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## ECOLOGICAL AND ECONOMIC ASPECTS OF RECYCLING: EUROPEAN AND UKRAINIAN EXPERIENCE

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The issues of efficient waste energy use with a view to ensure environmental protection of the country are considered. EU experience in this sphere is studied. Disadvantages of solid domestic waste treatment in Ukraine are pointed out. The directions of state support of secondary resources recycling are suggested.

**Keywords:** secondary resources, solid domestic waste, recycling, recycling programs, environmental policy.

**Problem statement.** Production and household activities inevitably involve the formation of waste. Growing human pressure brought the situation from increasing garbage volumes and waste products to the level of the global up-to-date problem. The issue of the most efficient and long-cycle circulation of raw materials in the production process rose. This became possible due to recycling of reusing and returning to circulation waste. Recycling in enterprises is a promising direction of development, as products that have completed their life cycle are often a cheaper source for many substances and materials than their natural counterparts.

**Analysis of recent papers.** An important component of general administration system of solid waste is the process of utilization, involving waste reusing or recycling, which allows to significantly reduce the cost of funds of waste storage, to minimize its negative impact on the environment, as well as to turn valuable resources into economic circulation. Theoretical and practical aspects of resource reusing in the context of environmental security were reflected in a range of scientific publications

The main feature of the control system that is formed in the field of waste management is the prevalence of administrative methods over the economic that is stated in this research [1]. Kharichkov S. K. [2, p. 89] focuses on the high level of pollution of all natural resources and reduction of quality for environmental

services. Khumarova N. I. [3] emphasizes the importance of the transition to preventive measures of waste generation and draws attention to the «environmentally friendly production». The development of «clean production» and «environmental technologies» in Ukraine can be successful only if the broad international cooperation in this area will be established [4, p. 186].

In general, it should be noted that only 2% of natural resources are processed into a usable product, and the rest goes to waste. This means that the problem of waste that is being generated and has already formed, becomes global. The recycling process allows to save primary raw materials (minerals) substantially and thus effectively solve the problem of resource saving. The reusing process of resources that are allocated from the waste (recycling) – is a promising strategy element of solution for crisis situation of solid waste through its complex using [5, p. 231].

**Aim of the article.** The purpose of this article is to study the European experience, as well as national achievements of resource reusing, for activation the involvement process of resource reusing potential in economy of Ukraine.

**Materials and methods.** According to the UN European Economic Commission, in the period between 1996 and 2007 the total volume of waste in the EU and EFTA increased by 2% each year. This especially concerns solid household (municipal) waste, its formation in

the world since 2007 exceeded 2 billion tons, and the annual growth rate reached 7% [6]. A complete European statistics was formed the beginning of the 2000s, the system data appeared in 2006. This was facilitated by the adoption of the European classification of waste (List of waste).

Large scales of resources use, energy and raw materials specialization of Ukraine's economy together with outdated technological base determined and continue to determine the high rates of annual formation and accumulation of waste. Over the past 10 years, the total volume of formation of industrial and

household waste in Ukraine continuously grew, except for a crisis year of 2009. According to government statistics, updated annual waste generation in 2010 made up 419,2 million tons, and the amount of savings in «specially designated areas or objects» – 13,27 billion tons (Table 1). According to statistics of 2010, in the European region, Ukraine's share in waste generation is about 7%. If the European standards were taken as a base, waste only of I to III hazard classes would enter the category of dangerous waste in Ukraine. In 2010, for example, there were 1,66 million tons of waste, or about 2% of that in the EU-27.

Table 1

Waste generation in European countries

Country, region	Total waste generation, billion tons / year	Waste generation per person, tons	Formation of solid household waste, million tons / year	Formation of dangerous waste, tons / year
European region	6,0–7,0	–	–	–
EU-27 (2006-2009 years)	2,6–2,7	5,2–5,5	254–260	88,7–100,7
Ukraine	0,42	9,2	11,0	1,23–2,58*
Poland	0,14	3,7	10,0	–

\* Waste of I to III hazard classes (2008–2010 years)

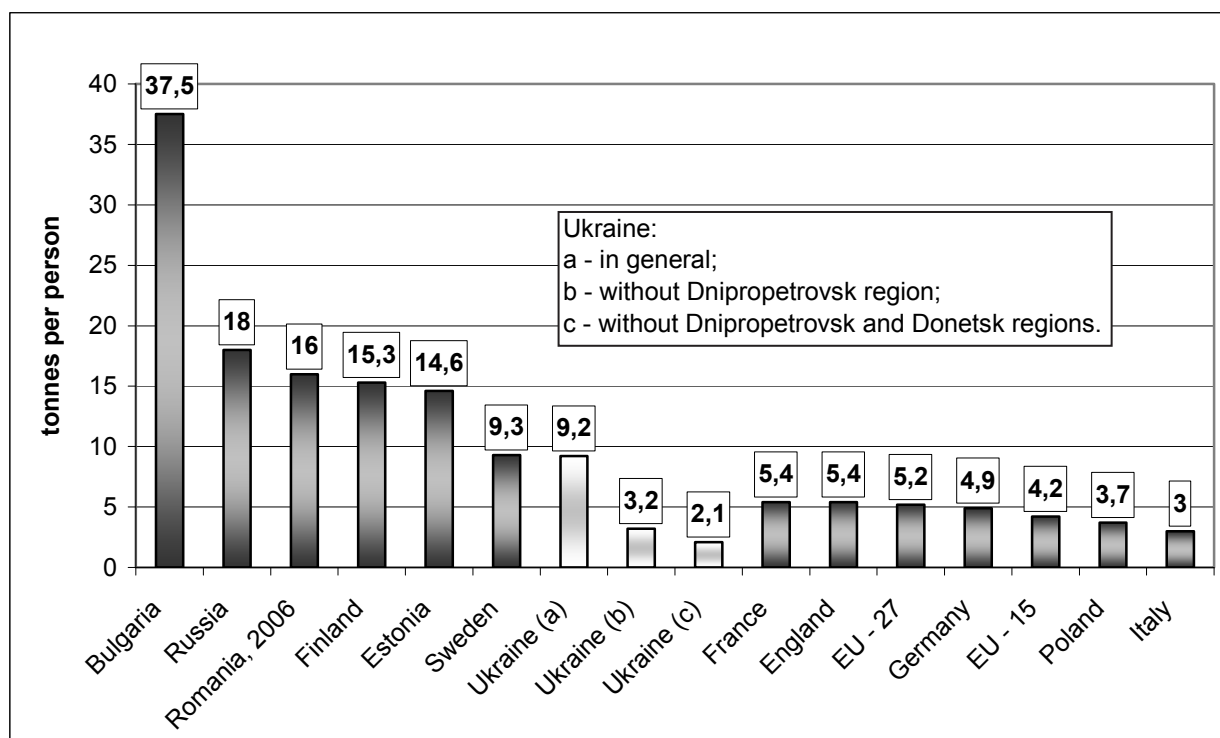


Fig.1. The volume of waste generation in the European countries per person (the State Statistics Committee (2010) and Eurostat (2009))

Ukraine's share of waste generation in the general European is about the same or

slightly higher than the proportion of the population. Dominating volumes belong to EU-

27 and Russia. Besides Ukraine, so relatively high absolute indicators of waste generation are specific to Germany, France, Britain, Bulgaria (from 190 to 372,8 million tons) [6], and some of these countries are closely approaching Ukraine's one with its 419,2 million tons.

In the comparative context, the most interesting are the specific indicators of waste per person (Fig. 1). Ukraine annually produces 9.2 tons of waste per person, that is in 1,76 times higher than the average for the EU-27 (5.2 t / per person according to Eurostat). If Dnipropetrovsk region is «excluded» from Ukraine, the rate of waste per person in the rest of the territory immediately will fall to 3.2 tons. If Donetsk region is additionally «separated», the specific rate will reduce to 2.1 t / person [6].

The analysis shows that all European countries with high absolute indicators of waste generation are «grateful» for that rate, primarily, to mining, namely mineral wastes. In Bulgaria, this is due to large-scale extraction of lignite (with large amounts of stripping works), Estonia – oil shale, etc. Ukraine is in the same row with other industrialized countries, and the existing difference was generated by large-scale mining of mineral resources and its primary processing (which is concentrated in Dnipropetrovsk and Donetsk regions).

Municipal solid waste (MSW), unlike the industrial waste, is characterized like solely dispersal. The volume of its formation in the world is continuously increasing. In the EU-27 in 2009 this indicator was 260 million tons. Relative to this indicator Ukrainian volumes are – 11 million tons (and according to Development And Construction Ministry (2012) – 13 million tons) – just 4%.

Nowadays, the specific indicator of domestic waste per person in Ukraine is up to 310–330 kg / year (formally by the volume of its export – is only about 280 kg). In EU countries this indicator ranges from 316 kg in the Czech Republic to 833 kg – in Germany, and the average is 513 kg [6]. So in Ukraine waste formation per person is at the lower limit of the European range. But the infrastructure of waste management in Ukraine, unlike the EU, is in its infancy. The dominant share of waste is piled up on environmentally hazardous landfills. As a result, both resources, and clean

environment are lost.

The problem of waste in Ukraine differs in special scale and significance as a result of the dominance of many intensive-waste technologies in the national economy, and lack of long-term adequate reaction to its challenges. Despite the fact that the solid waste formation per person in Ukraine is not very high, it is expected almost double increasing of its volume with all the consequences. Differences between Europe and Ukraine once again concerns not with the amount of waste, but with the lack of adequate waste management, including separate collection and recycling.

In world practice, household waste management characterized by five obligatory aspects of this process, namely: social, economic, political, institutional and financial [7]. Each of these aspects is not sufficient, but rather requires a harmonious and integrated combination of efforts to ensure effective waste management. International experience suggests three basic ways of management in field of solid wastes, namely:

- creation of disposal sites (to prevent harmful effects on the environment);
- destruction of solid waste by burning it;
- cleaning of solid waste from hazardous components and its utilization on purpose to extract resources that contains valuable components.

The backlog in creation of efficient waste management infrastructure is especially obvious in a comparative context. In European (EU-27) practice only 38% of such wastes placed in landfills, while in Ukraine – 93%. It is processed and composted 42% and 3% of wastes in accordance (Table 2). Therefore, environmental threats are increasing, while a significant potential of resource saving remains idle.

During the last decade, solid waste management of the EU tends to gradually reducing the share of waste that is burning and disposing in landfills, but in absolute terms, this proportion is still quite large. At the same time some European countries (Germany, Austria) are seeking to stop the practice of solid waste disposal sites in the near future.

Table 2

## Management of solid waste in the EU and Ukraine

Indices	EU-27 (2009)		Ukraine (2010)	
	million tons	%	million tons	%
Volumes of formation among them:	260	100	11,0	100
– creation of disposal sites ;	99	38	10,2	93,0
– burning;	52	20	0,4	4,0
– processing (recycling);	62	24	0,3	3,0
– composting	47	18	–	–

The negative consequences of using disposal sites and burning of waste should be noted. Storing of solid waste in landfills is imperfect and environmentally dangerous way of dealing with, because toxic filtrate (sewage of dumps) pollutes the soil, surface and ground water of places, that are located next to the landfills, and the immolation and waste rotting leads to air pollution. Burning of waste is extremely dangerous for the environment and has a very negative impact on people health, because waste incineration leads to forming of toxic substances and compounds that accumulates in the atmosphere. In addition, this method is the most lagging and costly method of waste management. That is why today the legislation of many countries are directing to partial prohibition of waste burning, and some forbid it completely.

One way of solving the problem of using waste as a secondary resource is the practice of using the achievements of modern bio-energy by entrepreneurs and farmers that are specialized in food and livestock recycling. In the EU bio-energy complexes allow you to produce billions of kilowatt-hours of electricity and heat energy annually [5].

European countries are guided by a number of directives and regulations in the field of solid waste management. The basic law of the EU waste management is «The Waste Framework Directive (WFD) », which covers all waste streams and establishes, so-called, hierarchy of waste, rules of planning, waste management, qualified collecting, recycling, and requires obligatory compliance with licensing procedures for recyclers [8]. Therefore, it is actual for Ukraine to form the same normative, legal and information development in the field of waste management

and to cross to international regulations – classification and accounting of wastes, its transportation, disposal and neutralization in compliance with all the requirements of environmental safety of the EU.

In Ukraine, the process of using production and consumption waste as a reusing resources, characterized by positive dynamics, but is below the real possibilities. According to government statistics, during 2005–2008, the annual amount of waste as reusing raw materials was about 110 – 120 million tons, and in 2010 was around 145 million tons [9]. But some aspects of waste management generates concern. Quite controversial is the direction of using the waste incineration technology. Indeed, in the EU it can be traced a stable tendency to decrease the share of combustion (Table 2). Modern technology makes waste incineration sufficiently competitive business, but those technological approaches are among the most expensive and risky, and if it is required it can be used to achieve rapid results. In modern terms also extremely shortsighted is to attract foreign investors. Strategically, the main task is to create its own industrial, scientific and technological base, aimed at forming an infrastructure for waste management.

As mentioned above, the difference between the situation of waste in Ukraine compared the developed countries consist both in more significant volumes of waste and the lack of waste management infrastructure, that is an integral part of the economies of European countries. The only civilized and safe way to manage solid household waste is to minimize the generation of it on the basis of spreading public ecological awareness and recycling, because almost all components of solid waste

can be reused. Schematically, the process of recycling can be divided into three segments, in which participants are separated business entities [10]:

A – the segment of collection and preparation of waste for recyclable condition;

B – the production process, which consists of waste converting into substance or product that contains the value for final consumer as an effect of recycling process;

C – the segment that uses the result of the recycling process as a substitution of element that is made from natural raw materials.

There are two main types of recycling: material (mechanical) and raw material (chemical). Material recycling – is a process in which waste is converted only mechanically, primarily as a result of crushing, screening and grinding. This type of recycling uses the physical properties of a substance without a significant breach of its chemical structure. The product of recycling can be used for new production. Its quality depends on the chemical composition and purity of recycled material.

With high quality recycling product it can be replaced a new material for making the same products. When quality of the recycling product is an average, for example, mixed of waste fraction with other substances, it can only be applied to products which are usually made from other materials.

Non-waste production – is attractive, but hardly doable at present. In applying of recycling at the end of the production process there will be no waste in obtaining of basic products, because at each stage of technological cycle it will be either recycled, or products that are made from it, will have a consumer value. Such technology of basic product producing called quasi-wasteless, compared with a truly non-waste technology, which does not produced waste at all.

In world practice, imple-mentation and realization of state recycling programs are actively pursued for the last 20–25 years. Implementation of the recycling program is caused by the influence of many aspects (Table 3). Ukraine is trying to rely on the European experience in solution of these issues.

Table 3

The list of aspects that affecting the decision of recycling programs implementation

Aspect	Factors of influence
Moral and ethical	The level of society development, the totality of the current rules and norms of behavior, values, attitude to the problem of environmental pollution, etc.
Ecological	The level of soil, air and water contamination, including groundwater, from the results activity of industrial enterprises
Technical	The set of tools of human activities aimed at the implementation of production processes and non-production service of public needs
Technological	The set of available methods and processes suitable for using in the production cycle at this stage of scientific and technical progress development
Economic	The total effect from introduction of new environmentally friendly technologies, in terms of profit, sales, demand on new products, general market trends and payback period from investments in new equipment
Administrative	The presence of economic, legal, financial, fiscal and other mechanisms, the application of which allows to carry out implementation of the provisions of recycling program

Market conditions contributed to the growth of workpiece and waste processing sphere. In Ukraine both organizational and industrial infrastructure of recycled resource market is being developed, the formation of a separate industry sector is founded, nowadays some types of waste are successfully recasted by small businesses. In fact, the new industry is forming and a new origin of resources is developing. However, this process is largely

spontaneous and contradictory, although more than 1,500 companies deals with waste recycling. The level of waste value (mainly waste paper and glass cullet) depends on coordination of collecting and workpiece system. About 1 million tons of such waste has already been involved in the processing. But the comparing of using volumes of mentioned types of recycled materials with their potential resources shows significant reserves to attract it

into economic circulation. In the EU the field of recycling forms 0.4–0.6% of GDP, employs over 1.5 million workers, and cash flow reached 100 billion euro.

Over the last ten years in Europe there have been significant changes in approaches to secondary natural resources consumerism as an organic component of civilization development and construction of the most important vector of Ecological Economics. In other words, Europe has recently followed the formation of «recycling society». The most important task in waste management was to prevent ingress of flammable waste to landfills. Recycling of plastic is especially important because it gives a lot of possibilities, including the regeneration of calorific value properties. Mechanical recycling will remain the preferred method for processing a streams of homogeneous plastic waste, while other technology of utilization for receiving energy at presence are preferable of mixed flows. Both methods allow you to save resources and reduce carbon emissions.

Deserve attention an innovative achievements of scientists from the Netherlands, who presented an improved technology that, in one system, allows to separate and purify all the waste without preliminary sorting, so that it comes back to the initial material. The system fully recycles all kinds of waste (medical, household, technical) in a closed cycle without a trace. Raw materials are completely cleaned from impurities (pollutants, dyes, etc.) are packed and can be used again. This system is environmentally neutral.

The progressive solutions in Switzerland are characterized by effective waste recycling, where it is introduced the practice of local selective collection of municipal solid waste (glass, paper, organic waste). In Holland, it should be noted an effective organization of work at the municipal level, based on logistic approaches to ensure separate collection and timely transportation of solid waste. Financing of this program is at the expenses of municipalities of the region. Successful pricing policy in the field of secondary resources is developed in Germany, Denmark, the Netherlands and Sweden. Particularly, in the Netherlands the maximum

possible collection of plastic containers is provided, mainly due to the fact that the price of empty plastic reservoir is up to 50% of the drink. [5, p. 232] Thus, the cost factor acts as a regulator that stimulates consumers to collect secondary resources.

Mineral wastes in Ukraine (71.5%) are drastically dominated in the volume of utilization. This is mainly because of low technological using of overburden rocks, mining waste and enriching process of mineral resources during the construction of roads and dams. Thus, while iron ore mining at JSC «Zaporizhzhya iron-ore plant» like an inert filler of the produced space for preparing the embedded mixture used waste products of energy, metallurgical and mining industry, namely: lime-dolomite, sand, gravel, ash-slag, breed, etc. [11]. It positively influences on ecological environment and improves the financial and economic performance of the plant.

In Ukraine there has been actively conducted researches of the possibilities of using waste from industrial production. Thus, the industrial waste of basalt fibers can be seen as reinforcing mineral filler, i. e. like reinforcing material in building mixtures and materials [12]. Using energy-saving technologies at manufacturing of building materials will significantly improve environmental and economic indicators in construction production due to the fact that basalt is the mineral of raw components and reserves of such raw material in Ukraine are practically inexhaustible, and the annual output of technogenic waste of basalt fiber counts tens of thousands of tons.

The further development of secondary resources consumerism is hampered by a lack of development and poor infrastructure, low motivation of concerning activity of waste management, passive position of the authorities at various levels, some riskiness of the business in its infancy. The system of waste collecting is imperfect and has fragmentary nature, regulation and economic stimulation of related activities is almost absent [9].

From the experience of foreign countries, for the financial support of production activity of Ukrainian system of

secondary resources it is appropriate to introduce environmental payments (or system of license fees) for using of packaging. In addition, it should be developed the mechanism of funds using for this purpose, that are formed by fees for waste disposal. An important tool for economic stimulation, that completes payments for the packaging and waste disposal, should become the mechanism of reimbursement for collecting and preliminary processing of certain categories of the most resource-valuable waste, in particular: used oils (drying oil), used tires and rubber waste, packaging materials and containers, vehicles, electrical and electronic equipment, batteries and accumulators, etc. This process requires a state support, identification of national and regional priorities, on which an appropriate support measures will be extended, and creation of territorial industrial complex that is concerned to recycling in regional centers and coordination of its development at regional formation. One of the main tools it should become the adoption of special laws that regulate activity in connection with reusing resources (material recycling) in general, as well as packing materials, in which specific mechanisms should be involved.

**Conclusions.** The infrastructure of solid waste management in Ukraine, unlike the EU, is in its infancy, because a large part of waste is piled up on the environmentally hazardous landfills, resulting losses of resources, and clean environment. It should not be speculated on an emergency of situation, problems should not be solved by rush, but the pragmatic national policy that is based on the strategic approaches and calibrated with international experience need to be formed.

European practice in using of secondary resources indicates the predominance of commercial approach, which implementation is possible in Ukraine, but it requires the creating process of favorable business environment, properly secured by institutional, innovative and investment accompaniment and stimulating instruments.

An important part of assistance in attracting of reusing resource potential to Ukrainian economy is to achieve the appropriate technological research for studying

of the material composition of waste and regulating of the status of technogenic deposits and its ownership.

The financial support of the state for recycling of resources should be based on both effective mechanism of reimbursement for collecting and preliminary processing of certain categories of the most resource-valuable waste, and the environmental payments (or system of licensing fees) for the use of packaging and waste storage.

### Literature

1. Міщенко В. С. Нормативно-правові та економічні аспекти поводження з відходами в Україні / В. С. Міщенко, Г. П. Виговська // Waste ECo-2012. Сотрудничество для решения проблемы отходов, 9-я Международная конференция 28–29 марта 2012 г., Украина (Харьков) (online) / Available at: <http://waste.ua/cooperation/>.
2. Харічков С. К. Інноваційна модель екологічної інфраструктури в Україні / С. К. Харічков // Экономика и управление – 2013. – № 3 – с. 89–97.
3. Хумарова Н. І. Складові та тенденції формування екологоорієнтованого управління в Україні. монографія // ІПРЕЕД НАН України. – Одеса, 2010 р. – 200 с.
4. «Зелена» економіка крізь призму трансформаційних зрушень в Україні / Б. В. Буркинський, Т. П. Галушкіна, В. Є. Реутов – Одеса: ІПРЕЕД НАН України – Саки: ПП «Підприємство Фенікс», 2011. – 348 с
5. Скороход І. С. Світовий досвід використання вторинних ресурсів / І. С. Скороход // Міжнародні економічні відносини. – 2007 – № 12 – с.229–233.
6. Світ відходів і Україна в ньому (online) / Available at: [http://gazeta.dt.ua/ECONOMICS/svit\\_vidhodiv\\_i\\_ukrayina\\_v\\_nomu.html](http://gazeta.dt.ua/ECONOMICS/svit_vidhodiv_i_ukrayina_v_nomu.html).
7. П'ять аспектів поводження з відходами // Київ – 2012 (online) / Available at: [http://eco-invest.org.ua/ua/smi\\_about/5%20aspects.htm#.UQ\\_kn3UkWyY](http://eco-invest.org.ua/ua/smi_about/5%20aspects.htm#.UQ_kn3UkWyY).
8. Рециклінг – єдиний цивілізований шлях поводження з твердими побутовими відходами // Київ – 2012 (online) / Available at: [http://eco-invest.org.ua/ua/smi\\_about/eco-invest.htm#.UQ\\_iQHUKWyY](http://eco-invest.org.ua/ua/smi_about/eco-invest.htm#.UQ_iQHUKWyY).
9. Концепція загальнодержавної програми поводження з відходами (проект) // Київ – 2012 (online) / Available at: <http://ua-ekonomist.com/13-konceptiya-zagalnoderzhavnoyi-programi-povodzhennya-z-vidhodami.html>.
10. Вороніна Р. М. Логістика рециклінгу / Р. М. Вороніна // Вісник Національного університету «Львівська політехніка» – 2008. – № 623. – с.28–33.
10. Тимошенко Л. В. Управління витратами

екологічної системи при підземному видобуванні рудної сировини / Л. В. Тимошенко, С. А. Ус // Науковий вісник НГУ. – 2010. – № 7–8. – С. 128–134.

11. Мандзюк І. А. Розробка складів і дослідження властивостей будівельних матеріалів з

використанням відходів базальтових волокон / І. А. Мандзюк, В. П. Нездоровін, Ю. В. Нездоровіна // Вісник Хмельницького національного університету – 2011. – № 1. – с.249–252.

Встановлено, що інфраструктура поводження з твердими побутовими відходами в Україні, на відміну від ЄС, знаходиться в стані становлення. Доказана стратегічна доцільність створення власної промислової і науково-технологічної бази оборнення з відходами.

Визначено, що розвиток використання рециклінга потребує створення сприятливого підприємницького середовища.

**Ключові слова:** інфраструктура поводження з відходами, вторинні ресурси, рециклінгові програми, фактори впливу, державна політика.

Установлено, что инфраструктура обращения с твердыми бытовыми отходами в Украине, в отличие от ЕС, находится в состоянии становления. Доказана стратегическая целесообразность создания собственной промышленной и научно-технологической базы обращения с отходами. Определено, что развитие использования рециклинга нуждается в создании благоприятной предпринимательской среды.

**Ключевые слова:** инфраструктура обращения с отходами, вторичные ресурсы, рециклинговые программы, факторы влияния, государственная политика.

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