

6. Management of the processing and sale of solid household waste as a direction of ensuring ecologically effective development of territorial communities

Increasing energy efficiency is an important prerequisite for reducing the man-made burden and import dependence of the country in the energy sector. Achieving this goal requires the application of the principles of the circular economy, which is based on renewable resources, circular material flows, and taxes used to balance demand. Organization of the full cycle of resource turnover in a sustainable and ecologically safe way is a possible direction of regeneration of natural capital. An economy based not on fossil, but on renewable biological resources, capable of transforming them into food, feed, chemicals, materials, fuel and energy, returning nutrients and carbon to the soil, is seen as a way to meet the needs of society, while at the same time forming cyclical processes in agriculture. The agricultural sector occupies a central place in the production of an alternative source of energy - biomass for its further transformation into commercial products, including bioenergy resources, and the task of local authorities is to create favorable conditions for conducting relevant activities. Biomass is considered the energy source of the future, and its global potential can meet almost one-third of the projected demand for energy resources by 2050. In addition, biomass provides lower energy consumption and CO₂ emissions compared to fossil fuels

Natural resources are an important component of full-fledged human activity, but among them there are those without which the existence of society is impossible. Biological resources, which form the biological cycle of matter and energy in nature, are basic for its life. Natural resource potential includes renewable and partially renewable resources. Among the renewable ones, energy carriers of biological origin or biofuels (biodiesel, bioethanol, biogas) are becoming more and more developed as energy sources, the main raw material for the production of which is agricultural products.

The implementation of measures for the effective (optimal) use of renewable energy sources remains a strategic issue for the development of the agricultural sector.

This is due to a number of objective factors: ensuring energy security and reducing dependence on energy imports; development and efficiency of the work of enterprises; creation of new jobs and increase in revenues to budgets of all levels; improvement of the ecological situation.

The works of such domestic specialists as: H. Kaletnik, I. Honcharuk, V. Bondarenko, R. Logoshi, I. Furman, O. Dmytryka, K. Mazur are devoted to the problems of organizing the processing of solid household waste (hereinafter referred to as solid waste) and the sale of relevant products. , D. Tokarchuk and others.

Despite the significant scientific contribution of domestic and foreign authors to the solution of the mentioned problems, questions remain open regarding the definition of the essence, formation and implementation of the bioenergy potential of territorial communities, that is, the transformation of external and internal possibilities aimed at the production of alternative energy sources. Therefore, we consider it necessary to reconsider the existing developments and developments, as well as to offer our vision of solving the above problems.

The scientists made a significant contribution to the theoretical and methodological perspective of the research of the mentioned problem, many of its methodological and applied aspects were solved. However, individual issues of this multifaceted problem have not been sufficiently investigated. In particular, the issues of developing the bioenergy potential of rural areas and the production of biofuels from alternative energy sources remain debatable.

The purpose of the work is to determine the theoretical and practical principles and problematic aspects of the organization of solid household waste management and the sale of products made from them.

Along with the annual increase in the volume of waste accumulated in Ukraine for all classes of danger, which reached almost 12 million tons [108] last year, there are many natural landfills of household waste that have already become part of urban and suburban areas. Today, there are tens of thousands of unauthorized landfills where not only household, but also construction and other hazardous waste are stored without control [109]. Such landfills are a serious source of pollution not only of thousands of

hectares of land, but also of the air and water environment. That is why special attention needs to be paid to the issues of proper accounting of stray waste, their timely detection, establishment of the causes of their formation, development of measures to prevent their further formation and processing, disposal of such accumulated waste [110].

Stray waste is subject to separate state accounting. According to Art. 12 of the Law of Ukraine "On Waste", waste that has no owner or the owner of which is unknown is considered to be ownerless. If the owner of the waste is determined in accordance with the provisions specified in the Procedure for identifying and accounting for stray waste, approved by the Resolution of the Cabinet of Ministers of Ukraine dated 03.08.1998 No. 1217 [111], he bears full responsibility for observing the conditions of their handling and preventing the negative impact of waste on the surrounding natural environment. If the ownerless waste is not accounted for, then the local self-government body is considered to be its owner, and a "spontaneous" landfill was created on the territory. At the same time, it should be noted that the status "owner not established" is the result of certain procedures for its determination. Currently, this is the function of local commissions for identifying and accounting for stray waste. At the same time, at the legislative level, a specific algorithm of actions to establish the owner, certain powers of the commission are not fixed, which in practice leads to the limitation of the commission's actions only to the detection and accounting of stray waste without establishing its owner. This creates additional financial problems for local self-government bodies during the practical implementation of this provision and does not contribute to solving the issue of handling stray waste.

Thus, it is proposed to understand waste as materials, objects, substances, the creation of which must be avoided, but objectively formed as a result of any human activity, the functioning of other living organisms, natural and man-made situations, which do not have their further use at the place of their formation, have lost their consumer properties, have an owner who must prevent their formation by all legal means, or get rid of them in accordance with the procedure established by law by disposal, removal or processing, in order to ensure the protection of the natural

environment, the protection of life and health of people and the economic benefits. The system of legislation of Ukraine on waste consists of a large number of legislative acts. The legislative system of Ukraine on waste includes such legislative acts as the Laws of Ukraine "On Ensuring Sanitary and Epidemic Welfare of the Population" [112], "On Handling Radioactive Waste" [113], "On Scrap Metal" [114], "On Housing communal services" [115], "On chemical current sources" [116], "On veterinary medicine" [117], "On removal from circulation, processing, disposal, destruction or further use of low-quality and dangerous products" [118], Code of Ukraine on subsoil [119], other normative legal acts.

Pursuant to Article 28 of the Law of Ukraine "On Waste" with the aim of strengthening control over the ecological state of waste disposal sites, assessing their impact on the natural environment and human health, Resolution of the Cabinet of Ministers of Ukraine dated August 3, 1998 No. 1216 approved the Procedure for Keeping a Register of Sites waste removal. The register is created and maintained on the basis of passports of waste disposal sites, reporting data submitted by waste producers, information of specially authorized executive bodies in the field of waste management. Based on these passports, state administrations prepare conclusions on the level of environmental safety of waste disposal sites, determine the category of their level of environmental safety for the environment and human health. The registry is maintained by local state administrations [120].

Natural landfills in accordance with the decision of the National Security and Defense Council of Ukraine "On challenges and threats to the national security of Ukraine in the environmental sphere and priority measures for their neutralization", implemented by the Decree of the President of Ukraine dated 03.23.2021 No. 111/2021, are assigned to territories, which have a high level of risks for natural ecosystems and public health [121].

One of the ways to ensure the efficiency of household waste processing is to overcome the common practice of using plastic for packaging consumer goods. In accordance with European waste management standards, the Law of Ukraine "On Limiting the Circulation of Plastic Bags in the Territory of Ukraine" was adopted on

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June 1, 2021. This Law is aimed at reducing the volume of use of plastic bags in Ukraine, limiting their distribution in order to improve the state of the environment and beautify the territories. The adopted act prohibits retail, public catering and service facilities from distributing plastic bags of the following types: ultra-thin, thin, oxo-degradable. The exception is biodegradable and size-limited bags (size 225×345×450 mm), which are used for meat, fish and their products, as well as for the primary packaging of loose products (valid until January 1, 2023). All other plastic packages that do not meet the established requirements are subject to withdrawal from circulation. The law also prohibits their free distribution. Plastic bags should only be provided for cash. At the same time, retail prices for such packages cannot be lower than the minimum prices set by the Cabinet of Ministers of Ukraine. Mandatory labeling of biodegradable plastic bags is also provided, and fines are established for violations of these norms [122].

By signing the Association Agreement between Ukraine, on the one hand, and the European Union, the European Atomic Energy Community and their member states, on the other hand, Ukraine undertook to implement the provisions of (Framework) Directive No. 2008/98/EC of the European of the Parliament and the Council of November 19, 2008 "On waste and repeal of some directives" to the national legislation [123].

The Law of Ukraine "On Waste Management" provides for the creation of a National List of Waste, which will serve as the basis for waste accounting and reporting on the results of waste management, filing declarations and implementing permit procedures in the field of waste management. The information contained in the National List of Waste has the character of public information, which creates opportunities for increasing the effectiveness of public control over the use of stray waste [124].

In accordance with the Law of Ukraine "On Waste Management" of June 20, 2022 No. 2320-IX (coming into force on July 9, 2023), the hierarchy of waste management is implemented by central and local executive bodies, local self-government bodies, enterprises, institutions and organizations with the aim of (in order

of priority):

- 1) prevention of waste generation;
- 2) waste preparation for reuse;
- 3) recycling;
- 4) recovery of waste (including energy production);
- 5) waste removal.

Enterprises, institutions and organizations whose activities lead to the generation of waste ensure compliance with the waste management hierarchy by:

- 1) planning and carrying out its activities in such a way as to prevent the generation of waste, reduce its generation, prevent its negative impact on human health and the surrounding natural environment during the design of products, their production, during and after the use of products;

- 2) carrying out the recovery of waste, the formation of which could not be prevented, ensuring the preparation of waste for reuse, recycling or carrying out other recovery operations, including energy production;

- 3) removal of only those wastes that are unsuitable for technological or economic reasons for recycling or other waste recovery operations [124].

In accordance with this law, the following terms are used in the following sense:

- 1) bio-waste – waste that is subject to anaerobic or aerobic decomposition, such as food waste or food industry waste at all stages of production and consumption, waste from green areas;

- 2) bulky waste – household waste that cannot be placed in containers up to 1.1 cubic meters in size;

- 3) waste removal – an operation that is not waste recovery, even if one of the consequences of such an operation is the use of substances or energy [124].

In accordance with the Law of Ukraine "On Waste Management", 15 waste disposal operations are defined, which include from their collection and storage to their processing and incineration for the purpose of obtaining energy or their disposal (Table 1).

Table 1

List of waste removal operations

Conventional designation	Operations on the issue of waste
D1	Placement on the surface or in the ground, including burial, etc
D2	Soil treatment, including biological decomposition of liquid or sludge waste in the soil, etc
D3	Deep injection, including injection of waste of appropriate consistency into wells, salt domes or natural reservoirs, etc.
D4	Discharge to the surface of liquid and sludge (sludge) waste, including discharge of liquid or sludge waste into pits, ponds or settling tanks, etc.
D5	Disposal at specially equipped landfills, including disposal in separate sections, closed and isolated from each other and from the natural environment, etc.
D6	Discharge into bodies of water other than seas/oceans
D7	Discharge into seas/oceans, including on the seabed
D8	Biological treatment, not specified in other headings of this annex, resulting in the formation of final compounds or mixtures, which are removed by carrying out the operations defined in headings D1-D12
D9	Physico-chemical treatment, not specified in other headings of this annex, resulting in the formation of final compounds or mixtures, which are removed by carrying out operations defined in headings D1-D12, including evaporation, drying, calcination, etc.
D10	Burning on land
D11	Incineration at sea (prohibited by the legislation of the European Union and international conventions)
D12	Permanent storage, including in special containers in the mine, etc
D13	Preliminary waste operations prior to disposal operations specified in items D1-D12, including sorting, crushing, compaction, granulation, drying, grinding, conditioning or separation
D14	Repacking before carrying out the operations specified in items D1-D13
D15	Storage before carrying out operations defined in items D1-D14

Source: systematized based on data [108]

In accordance with this law, there are also provisions for waste recovery operations of 13 types (Table 2).

Special attention should be paid to the use mainly as fuel or in another way for energy production (R1), which also includes installations for thermal treatment of household waste, if their energy efficiency is at least:

0.60 – for installations, the operation of which began before the entry into force of this Law;

0.65 – for installations, the operation of which began after the entry into force of this Law.

Table 2

List of waste recovery operations

Conventional designation	Waste recovery operations
R1	Use mainly as a fuel or in another way to produce energy
R2	Recovery/regeneration of solvents
R3	Recycling/recovery of organics not used as solvents, including composting and other biological transformation processes, as well as preparation for reuse, gasification and pyrolysis when components are used as chemicals, and recovery of organic materials in the form of backfill
R4	Recycling/recovery of metals and their compounds (including preparation for reuse)
R5	Recycling/recovery of other inorganic materials (including preparation for reuse, recycling of inorganic construction materials, recovery of inorganic materials as backfill and soil treatment leading to soil restoration)
R6	Regeneration of acids or bases
R7	Recovery of components is used to reduce pollution
R8	Recovery of components from catalysts
R9	Refinement of oil products or other types of their reuse
R10	Tillage that promotes agriculture or improves the state of the natural environment
R11	Use of waste generated during the operations defined in positions R1-R10
R12	Preliminary operations with waste for carrying out operations defined in positions R1-R11. If another R-code is not appropriate, this may include operations prior to recovery, including pre-treatment, including dismantling, sorting, crushing, compacting, granulating, drying, grinding, conditioning, repacking, separating, mixing or mixing before being fed to any which operations are defined in positions R1-R11
R13	Storage of waste before carrying out the operations defined in positions R1-R12 (except for the collection operation)

Source: systematized based on data [108]

The formula is used to determine energy efficiency:

$$EE = [(E_p - (E_f + E_i)) / (0.97 \times (E_w + E_f))] \times KKK, \text{ where:}$$

EE - energy efficiency;

E_p is the annual production volume of electric and thermal energy (GJ/year), which is calculated according to the formula:

$$E_r = 2.6 \times E_e + 1.1 \times E_t, \text{ where}$$

E_e - annual volume of electric energy production;

E_t – annual amount of thermal energy production;

E_f is the annual amount of energy used for the production of steam (thermal energy) (GJ/year);

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E_w is the potential annual amount of energy that can be obtained from waste processing (GJ/year), based on the calculation of their minimum calorific value (calorific value);

E_i is the annual amount of additional energy supplied to the technological process, except for E_w and E_f (GJ/year);

0.97 is a coefficient that takes into account energy losses caused by slag formation and radiation.

During the calculation of the energy efficiency index of thermal treatment facilities for household waste, the climatic conditions at the location of the facility are taken into account, which depend on the assessment of the need for heating the specified area (PGD – degree-day indicator).

KKK is the climate correction coefficient.

KKK for installations, the operation of which began before the entry into force of this Law:

$KKK = 1$ – if PGD is at least 3350;

$KKK = 1.25$ – if PGD is no more than 2150;

$KKK = - (0.25 / 1200) \times PGD + 1.698$ – for other values of PGD.

CCC for installations, the operation of which began after the entry into force of this Law:

$KKK = 1$ – if PGD is at least 3350;

$KKK = 1.12$ – if PGD is no more than 2150;

$KKK = - (0.12 / 1200) \times PGD + 1.335$ – for other values of PGD.

The resulting KKK value is rounded to three decimal places.

PGD - degree-day indicator (estimation of the need for heating) is calculated as the annual sum of the differences between the temperature of 18°C and the average daily temperature (only for those days when the temperature does not exceed 15°C). At the same time, average daily temperatures are defined as averages between the maximum and minimum daily temperatures.

The planned indicator for a certain year for each installation of thermal treatment of household waste is calculated as the average over the last 20 years for the settlement

in which the installation is located.

Waste is any substances, materials and objects that were formed in the process of production or consumption, as well as products that have completely or partially lost their consumer properties and have no further use at the place of their formation or detection and which their owner disposes of. intends or must get rid of by disposal or disposal [125]. Household waste is waste generated in the process of human activity in residential and non-residential buildings (solid, large-sized, repair, liquid, except for waste related to the production activities of enterprises) and is not used at the place of their accumulation. Solid waste is the remains of substances, materials, objects, products, goods, products that cannot be used for their intended purpose in the future [126]. In our opinion, solid household waste can be interpreted as a part of municipal solid waste, which contains the most valuable components for use in the economy, as well as hazardous waste generated by individuals.

Management of this activity implies the organization of collection, removal, disposal and processing of solid household waste in a specially designated area in accordance with current legislation and is under the management of local self-government bodies. Management at the local level of activities related to the management of solid household waste is carried out on the basis of the following principles: protection and rational use of natural resources, as necessary conditions for ensuring a favorable environment and ecological safety of the population of the territories; a combination of ecological, economic, social and other interests in this field of solid household waste management based on long-term programs and plans for the development of solid household waste management; the use of methods of economic regulation of activity in the region with the aim of reducing the total amount of waste, its degree of danger and involvement in economic activity; preventing the formation of unauthorized waste dumps and preventing cluttering of territories; compensation for damage caused to the environment and citizens' health as a result of violation of requirements, norms and rules regarding solid household waste management; ensuring the availability of information in a certain area.

In Ukraine, there are officially 5,455 landfills and landfills with a total area of

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more than 8.5 thousand hectares. Research by Honcharuk I.V. testify that, despite a number of adopted strategies and program documents on environmental protection in Ukraine, the sphere of waste management was not properly reflected in them, although such waste harms human health and the environment [127, p. 30].

Today, there is a trend of increasing waste generation in Ukraine. During the period of 2015-2021, this indicator increased by more than 30% and in 2020 it amounted to more than 462 million tons (Table 3). In 2020, more than 11 million tons were household waste and more than 435 million tons of waste from economic activities. Only 25 percent of this volume was disposed of.

Table 3

The main indicators of waste generation and management

	2010	2018	2019	2020	2021	Deviation, +, -
Formed, thousand tons	425914,2	312267,6	352333,9	441516,5	462373,5	36459,3
including from economic activity	419191,8	306214,3	346790,4	435619,8	456423,8	37232
Waste generated per person, kg	9285	7288	8335	10505	11074	1789
Collected and received household and similar waste, thousand tons	9765,5	11491,8	11857,2	11792,7	12634,9	2869,4
Imported, thousand tons	4,1	3,4	89,4	22,0	2,7	-1,4
Total burned, thousand tons	1058,6	1134,7	1028,6	1059,0	1008,0	-50,6
including for the purpose of obtaining energy	840,3	1086,3	951,2	960,1	902,2	61,9
Recycled, thousand tons	145710,7	92463,7	103658,1	108024,1	100524,6	-45186,1
Prepared for disposal, thousand tons	...	1940,5	3193,6	2810,4	2641,3	-

Source: formed on the basis of [128]

The total volume of waste disposal in 2021 was 100.5 million tons, mainly this volume accounted for recycling or disposal of inorganic materials (Table 4).

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Table 4

Waste from economic activity and in households was disposed of, thousand
tons

	2010	2018	2019	2020	2021	Deviation, +, -
Everything is disposed of	145710,7	92463,7	103658,1	108024,1	100524,6	-45186,1
Utilization/generation of solvents	330,6	65,3	103,9	137,1	111,2	-219,4
Recirculation	2773,2	443,2	397,6	474,8	320,0	-2453,2
Composting of organic waste	147,4	651,1	671,6	619,8	549,8	402,4
Fermentation of organic waste	295,8	86,7	88,5	77,7	63,5	-232,3
Recycling / utilization of metals and their compounds	9564,4	6515,8	5798,9	5592,7	5356,2	-4208,2
Recycling / utilization of other inorganic materials	110658,2	58958,1	55930,2	58763,3	43068,9	-67589,3
Recovery of components used to reduce pollution	6125,2	13718,7	26649,4	27348,7	36553,7	30428,5
Re-distillation of used petroleum products	99,3	29,0	12,5	14,7	13,5	-85,8
Soil treatment that has a positive effect on agriculture or improves the ecological situation	9244,5	10763,3	12320,3	13263,0	13501,3	4256,8
Use of waste obtained from any of the above operations	6438,5	1208,1	1684,1	1731,0	984,1	-5454,4
Everything is prepared for disposal	...	1940,5	3193,6	2810,4	2641,3	-
Waste exchange for further disposal	...	34,9	14,2	17,1	2578,4	-
Waste sorting	...	163,1	28,2	28,3	32,3	-
Mechanical and biological processing of waste at MBP installations	...	57,6	65,6	38,1	15,3	-

Source: formed on the basis of [128]

Unfortunately, composting of organic waste, primarily from household landfills, was practically not used. In 2021, more than 15,000 tons were subjected to mechanical and biological processing of waste at the facilities, which, unfortunately, is almost 4 times less than in 2015.

Summarizing the above, it can be concluded that the effective management of solid household waste is the basis for the sustainable development of the state. The level of Ukrainian legislation in the field of waste management is quite high. The state policy of waste management in Ukraine, as well as the main principles and priorities, correspond to European ones. However, the mechanisms of their implementation in practice are implemented very slowly. Therefore, they need to be accelerated, because by taking these basic steps in solid waste management, you can get closer to solving the problem of exiting a large-scale environmental disaster in the near future. The adoption of such norms, rules and requirements and their application in economic activity will make it possible to achieve optimal costs, means and resources for solving problems with solid household waste. It is also advisable to develop solid waste management strategies and plans at the regional level. This will provide an opportunity to build a proper system that will be economically efficient and will have a significant impact on the development of communities and the country in general.

In Ukraine, unfortunately, waste management according to this principle is more the exception for communities than the rule. However, there are communities that pay due attention to effective waste management, and their activities can become a successful example for others. We are talking about the Illinetska urban territorial community of the Vinnytsia region, which has started a number of waste management projects since 2016 and is successfully implementing them [129].

An important step for the community was the implementation in 2017 of the project "Construction of a waste sorting complex on the territory of the solid household waste landfill" in the city of Illinty, Illinetsky district of the Vinnytsia region, and the creation of the communal enterprise "Dobrobut".

The structure of the enterprise, in addition to the direct waste sorting complex, also includes a contact zoo, a landscape nursery and a material and technical base focused on the provision of services for the improvement of the territory of the community and the contact zoo. The contact zoo is mostly used for the social tasks of the Illinets City Council - conducting excursions, maintaining the image of an ecologically oriented community and forming eco-awareness among young people.

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The complex of measures to create a positive image by the enterprise "Dobrobut" involves the constant provision of services of the Illinets TG in the field of community improvement under the brand "Illinets - everything happens here" and the implementation of educational activities in the field of ecologically safe development of the relevant territories.

The key to rational use of the community's waste is its high-quality sorting. The morphology of solid waste entering the waste sorting complex of KP "Dobrobut" is represented, in the vast majority, by organic waste - 28% (leaves, tree chips, organic household waste, etc.), 18% - unclaimed solid waste that cannot be sold and can be burned to ensure heating of the enterprise itself and, in the future, to heat the petting zoo in winter. More than 40% of sorted waste is sold for processing. During 2020, KP "Dobrobut" sorted 20,500 m³ of solid waste, of which 40% was sold, 14% was sent for processing, and 46% was sent to a landfill [129].

About 14% of solid waste is used for recycling within the community - as a component for the production of paving slabs. In the tile production workshop, sand and plastic agglomerate are combined into a mixture: 30% plastic waste, 70% sand (the technology requires the use of river sand) [129].

The appropriate mixture enters a special machine, which heats it up to 180 °C and turns it into a hot mass. This mass is weighed in portions and placed in a press, where the final formation of the tile is carried out. The tile is produced in the basic size of 17X12X3cm (0.02 m²) with an average weight of 1.15 kg. Paving tiles of this type are cheaper and of better quality than concrete counterparts. Corresponding products are practically not affected by salt solutions or temperature changes, and their service life is unlimited, and what is important - they are subject to repeated processing. During an 8-hour shift, KP "Dobrobut" produces up to 250 m² of tiles. Today, the entire volume of production is used for the needs of the city and the community - it was also used for the improvement of the waste sorting complex, namely the area around the utility company and more than 10,000 m² of pavement in the city of Illinka.

On average, one ton of waste can produce 350 kg (35%) of RDF fuel, which will have a moisture content of 12-14%.

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The priority measures for the implementation of such a project in the Illinets community are:

- 1) familiarization with advanced European experience in the production and use of RDF fuel by communities;
- 2) assessment of the community's solid waste potential for the production of RDF fuel;
- 3) retrofitting of the waste processing plant of the Illinets urban territorial community with a line for the production of RDF fuel.

In order to use the energy potential of organic waste, which makes up 28% of the solid waste structure of the Illinets community and is currently sent to the landfill, bioenergy recycling is proposed - the organization of biogas production at the solid waste landfill.

Utilization of biogas from landfills allows not only to improve the environmental situation, but also to produce electricity and heat, partially replacing minerals. In world practice, the following methods of waste disposal are known:

- flaring, which ensures the utilization of greenhouse gases, the elimination of unpleasant odors and the reduction of fire hazards on the territory of the MSW landfill, while the energy potential of the landfill is not used for economic purposes;
- direct combustion of BGZ for the production of thermal energy;
- use of BGZ as fuel for gas-piston engines in order to obtain electricity and heat;
- use of BGZ as fuel for gas turbines for the purpose of obtaining electrical and thermal energy;
- bringing the methane content in BGZ (enrichment) to 94-97% with its further use in general purpose gas networks and as motor fuel;
- production of commercial carbon dioxide [131-133].

Research, Hryshenko A.V. show that the intensity of biogas formation at a solid waste landfill depends on the composition of waste, its mass, the order of storage, the density of waste per square kilometer, the access of oxygen and water to landfill waste, air and soil temperature. In view of this, it is necessary to first of all assess the composition of solid waste at the landfill. As a rule, the basis of MSW of Ukraine is

organic matter (paper, food waste, plant remains, etc.), which is 70-80% capable of biological decomposition in aerobic and anaerobic conditions [134, p. 39].

It is also appropriate to partially use agricultural products for processing into alternative energy sources [135].

The priority areas for the long-term perspective should be: the introduction of waste-free production, biotechnology as the main condition for the production of products with high-quality consumer properties; expansion of the range of ecologically clean and dietary dairy products; increasing the level of competitiveness of dairy products both on the domestic and foreign markets, creating waste processing plants [136, p. 37].

According to Furman I.V. in the future, it is expedient to consider the possibilities of implementing technologies for the processing of waste into biogas, focused on the internal needs of the enterprise through the implementation of the experience of the leading countries of the world, which will make it possible to obtain not only biofertilizers, but also energy resources [130].

It should be noted that for agricultural formations, in addition to the financial effect of saving money on the purchase of mineral fertilizers, the use of such organic fertilizers for the needs of farms will allow to obtain a positive agrotechnical effect caused by their advantages, namely: maximum storage and accumulation of nitrogen, a high level of assimilation of organic substances, absence of weed seeds and pathogenic microflora, resistance to soil leaching, etc. Thus, their use will allow not only to improve the physical and mechanical properties of the soil, to increase the yield of agricultural crops, but in the future to help produce competitive environmentally friendly products for sale on domestic and foreign markets.

Therefore, the implementation of the corresponding model in practice will make it possible to partially reduce the energy independence of the state from energy carriers, increase the efficiency of agricultural enterprises, providing the crop production industry with organic fertilizers, and give an impetus to the development of the production of equipment for biogas production at solid waste landfills.

Development and improvement of technologies for the production of biogas

from the waste of enterprises and households of the development of Ukraine. The proposed measures within the Illinets TG will make it possible to:

- achieve an increase in the volume of waste processing at solid waste landfills;
- to improve methods of waste management of enterprises and households;
- to increase the indicator of the gross regional product and the profitability of communal enterprises focused on the improvement of communities.

At the same time, the production of biogas at solid household waste landfills can have the following effect on the economy:

- to increase the energy independence of the state;
- to reduce utility companies' expenses on energy carriers;
- to improve the ecological condition of territorial communities;
- reduce the volume of greenhouse gas emissions;
- to provide agricultural producers with organic fertilizers.

The choice of waste processing technology should be part of the development of a regional solid waste management plan. One of the first priorities of the plan is to determine the location of the regional landfill for solid waste disposal using the principles of interregional cooperation. In most cases, waste processing enterprises will be territorially bound to the regional landfill. The choice of a specific processing technology depends on many factors, some of which are discussed below (Table 3.5). One of the determining factors at the moment is the cost of processing a ton of solid waste.

The choice of energy utilization is usually determined by the following considerations:

1. the desire to increase the depth of waste processing, especially in the case of thermal processing methods in order to minimize landfilling;
2. the possibility of obtaining an own source of energy that replaces fossil fuels, such as natural gas or coal;
3. the possibility of obtaining additional income through the sale of electricity and heat, and in some cases also KOR/BYU7;

It should be noted that obtaining additional income through the sale of electricity

and heat obtained from solid waste does not in most cases mean achieving the economic parameters of the project that are attractive to the investor. In most cases, the implementation of projects requires a significant increase in the tariff for waste processing, especially significant for thermal processing methods. An exception to this rule are projects for the collection and utilization of biogas at waste disposal sites.

From a technological point of view, biogas collection and utilization projects are the simplest, followed by manual and automatic sorting lines, solid waste conditioning, aerobic and anaerobic processing methods, and thermal utilization of prepared and mixed solid waste.

As the complexity of the technology increases, specific capital costs increase. At the current level of Ukraine's economy, only relatively simple projects can be developed, in most cases the choice of technology will be determined by the principle of "reasonable sufficiency". In accordance with this principle, projects for the collection and utilization of biogas at landfills and landfills, the use of sorting lines, and the first MBO projects with a capacity of at least 80,000 tons per year are already being implemented. The latter circumstance is helped by the fact that the legislation of Ukraine provides for the use of a stimulating "green" tariff for electricity from biogas collected at landfills or obtained as a result of MBO.

For the implementation of thermal projects using equipment from European suppliers, there are no economic conditions in Ukraine yet. Similar projects can be implemented only in case of significant reduction of capital costs without loss of flue gas cleaning quality. An exception is the incineration of MZR/BRR by cement plants.

Solid fuel from solid waste can be used in specialized thermal power plants/boiler plants that supply heat to the central heating system/DHW system, as well as - if it is a thermal power plant - electricity in the network or for the needs of the utility industry. Implementation of such a project is possible in two variants - a CHP with a turbine operating in heating and condensing modes and a boiler room (without a turbine). The first option (REC) ensures a constant load of raw materials, in summer, excess heat can be used in cooling towers (up to 30% of fuel energy). The second option (boiler plant) allows you to reduce capital costs, increase the efficiency of fuel

use, but does not ensure a constant load of raw materials throughout the year. In the summer, the remaining fuel must be stored and used in the autumn-winter period. For projects of thermal utilization, the proximity of production facilities and heat networks is of fundamental importance.

The use of a stimulating "green" tariff for electricity obtained as a result of heat treatment is not provided for. Moreover, the hypothetical use of an electricity tariff at the level of the existing tariff for biomass and biogas does not create the necessary financial flows to increase the economic attractiveness of thermal treatment projects to the level required by the investor. At the specific costs of incineration of solid waste

100-150 EUR/t potential profit from the sale of electricity under the "green" tariff is 60 EUR/t for MSW with a lower calorific value of MSW 8.0 MJ/kg and 75 EUR/t for the case of 10 MJ/kg.

When burning MSW, electrical efficiency is quite low, in cogeneration schemes, a larger amount of energy from solid waste can be obtained in the form of heat. Therefore, the main income can be related to the sale of heat, and not electricity. For example, in the EU, waste incineration is particularly developed in countries that practice centralized heat supply (Denmark, Sweden). Despite the fact that there are negative trends in the development of DH in Ukraine, the potential for using heat from solid waste in DH/DHW systems is quite large.

In the absence of a CHP / boiler house for the production of RDF/RSF, the distance to the nearest cement plant, which is interested in using alternative fuel and has a full clinker firing cycle, is of great importance.

The risks of the projects are related to the dependence on the supply of waste/raw materials, dependence on the energy consumer, the need to allocate additional land in the immediate vicinity of the CH systems, as well as insufficient heat consumption in the summer. Risk reduction can be achieved by increasing the amount of raw materials and guarantees for their supply, determining the conditions for the transfer / sale of fuel to cement plants, creating conditions for the full use of heat.

The new Ukrainian waste management strategy until 2030 envisages a transition from disposal of waste to landfills and landfills to a system of integrated solid waste

management. In practice, this means achieving in 2030 the rate of recycling 50% of household waste from the total volume of its generation, putting into operation additional waste sorting lines and waste processing plants, creating within the framework of pilot projects facilities for the production of fuel from household waste on the basis of mechanical facilities -biological processing, provided they are located close to cement plants, introduction of a number of pilot projects on biological stabilization of mixed household waste in Ukraine.

In our opinion, an information model of the interaction of waste processing enterprises focused on the production of biogas is necessary, which should include interaction on the basis of public-private partnership of research institutions and relevant enterprises focused on the production of biofuel (Fig. 1).

The appropriate model should include the following measures for the production and promotion of biogas to the energy market:

- public-private financing of scientific research in scientific institutions in accordance with the needs of the enterprise (design of biogas plants, production at solid waste landfills);
- training of employees who will be involved in the production of biogas at the landfill in the scientific institution;
- conclusion of contracts with enterprises focused on the production of equipment developed by scientific institutions for the production of biogas at solid waste landfills;
- compensation of interest by the state budget for the purchase of equipment for the production of biogas to communal enterprises;
- establishment of the biomethane market in Ukraine;
- transfer of by-products from biogas production (digestate) for use as organic fertilizer for agricultural crops;
- establishment of cooperation with buyers of biogas (industrial enterprises - biogas).

PECULIARITIES OF MARKETING ACTIVITIES OF AGRARIAN ENTERPRISES IN THE CONDITIONS OF MARTIAL LAW

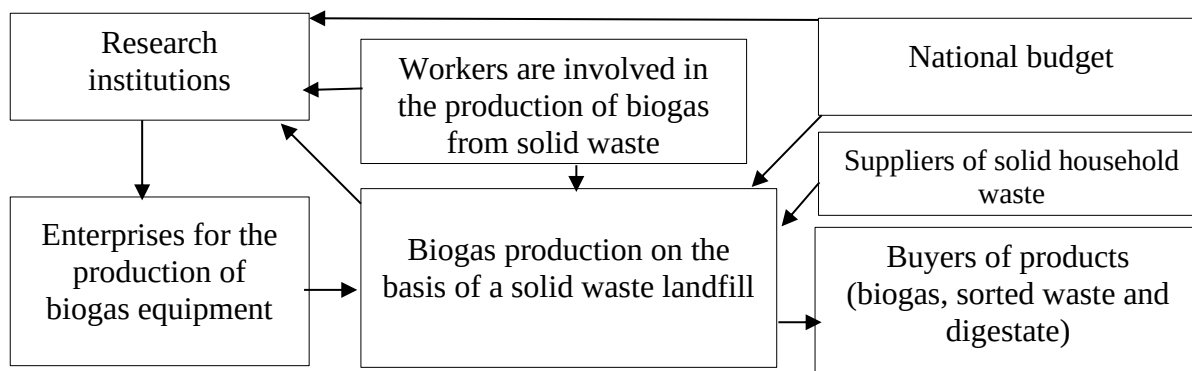


Fig. 1. The model of interaction of waste treatment enterprises focused on the processing of solid waste

Source: systematized based on [137-147]

Assessment of possible ways of developing the potential of energy cooperatives can to be carried out on the basis of three groups of indicators:

- 1) assessment of the abilities of economic entities for innovative activity;
- 2) assessment of the possibilities of using and developing this ability;
- 3) assessment of the effectiveness of the use of all types of resources (intellectual, financial, energy resources) possessed by this or that territory. The "EPIT" development index is calculated on the basis of three main components:

$$I_{epit} = Fr + Fe + Pn$$

where: I_{epit} is the "EPIT" development index,

Fr – financial expenses for R&D;

Fe – financial costs for personnel retraining and training;

Pn is the number of implemented patented technological solutions ($N1...$).

The prospects for the development of the domestic market are connected, first of all, with the construction of low-rise housing, especially cottage villages. As people's incomes increase, the number of middle-income people buying suburban housing increases, and thanks to the efforts of pellet and pellet equipment manufacturers, public awareness of the benefits of heating homes using stones and pellet boilers is increasing. For a private cottage, pellets are the cheapest type of fuel compared to firewood, fuel oil, coal, diesel and electricity. There is growing interest in the use of fuel pellets at industrial and utility enterprises.

PECULIARITIES OF MARKETING ACTIVITIES OF AGRARIAN ENTERPRISES IN THE CONDITIONS OF MARTIAL LAW

Agricultural waste, especially in rural areas, is available in fairly large volumes, but it is not suitable for burning in stoves and boilers in non-gasified settlements. The creation of cooperative formations for the processing of straw into pellets can become one of the ways to solve this problem.

Improvement of investment and innovation activity in the agricultural sector requires improvement of the current mechanisms of investment attraction. Investments in the agricultural sector will allow the introduction of innovative developments in agriculture.

The activity of energy cooperatives should be started according to the appropriate algorithm:

Step 1. Assessment of the potential of such a cooperative: analyze what resources are available for use in the selected community, potential participants and specialists.

Step 2. Choosing a technology to use these resources.

Step 3. First economic and technical calculations.

Step 4. Involvement of members of the cooperative and its supporters. Choice of the community.

Step 5. Choosing the legal model of the energy cooperative - LLC, PJSC or other.

Step 6. Development of documentation: charter and its registration in the registration service. At this stage, it is worth attracting future members.

Step 7. Purchase of production equipment.

Step 8. Start of operational activities of the energy cooperative.

Step 9. Establishing cooperation with commercial intermediary entities

The feasibility of energy utilization can be determined by reducing the amount of waste sent to landfills and increasing the service life of new regional landfills. The experience of developed countries shows that separate collection and reuse are developing simultaneously with the energy use of solid waste, competing to a certain extent for raw materials, but not contradicting each other.

From a technological point of view, the simplest projects are biogas collection and utilization, followed by manual and automatic sorting lines, MSW conditioning, aerobic and anaerobic methods, and thermal utilization of prepared and mixed MSW.

As the complexity of the technology increases, specific capital costs for their implementation increase.

The purpose of the work is to determine the theoretical and practical principles and problematic aspects of the organization of solid household waste management and the sale of products made from them.

The implementation of any recycling methods requires the consolidation of the solid household waste management system at the regional level with the potential of at least 100,000 tons of solid waste per year or more. For such a project, satisfactory economic indicators are demonstrated by the mechanical and biological treatment of solid waste with the production of biogas and the subsequent production and sale of electricity at a green tariff.

Another prospect is the production of solid fuel from MSW for further use in the cement industry. The complexity of such an approach is due to the lack of appropriate legislation in Ukraine and, as a result, the current uncertainty of the terms of transfer / sale of fuel to cement plants.

The current tariff for solid waste management mainly covers the costs of transporting waste to landfills, but the landfill itself is paid for on a residual basis. The cost of construction of future solid waste management facilities, both regional managed landfills and waste processing complexes, significantly exceeds the available volume of paid services in the field of solid waste management. Therefore, the need to use tariffs for processing and disposal has become ripe in Ukraine, which would ensure exploitation at the necessary technical and ecological level and would include a certain component for the implementation of investment projects.

Stimulating the production of biofuel through state funding of scientific research works in the field of biofuel production and compensation of interest on loans granted for the creation of factories focused on the processing of solid household waste on the basis of landfills is a necessary prerequisite for ensuring energy independence of Ukraine. It is promising for further research to determine the potential of agriculture in the field of biofuel production.

The main restraining factor for the development of biogas production at solid

household waste landfills is, first of all, the lack of state incentives and the necessary amount of investment. By means of state stimulation of the development of alternative energy and subsidies from local budgets for the relevant utility companies, it is possible to achieve the solution of the tasks in the short term. In further scientific studies, the peculiarities of the formation of information systems for waste management at solid waste landfills will be considered.

In our opinion, one of the main directions of the development of TG should be the implementation of energy saving projects and the use of renewable energy sources with the support of state and regional energy saving programs, which will take place, including through the awareness of employees of institutions about the possibility of receiving additional financing from various sources (including international).