.

The COVID-19 pandemic has exacerbated another environmental problem. The overall level of harmful emissions into the atmosphere has decreased due to the closure or transition to a new regime of some enterprises. However, the amount of medical waste has increased. These include containers for disinfectants, used gloves and masks, syringes that decompose over hundreds of years. The problem is further complicated by the fact that it is medical waste that must be disinfected before recycling. It should be noted that medical waste contains hazardous chemicals and microorganisms that can pose an epidemiological threat.

Thus, in 2020, hospitals in the United States produced 6 times more medical waste than usual [12]. What to do with this problem? We need to create an effective system of medical waste disposal in our country, and medical institutions must choose those contractors with whom to work safely. The problem of disposing of medical waste used by the population during the pandemic and thrown in the trash remains open. These wastes accumulate outside medical facilities and are not regulated or controlled by the state. Therefore, the question of personal responsibility of every citizen to the disposal of such waste is acute for humanity. The waste management mechanism should include the development and implementation of the necessary regulatory framework at all levels of government, the key point of which is to preserve the environment for healthy living. It is necessary to develop a system of measures for the treatment of household waste, which can become a raw material for enterprises for their processing. It should be emphasized that the first step is to start from the level of local self-government, because it is at the regional level that it is better to resolve some issues quickly, better and efficiently.

It should be noted that on January 1, 2021, the International Convention on the Prohibition of the Export of Plastic Wastes for Processing from Richer to Poor Counts entered into force. The new rules, agreed by more than 180 countries in accordance with the amendments to the Basel Convention, introduce a system of "prior informed consent" for all export operations with waste that is difficult to recycle or contaminated with plastic [11].

Let's analyze how different countries of the world solve waste disposal issues. For decades, the United States and other developed countries have exported most of their garbage to China. But in 2018, Beijing restricted imports to improve its own environmental situation. Other Asian countries have followed suit. Because of this, some countries have had to take serious care of the problem of recycling.

It should be noted that until recently, China was the largest importer of garbage. Since 1992, the country has imported 45% of the world's plastic waste,

according to Science Advances. At the same time, she accepted dirty and unsorted garbage. China has used the waste to produce new goods, and haulers have specifically offered a discount on garbage transportation so that their ships do not return from the United States and other countries empty. But in 2018, due to public dissatisfaction with foreign garbage, Beijing banned the import of 24 categories of waste. As a result, by October 2019, the supply of plastic waste from the United States to China decreased by 89% compared to the beginning of 2017, and waste paper - by 96%, according to the Institute for Industrial Waste Recycling. After the Chinese ban, the volume of plastic processing increased sharply in Turkey - from 159,000 to 439,000 tons in two years. Every month, ships enter the ports of Istanbul and Adana, carrying about 2,000 tons of garbage that was previously imported into China. Dozens of others from Great Britain and some other European countries join these cargo ships [13].

As a result, many countries have also started sending more garbage to India, Indonesia and Malaysia. But they also soon imposed their own restrictions. For example, in May, Malaysia began returning plastic waste containers to developed countries if it found other wastes in them.

American cities are currently having a hard time finding new buyers because many small towns are not used to sorting garbage. Republic Services, one of the largest garbage companies in the United States, has stopped accepting unsorted waste in Memphis. But not everyone is ready to relearn - for example, Memphis airport simply began to send garbage to landfills. Now American garbage companies have begun to invest in new technologies to quickly check the sorting of garbage and send for recycling. But because of this, the cost of their services doubles.

It should be noted that the United States produces more than 250 million tons of household waste annually. For every inhabitant of New York, for example, according to the statistics of the city health department, there are 11.33 kilograms of waste per week - 7.25 kilograms at the place of residence and 4.08 kilograms at work.

Requirements for recycling are set by local city and state authorities. And penalty systems encourage people to take garbage to certain places in strictly marked containers for waste paper, glass, plastic and other waste. For example, in a large 100-apartment residential complex in southern New York, garbage cans are installed on each floor with detailed instructions - even for metal hangers and used batteries have their own containers. In some states, when you buy recyclable goods, they include a certain amount (about 10 cents) as collateral.

The biggest problems are the cleaning of scrap - old tires, furniture, appliances, for the removal and transportation of which requires at least two people. Yes, the removal of one piece of furniture will cost $ 80, an old refrigerator - $ 100, baths - $ 130. The real scourge of American cities is plastic garbage. In New York, the "plastic problem" is being addressed through bans and incentives for recycling. For example, depending on the size, some stores have to install containers to collect used plastic bags, while others have to develop their own plastic recycling programs. From 2019, the city will not be able to serve food in disposable food containers made of expanded polystyrene.

In general, different states and cities solve the problem of plastic pollution in their own way. At the federal level there is a program of three R - reduce, reuse and recycle (reduction of consumption, reuse, recycling). Its goal is to increase waste recycling and reduce the number of landfills. Citizens are taught to reuse what can be disposed of, sorted and disposed of properly. The program obliges Americans to buy special packages for general waste and provides them with tax benefits for the export of useful secondary raw materials or organic matter to special points.

More than 550 plants in the United States process secondary raw materials, about one thousand more plants specialize in the production of biofuels based on secondary raw materials, and there is also a plant for the production of liquefied gas from recycled household waste. To date, 1.5 million people are employed in waste recycling, and the turnover of this industry is about $ 250 billion. Over the past 30 years, the level of waste recycling in the country as a whole has tripled and exceeded 34%.

Japan, the second largest exporter of plastic waste after the United States, has also historically shipped garbage mainly to China. After the restrictions were imposed, it began to accumulate garbage, hoping that a new market would emerge. As a result, 500,000 tons of plastic wastes were collected in Japan last year (according to the Ministry of Environment Hiroaki Kaneko).

Japan is currently trying to encourage waste disposal by subsidizing private companies. It should be noted that the country belongs to the group of states that are implementing the already mentioned initiative of the three R - reduce, reuse, and recycle - to reduce, reuse and recycle waste. Japan has long gone for separate garbage collection. In some cities, it began to be sorted in the first half of the 1970s. And now waste sorting has become an integral part of Japanese culture.

Requirements vary depending on the location, but the basic principles are the same everywhere. First of all, waste intended for incineration is collected - burning kitchen waste, paper, leather and plastic. In special containers, residents store resources for reuse - glass bottles, PET bottles, steel and aluminum cans - all separately. Empty metal spray cans, frying pans, kettles and other small metal kitchen utensils are also isolated. Packs of newspapers and magazines and cardboard are sold separately. In some areas, non-standard waste is still collected - batteries, light bulbs and ceramics.

Large household waste - furniture, old mattresses, and suitcases - can be thrown away only by paying in advance. The municipal service will not take away such items without a receipt for payment of the relevant fee. You can buy it in any shop. For example, the removal of the mattress will cost about $ 3-4.

Garbage can be stored only in special transparent bags: payment for them, in fact, becomes a contribution to the removal of waste. However, by Japanese standards it is very small - $ 3 for ten pieces. Most of the costs are covered by local taxes paid by the Japanese. They differ in different settlements, but generally account for less than 10% of monthly income.

During the collection, garbage truck workers check whether the contents of the bags correspond to what is collected on this day of the week. The package with the "wrong" garbage will not be taken.

Of course, there are those in Japan who violate the rules of waste sorting. In apartment buildings, they are usually morally influenced by neighbors. But there is also a law that allows for punishing malicious violations: it carries a fine of up to 10 million yen (over $ 90,000) or even imprisonment for up to five years. However, such punishments are not used often - in glaring cases.

According to various estimates, about 21 to 46 percent of Japan recycles almost 44 million tons of household waste collected annually. These are not the highest rates compared to the most modern EU countries, but the Japanese are actively working to improve the situation. This country is working to remove from the garbage a variety of useful materials contained in household appliances. For example, gold medals for the 2020 Tokyo Olympics were made of precious metal extracted from garbage.

But some household waste still goes to the stove. And while back in the late 1990s, the country was rocked by scandals involving high levels of harmful dioxins in incinerators' emissions, after a series of laws were passed, the problem was solved and emissions were reduced by 90%. Based on the new regulations, Japanese industry has developed and started to produce, perhaps, one of the best waste recycling and disposal plants in the world. One of them is a 10-15 minute drive from Gindi - the central shopping and entertainment district of Tokyo, right next to luxury housing. There are 1,120 waste incineration plants in Japan, with 358 of them producing electricity.

Britain, in turn, began to burn more garbage. Due to the lack of landfill space in Europe, this method of waste management is more popular than in the United States. In England, about 42% of waste is now incinerated and recycled. China's ban has stressed that Britain can no longer export its problem and transfer it to other countries. China is a country that has been trying to solve the problem of waste recycling for more than a year. Recently, this issue has become particularly acute due to the growing environmental threat affecting the overall economy of the state. Since 2009, the country has had a law aimed at complying with regulatory requirements for the recycling of industrial and household waste, as well as the disposal of non-reusable waste. This, so far, does not reduce the emergence of huge and slightly disguised landfills at the exit from large cities.

Tanks with two or three types of containers are installed on the streets of Chinese cities - for recycling, non-recyclable garbage and food waste. Sometimes separate plastic and glass tanks are added to them.

But despite the possibilities for sorting, garbage in China is often disposed of on the principle of "which container is closer." Because today in the country there is no concept of such social responsibility for improperly disposed of garbage, as there are no fines for the population for throwing a plastic bottle in the food waste compartment. This issue is "regulated" by everyone's personal conscience. But for legal entities, penalties are gradually being introduced.

The Chinese population does not pay separately for garbage collection - this column is included in the cost of utilities. On average, the Chinese pay from 200 to 800 yuan ($ 29.5-147) per month - the size of the tariff depends on the area of the

apartment, housing, type of housing. This price also includes payment for water supply, electricity, elevator use, maintenance of common areas. It is worth noting that residential buildings in China are usually combined into complexes, and therefore the fee for garbage removal and disposal is included in the cost of services for cleaning and landscaping, protection and video surveillance of the complex, as well as cleaning entrances houses.

In China, along with many companies specializing in the collection, sorting and disposal of waste, as well as the dismantling of landfills and the disposal of relevant raw materials for recycling, an important part of the system remains landfills. It is they who dismantle the pile of household waste dumped into a common pile by ordinary citizens and sort it according to their future purpose. At the same time, in China, garbage is an honorable profession, whose representatives are loved and respected.

According to the Ministry of Environment of China, currently about 90% of China's waste is disposed of by incineration or landfill.

It is enough to read the reviews of tourists on the Internet to understand that India needs a general cleaning. But this has not always been the case, and in fact the dirt on Indian streets is a fairly new phenomenon, say urban experts. They explain the problem by tradition - in India, waste is traditionally dumped on the street. But if before the heat and the sun dried them to dust, then with plastic, cardboard and other modern products that appeared in the XX century, they can no longer cope. This is exacerbated by the migration of the rural population to the city, which continues to throw garbage on the streets in the old way.

The total mileage of all landfills in India, according to the Indian non-profit organization Waste Ventures India, by 2047 will be 1.4 thousand square meters. Kilometers, equal to the area of the three largest cities in the country - Hyderabad, Mumbai and Chennai.

Another important problem is that India is just beginning to organize a modern system of waste collection and disposal. At the same time, the profession of garbage remains caste, garbage is dealt with by the Dalits - the untouchables. Twice a day (morning and evening), men bring waste directly to the neighborhoods where they live. The women then sort it by selecting plastic bottles, waste paper, scrap metal, glass, rags, discarded clothes and shoes. All this is then sold. But if something is not good for garbage, then this garbage often remains on the streets.

Cleaning companies also employ people from lower castes, who often protest against any changes in the system that threaten their unemployment. In other words, waste collectors are blackmailing the government with a social explosion, but they are clearly failing to clean the streets properly.

Due to the lack of a modern waste disposal system and its caste nature, there is no single fee for garbage collection in India. It varies by city or district. On average, rates range from 50 to 200 rupees.

If we are talking about apartment buildings or affluent areas, then the residents throw waste in the bins, where they are then taken away. If there is

someone among the residents of the house who throws garbage anywhere, he will be persuaded and embarrassed in the neighborhood.

No one is fined, although environmentalists have called for "Singapore-style" fines of up to 10,000 rupees for dumping garbage in the wrong place. But these proposals have not yet come to fruition.

Previous Indian governments have repeatedly tried to change people's attitudes to waste since the 1970s. The government has announced a program under which India should completely abandon disposable plastic products by 2023. A project banning the import of such products is currently being considered.

In addition, since 2016, the country has been implementing a Waste to energy recycling program, which employs about 80 incinerators. The government plans to build another 100 incinerators.

New Delhi understands that one big campaign cannot solve the problem of garbage - it is necessary to act gradually and purposefully.

Germany remains one of Europe's most successful examples of waste management. It should be noted that in 2018, 5.2 tons of waste was generated per capita in the EU, 38.5% of waste was disposed of and 37.9% was recycled [14].

Residents of Germany began collecting garbage separately in the late 1980s, and now Germany has a system of deep sorting. Yes, there should be at least three containers on the site assigned to the house - for food waste, for plastic, bags and packaging, and for paper and cardboard. Glass bottles and jars of wine, oil or jam are classified as separate public tanks on the street. And containers for drinks can be handed over to special receivers - fandoms installed in all online stores. The cost of a plastic bottle or jar is included in the price of almost every drink, and by handing over the container, this overpayment can be refunded. Clothes are accepted by charities, and batteries are accepted by shops, where special boxes are installed.

At the same time, how residents sort garbage in their kitchen is their personal business, the main thing is to properly pack it in public containers. Penalties for violating these rules vary significantly in all federal states - you can pay between € 30 and € 75 for waste dumped in an unauthorized place. But the old cabinet or refrigerator left in the tank will cost € 50-2500. However, if the violator cannot be found, the management company will then divide the costs of removing such garbage equally among all the apartments in the entrance.

Every household pays for garbage collection. The cost can vary greatly depending on the place of residence, the number of apartments, the volume and the number of tanks on the porch. Taking these factors into account, management companies set tariffs. On average, for large cities it can be a fee of € 150-300 per year.

There are containers in separate rooms - either in the basement or in the yard, but with a special wicket that closes with a key. Every house or porch has its own tanks, so you can't use your neighbor's garbage in Germany.

Every year the country produces about 41 million tons of garbage - about 500 kilograms per person. According to various data, from 60 to 80% of this amount goes to recycling or incinerators - to generate electricity, and the rest goes to landfills. Almost 15% of all raw materials used by German industry are obtained

through processing. It is also a profitable business - in 2017 the turnover of the waste processing industry amounted to approximately € 70 billion, and more than 250 thousand people worked in this field.

But despite the well-established disposal mechanism, Germany still has unresolved problems in the garbage sector. They are mainly related to the modern culture of irrational consumption. Environmentalists say that over the past quarter-century, the amount of non-essential waste (disposable cutlery, dishes, napkins, packaging, etc.) has increased so rapidly that society simply did not see the problem in time. According to the German Union for the Protection of Nature (NABU), consumers began throwing away twice as many plastic forks, spoons and knives and six times as many disposable cups. This "wastefulness" also applies to food - the Germans send an average of 7 million tons of edible food a year, according to estimates at the University of Stuttgart. Experts suggest looking for solutions in social advertising, which would tell citizens that they could not buy what they do not need, but donate money to charity instead.

In France, there has long been a separate collection of waste. Garbage cans are marked with lids of different colors. White cover means glass. Yellow is waste that goes to recycling. The rest of the waste to be incinerated or disposed of in landfills is disposed of in a container with a brown lid. Pharmaceutical products (old pills, packaging, thermometers, etc.) can be delivered to any pharmacy, so that toxic substances do not get into recycling or general landfill.

In some places there may be more containers. Tanks for plastic products, cardboard and wood can stand separately. Keep in mind that not all plastic can be recycled. To make life easier for the population, the French authorities are trying to better inform them and explain the principles of sorting. For example, in Paris, a system of "electronic helpers" was common, which hung over the garbage and, after scanning the package, suggested which urn to drop it into.

For non-standard things there are special points where you need to take them yourself. But for the disposal of such waste in inappropriate places faces a fine.

The problem of garbage for France is not only environmental but also political. The main challenge in the field of environmental protection in the European Union is called plastic processing. In May 2018, the European Commission published rules according to which toxic plastics should be replaced by alternative materials. France is still behind its neighbors - according to Eurostat, the country processes about 25% of plastics, which is twice less than in Germany and the Netherlands. But authorities have already banned disposable plastic bags in local supermarkets to fulfill their promise to use only recycled materials throughout France by 2025.

300 specialized enterprises are engaged in waste processing in the country, producing 2.3 million tons of secondary raw materials annually. And the overall level of processing in the country is 42%. At the same time, since the adoption of the first law on household waste recycling in 1975, the number of landfills in the country has decreased from 6,000 to 230, and the number of incinerators - from 300 to 128. Also in France in recent years is gaining popularity socially responsible

concept of consumption. It is based on four principles: democracy, public utility, mixed resources and their sharing. In Paris, for example, this approach has resulted in the creation of 15 centers for the collection, repair and re-sale of various products. These centers are divided into categories - textiles, cardboard, sporting goods, toys, appliances and some others.

But not all garbage be recycled and reused. So, now in France there are about 130 plants for incineration of non-recyclable waste. The ash left after combustion is used in road construction, and the heat released in the process is used to heat nearby houses. Some plants are located underground and use technologies that do not produce smoke or odors.

Violation of the rules of garbage disposal is subject to a fine for individuals - 35 euros. You will have to pay around € 70 for rubbish left on the road, with the amount varying from city to city. And those who, for example, decide to throw away an old sofa somewhere in the field will have to pay a fine of € 150 and risk confiscating the car. To properly dispose of large furniture or appliances, you must contact the municipal services, which will take it out by special transport.

In addition, in addition to France's own waste, it has to fight Swiss "garbage tourism". The fact is that residents of the border areas of Switzerland often - because of the double tax at home - go to dump their garbage on French territory.

There is separate garbage collection in almost all of Italy, again to a greater or lesser extent. In Rome, for example, clean paper and cardboard, plastic and metal, organic waste and non-recyclable waste, and glass must be collected separately. Each type of garbage has its own container, which is removed on certain days.

As for the fee for garbage collection, each city administration sets its own tariffs. As a rule, they are calculated taking into account the number of registered persons per living space and range from € 150 to € 600, but on average - € 300 per year. A large family pays more than a single person. At the same time, tariffs are higher in the south, although the average income of the population is lower than in the north - € 600-700 against € 1,000 in the country.

There are no joint benefits or incentives. On the contrary, the removal of bulky garbage is carried out for an additional fee by private companies. Some items (washing machine, wardrobe, and mattress) can be picked up free of charge by municipal services.

In apartment buildings there is such a tool of management as the meeting of residents. And for garbage dumped in an unauthorized place, there are large fines - up to several hundred euros. However, in Italy there are landfills along secondary roads. A special problem is observed with plastic, which is littered with everything, including beaches and seashores.

In general, the situation in Italy is very heterogeneous - somewhere the service of garbage collection and disposal is provided better, somewhere worse. Suffice it to mention the high-profile "garbage scandals" in 2007 in Naples.

Rome is now on the verge of collapse. In the capital, the garbage collection service is not called anything other than a catastrophe: the schedule for the removal of one or another type of waste is not met, full containers are on the street, and

everything is thrown away. And in summer, due to high temperatures, the situation is only getting worse.

One of the exemplary regions for waste disposal is the island of Sardinia, where several state-of-the-art incinerators operate. In total, there are 39 incinerators in the country, which in 2017 disposed of 18% of waste and produced 4.5 million MW of electricity and 2 million MW of heat. About 27% of waste is recycled by the Italians to obtain new materials, and the rest goes to composting and underground disposal.

In Italy, there is a lot of talk about the problems of pollution, the need for a more responsible approach to waste collection. In different parts of the country, the level of civic consciousness is different - usually northerners are more responsible. Authorities are trying to close landfills, but there is no real alternative at the national level yet. There are a total of 127 landfills in Italy.

In some regions, new innovative technologies for recycling and young startups are encouraged. The country also tried to impose bans on plastic bags, but as a result the measure was halved. Thus, large supermarkets and chain stores have switched to packages of recyclable materials, and in the markets and the Chinese are still in the process of plastic. Examining the main problems in the field of waste management in different countries, we can identify the following systemic problems, the presence of which is noted in many countries: low capacity of landfills (existing landfills have almost reached the limit of their capacity); growth of hazardous waste generation; non-compliance of existing waste collection sites with safety standards; the non-governmental sector plays an important role in waste management (up to 50% of the available amount of waste intended for processing and disposal), which reduces the effectiveness of state measures in the field of waste management; low level of waste processing (most of the generated waste is disposed of by landfill; changes in the legal and institutional framework for municipal waste management have created problems in the field of waste management carried out by municipalities that were not ready for such changes; non-compliance with safety requirements in the field of waste management; in the field of waste management, attention is paid to certain types of disposal, resulting in excess capacity (for example, in the Netherlands, special attention is paid to waste incineration and use of thermal energy, which led to excessive waste incineration capacity; in Estonia, investment in incineration and mechanical biological treatment led to excessive capacity in both directions of waste treatment); the presence of obstacles in households in the separation (sorting) of waste generated.

The study of the patterns of development of the elements of the "nature-production" system made it possible to conclude that the production waste management system should be formed as a subsystem of innovative nature management. The purpose of the functioning of the waste management system is to maintain the environmental sustainability of the "nature-production" system. The way to achieve the goal is innovation in the technological processes of the main production and environmental activities, minimizing (preventing) the negative impact on the environment. This will lead to the formation of additional competitive

advantages, and will also reduce the amount of environmental costs (both internal and external for the enterprise).

The foregoing makes it possible to formulate the main theoretical provisions for the formation of a production waste management system on an innovative basis: the processes of managing innovative nature management are based on the mentality “from nature to production”; the development of an environmental strategy is carried out in combination with innovation; the purpose of the functioning of the production waste management system is to ensure the environmental sustainability of the "nature-production" system, the structure of the system is based on the stages of the resource cycle.

The waste management scheme can be based on the stages of the resource cycle. As part of the functioning of the production waste management system, the object will be the composition and structure of losses characteristic of the stages of transformation of natural resources in order to ensure the closeness of the resource cycle, which will lead to minimization of monetary losses and identify the possibility of innovative development. When forming a waste management system at an enterprise, it is proposed to consider waste as a resource potential and, on the other hand, as a dangerous factor influencing the environment.

Evaluation of the functioning of the production waste management system can be carried out using a set of indicators that are grouped by stages of the resource cycle, each of which has its own strategic priorities. A distinctive feature of the proposed set of indicators is taking into account the impact of the result of the waste management system on the state of the external and internal environment of the enterprise. We consider the external impact through indicators characterizing the state of the land fund, since the disposal of waste leads to the rejection of land and, as a result, to a deterioration in their quality and the likelihood of emergencies. Internal - through indicators characterizing the level of waste intensity of production and related costs, taking into account the activities of the scientific subsystem.

Simply put, from an economic point of view, little profit can be made from a product that is produced in significant volume but with little intrinsic value. Indeed, most manufactured products lose their original function when they are consumed or used, reducing the cost of each product to the value of the materials from which it is made. This is the main characteristic of waste. How can the global waste market worth around $300,000 million a year be so lucrative? How can waste be turned into a competitive commodity? Profit, obviously, is possible only in conditions where the income from waste exceeds the costs of their processing. Therefore, the waste market largely depends on the price of raw materials and energy.

High prices for primary raw materials increase the income that can be expected from the sale of the valuable part recovered from the waste. Since metals occupy the first place in the commodity market (in terms of price per unit volume), the demand for waste containing metal elements is extremely high. In several regions, the consumption of metals often exceeds the volume of mined ore with a mineral content. Therefore, if scrap metal is cheaper than primary raw materials, it can become the main source of supply for entire countries and industries. Among

scrap metal, precious metals, present in small quantities in electronic devices and parts of used vehicles, have the highest economic value and are therefore the most attractive. In terms of volume, however, steel, aluminium, copper, zinc and iron, which are used in shipbuilding, automotive and various infrastructures, still occupy the leading place among scrap metal.

The second condition for profitability is the existence of state norms of legal regulation. Through taxes or subsidies, governments can increase the income of waste market operators or, alternatively, reduce their costs. By setting standards or guidelines for waste management, or by creating an enabling environment for similar private initiatives, governments can also force waste producers to approach specific economic sectors to dispose or recover their waste in accordance with specific environmental or social criteria. This entails unavoidable costs for the producer, such as waste disposal fees, but protects the income of the stakeholders involved. The recovery industry, for example, is completely dependent on regulatory obligations placed on producers of hazardous or other types of waste to properly dispose of it. Emerging industries such as biogas production and composting illustrate the vital need for government support for projects that may not be economically viable without appropriate regulations and incentives. Raising public awareness and providing appropriate infrastructure are also important levers in the hands of the government.

On the contrary, the lack of strict standards or non-compliance with existing rules allows the actors in the waste market to avoid certain costs and thus increase their bottom line. Such socially irresponsible behaviour is also illegal when it is a conscious practice in a regulated context. Meanwhile, in developing countries, environmental legislation is imperfect, and the implementation of existing regulations is often hindered by corruption, as well as a lack of knowledge and technology and the ability to control compliance with the law.

It should be noted that in order to effectively manage waste and increase the share of secondary raw materials that go to processing, it is necessary to automate processes and use IT technologies at all stages: during collection, accumulation, logistics and processing.

For the efficient collection and accumulation of waste, there are several automated solutions: vending machines, bins with automatic sorting into fractions and pressing of raw materials at the collection point.

Bins with automatic sorting by fractions recognize the composition of recycled materials using artificial intelligence, sort, and press and control the filling level.

Bin-e is a European manufacturer of smart waste bins.

SmartCity Bin is the development of a bin that is compacts waste with garbage collection control; it works completely autonomously on solar panels.

To monitor the fullness of garbage containers and manage the logistics of exporting companies, there are solutions both on the foreign and Ukrainian markets.

IT solution was waste collection companies. Sensors determine the level of container occupancy, predict the time when export will be necessary, and special software optimizes logistics.

Enevo is an American company with subsidiaries in Europe that provides similar IT solutions.

We are talking primarily about automated solutions for industrial sorting of waste. There are no such technologies in Ukraine yet, but there are several solutions on the foreign market.

Zen Robotics uses machine vision to identify different types of materials and separate them on a conveyor belt. The separation process is carried out by a robot arm - this solution works better with large, unground waste.

Tomra uses spectral sensors to determine the type of material and separate them on the conveyor. The separation process takes place by a pneumatic mechanism: particles of waste of different types are shot off by air flows at different distances, due to which objects are separated in space between different containers.

Eat me is a food-sharing service that prevents food that has not yet gone bad from entering the landfill.

What new IT solutions are waiting for us in the future?

In the coming years, the digital transformation in the global waste market will develop in several directions: urban infrastructure will see many novelties within the concepts of smart city and the Internet of things, such as PaaS (Platform as a Service) - a combination of an application platform with cloud infrastructure managed services, as well as SaaS (Software as a Service). Classic waste processing and IT companies are planning joint projects. More than 50 major technology brands are already developing IT solutions in the global waste market.

In the coming years, the following will be launched: a system for accounting and management of production and procurement enterprises (reception points where recyclable materials are pressed and accumulated for further sale to processing plants); payment platform for collecting recyclables from individuals; an online platform that brings together producers and processors to implement Extended Producer Responsibility.

Conclusions. Garbage will not leave room for further quality of life of mankind, because the existing system of waste management, which is focused mainly on their disposal, is imperfect, leads to pollution of the air, groundwater and, consequently, reduced quality of life that does not comply with sustainable principles. Economic development and needs radical modernization.

Having studied the problems of waste disposal, you can find ways to solve them. The question of the ability of human civilization to reduce the level of environmental pollution by waste is important from both environmental and economic points of view.

Given the environmental literacy of people, the availability of legislation that ensures the profitability of environmental measures, the constant introduction of new technologies and materials, as well as systems of engineering and biological control of environmental parameters, humanity is able to reduce anthropogenic impact on the biosphere benefit.

Analyzing the situation with the disposal of household waste in the world, I would like to recommend to the inhabitants of the planet: before accusing someone

of uncontrolled garbage disposal, you need to start with yourself; littering the area with waste that rots badly, we need to think that our descendants will be left behind; try to throw garbage in the landfill as little as possible, dispose of the utilized as much as possible.

And it is then, despite the various environmental challenges facing all countries in today's global world, that our descendants may inherit a clean living environment.

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