METHODOLOGY OF MARKETING RESEARCH FOR BIOGAS MARKET DEVELOPMENT IN EU COUNTRIES AND UKRAINE

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Introduction. The energy supply of the population and the global ecological crisis are forcing countries worldwide to introduce and apply new alternative means of energy production. Given the almost inexhaustible raw materials, biogas extraction and processing methods are attracting more and more attention from states. Favourable changes in legislation further stimulate investors to invest in the construction of biogas plants. The primary method of solving the problem is the introduction of effective waste processing measures to obtain a positive economic and environmental effect from biogas production [1].

Biogas production has long been no longer an exotic business activity since it is a solution to the environmental issue of marketing organic waste from animal husbandry on an industrial scale and preventing methane formation in natural conditions with its negative impact on the Earth's atmosphere. Renewable energy development is considered one of the crucial criteria for energy security worldwide. The main reason for the need to increase the use of renewable energy sources is the uncontrolled growth of household and industrial waste, which leads to environmental pollution and requires high costs for disposal or disposal. Modern waste management methods can effectively protect the environment [2].

In this study, we were guided by the need to study the European experience in shaping waste management policies, biogas, and biomethane production in the context of adequate environmental protection and the transition to sustainable energy. The EU's production and use of biogas and biomethane must meet sustainability criteria proclaimed by the Directive (RED II) on renewable energy sources in 2018. That is why the experience of European countries in biogas production has become a positive example for implementation in the development of bioenergy in Ukraine [3].

The purpose of the scientific research is to study the methodology for researching the development of sustainable technologies in the context of the ideology that underlies the development of the biogas industry in the EU countries and Ukraine.

Results. In achieving the long-term goals of European countries regarding energy security and climate change mitigation, biogas will play a key role as part of a promising and balanced set of renewable energy sources. One of the priority vectors for developing renewable energy is biogas production from organic residues. Given the growing dependence on gas imports, sustainable biogas production is strategically essential. A study of the materials of the European Biogas Association showed that biogas and biomethane are becoming increasingly important energy sources in the EU energy mix, and their production has been increasing over the decade. Biogas production technology is obtained from organic waste in biogas plants and used to produce heat or electricity. Biogas is formed during the decomposition of biomass in landfills, swamps, sewage, and municipal waste landfills. The most effective raw material base for biogas production is agrobiomass and cover crops, which are grown in the interval between two annual food crops [4].

The beginning of the development of biogas technologies was laid back in the 17th century by observing how the release of flammable gas accompanies the decomposition of biomass. The first documented biogas plant was built in India, and the idea was borrowed from the technology developed for the treatment of municipal wastewater and implemented in The Hague. Already in the 40s of the last century, two scientists in Algeria patented and built a plant to produce biogas from manure. In the last quarter of the 20th century, many European countries were actively searching for effective fermentation technologies to produce biogas from various raw materials of agricultural origin. Developed countries are currently focusing on developing and implementing powerful industrial, agricultural, and commercial biogas plants that further convert biogas into electrical and thermal energy or biomethane. Biogas technologies for the utilization and energy conversion of waste and by-products of agriculture and industry, municipal and organic waste, sewage sludge, etc., have a wide range of advantages, which makes them one of the most attractive ways of sustainable use of renewable energy sources [4].

The main prerequisite for developing the renewable energy sector in the European Union was the relevant Community policy, the basis of which was laid in 1997 by the approval of the Community Strategy and Action Plan by the Council of Europe and the European Parliament. To this end, some interim Directives

on renewable energy sources were developed and implemented. The Bioeconomy Strategy, the Energy Roadmap to 2050, the Paris Agreement, the Climate and Energy Framework Programme to 2030, etc. Thus, the favourable EU framework conditions and the significant advantages of biogas production create excellent prospects for the further development of the industry and the widespread use of biogas in various sectors [5]. Until recently, waste generation in connection with production and consumption was perceived as an unavoidable necessity. Environmentally sound waste management has been an essential issue of European policy from the beginning, and significant progress has been made in reducing the impact of waste generation on the environment and human health. Clear European climate targets oblige the agricultural and livestock sectors to reduce their climate impact by using more favourable sectoral practices to limit their environmental impact. Developing effective methods for managing farm waste and converting it into biomass energy accessible to people can alleviate the current global energy crisis and improve agrarian production's environment, effectively protect the environment, and significantly contribute to reducing carbon emissions. Therefore, to support the sustainable development of global energy use and the ecological environment, the study of the rational use of agricultural waste to mitigate the energy crisis and environmental pollution has become the responsibility of all countries [6].

The production and use of biogas have several justified and proven advantages in world practice since the wide range of raw materials required for biogas production allows the construction of biogas plants in areas of concentration of agricultural output and technologically related industries.

Biogas will play a key role in achieving Europe's long-term goals for energy security and climate change mitigation [7].

The state of technology and development of the biogas market for 2009-2022 is evidenced by the increase in the number of biogas plants in Europe by 2.5 times; in 2022 it will be 19,491 units. (Figure 1).

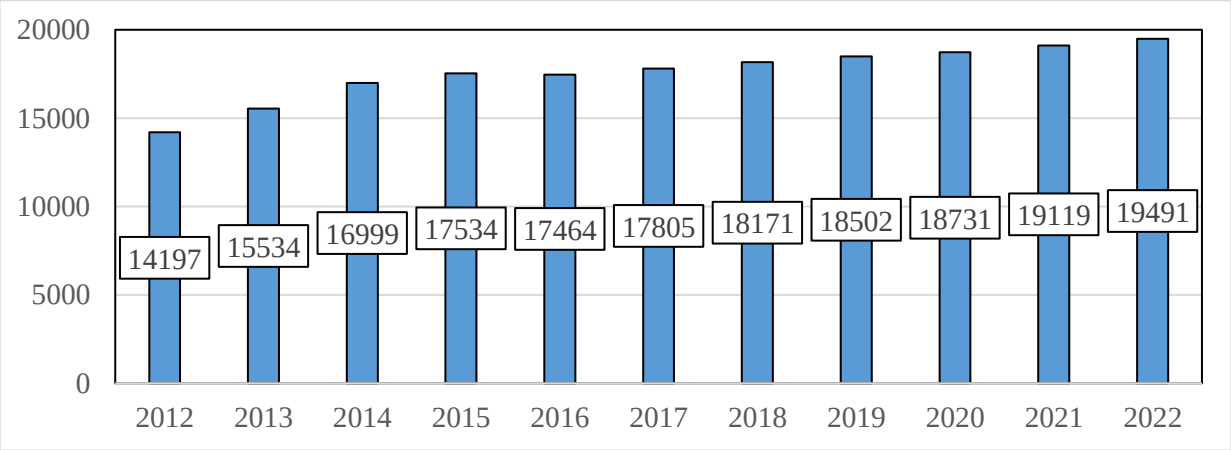

Fig. 1. Number of biogas plants in the EU, units (Covered by the authors) [8].

Biogas production has been increasing since the 1990s. Market conditions, together with targeted policies, stimulate the use of biogas. The production and use of biogas in the EU must meet a set of sustainability criteria announced by the Renewable Energy Directive (RED II) in 2018. The RED II policy has positively impacted the quality of the raw materials used for biogas production. Data show that since the introduction of the regulations, new biomethane plants have increasingly used waste and residues in their operations [9].

Biogas is mainly used to produce electricity and heat. There are, however, several cases of conversion of biogas into biomethane injected into the natural gas grids or used as biofuel in vehicles. In this last direction, a few north-central EU countries are worthy of note, as they have implemented an effective policy to promote the use of biomethane for public and private transport. Until recently, waste generation in connection with production and consumption was perceived as an unavoidable necessity. Environmentally sound waste management has been an essential issue in European policy from the beginning, and significant progress has been made in reducing the impact of waste generation on the environment and human health. Clear European climate targets oblige the agricultural and livestock sectors to reduce climate impact by using more favourable sectoral practices to limit the industry's environmental impact. The development of effective methods for managing agrarian waste and converting it into biomass energy accessible to people can not only alleviate the current global energy crisis but also improve the agricultural production environment, effectively protect the environment and at the same time, significantly contribute to reducing carbon emissions. Thus, to support the sustainable development of global energy use and the ecological environment, the study of the rational use of agricultural waste to alleviate the energy crisis and environmental pollution has become the responsibility of all countries [6].

According to the statistical report of the Biogas professional association in 2023, the combined production of biogas and biomethane in 10 European countries in 2022 is presented, among which Germany is the leader (Figure 2).

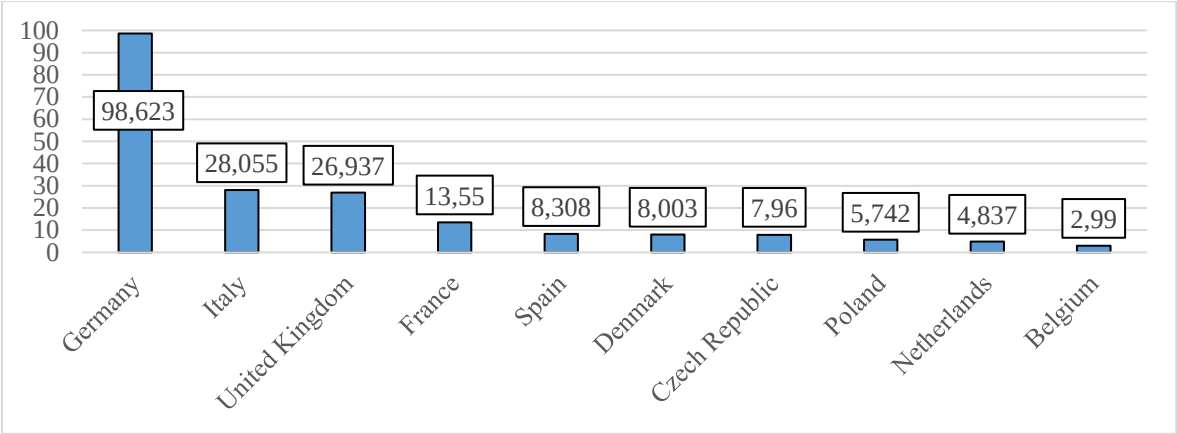

Fig. 2. Number of biogas plants in the EU, units. (Covered by the authors) [8].

According to the calculations, the prospects for biogas production in Europe indicate a tenfold increase in production by 2030. Currently, there is a view that biogas production is better focused on less controversial feedstocks, such as livestock manure, agricultural waste and residues, which do not compete with agricultural land used for food production. This model is championed by Denmark, which opened its first biogas plant based on manure in 1975. Following adopting a national «energy deal» for 2012-2020, the country has begun developing biomethane, which accounts for about 10% of what is injected into the natural gas network. [9]. A report by the European Biogas Association showed that biogas and biomethane are becoming increasingly important energy sources in the EU energy mix, and their production has been increasing over the decade. In 2022, there were 1222 biomethane plants in Europe, which is 6.7 times more than in 2011 (Table 1) [10].

Table 1

Number of biomethane plants in the EU [10]

Years	Existing plants	New plants	Total
2011	182	0	182
2012	182	61	243
2013	243	59	302
2014	302	71	373
2015	373	58	431
2016	431	73	504
2017	504	58	562
2018	562	65	627
2019	627	90	717
2020	717	166	883
2021	883	184	1067
2022	1067	155	1222

The forecast for developing the biogas industry in European countries was calculated based on statistical data from past periods using regression analysis and the Excel spreadsheet editor. Regression analysis allows you to determine the degree of relationship between variables and predict the value of a particular variable based on known values. The trend line is a geometric representation of the average values of the analyzed indicators. The resulting linear trend graphs illustrate the relationship between periods and volumes of production and the coefficient of determination (R2). It makes it possible to assess the density of the relationship between the studied phenomena, which is determined by the quantitative value.

The closer R^2 is to 1, the more precisely the relationship is defined, which reflects the relationship between the values and the tendency to positive or negative changes. The calculations showed that for the trend line of energy production from biogas, $R^2 = 0.8767$, and a high-density level of the relationship between the values was determined. For the trend line of energy production from biomethane $R^2 = 0.9577$,

which characterizes a significantly high degree of reliability of the relationship between the values, i.e. the linear regression equations are in good agreement with the sample data. Also, the high density of the relationship between the studied phenomena is illustrated by the trend line of the total energy production from biogas and biomethane, which confirms the obtained coefficient of determination R^2 = 0.9745 and predicts an increase in these indicators in the prospective period (Figure 3).

According to the regression analysis indicators, the trend line on the graph was extended beyond the available data to predict future values. Statistical data on energy production from biogas and biomethane for 2013-2022. made it possible to obtain graphs that reflect the expected values of the development of biogas production for 2023-2026. Analysis of the results of the trend model of energy production from biogas and biomethane in the EU countries for 2013-2022. showed that its production during this period is characterized by constant growth. The trend line shows a further growth trend until 2026. where energy production from biogas will increase to 19.1 billion m³/year, energy from bioethanol will increase to 5.2 billion m³/year, totalling 24.3 billion m³/year. The research results indicate that European countries pay due attention to the development of this industry. Ukraine has been following global trends and developing clean energy in recent years. An essential condition for the further development of the energy sector in Ukraine is using such types and sources of energy that would not disrupt the balance in nature and replace the exhaustible reserves of organic fuel. The necessary resources and sufficient potential for producing this new product type exist. One promising area is biogas production as a renewable energy source, the raw materials agriculture supplies [11].

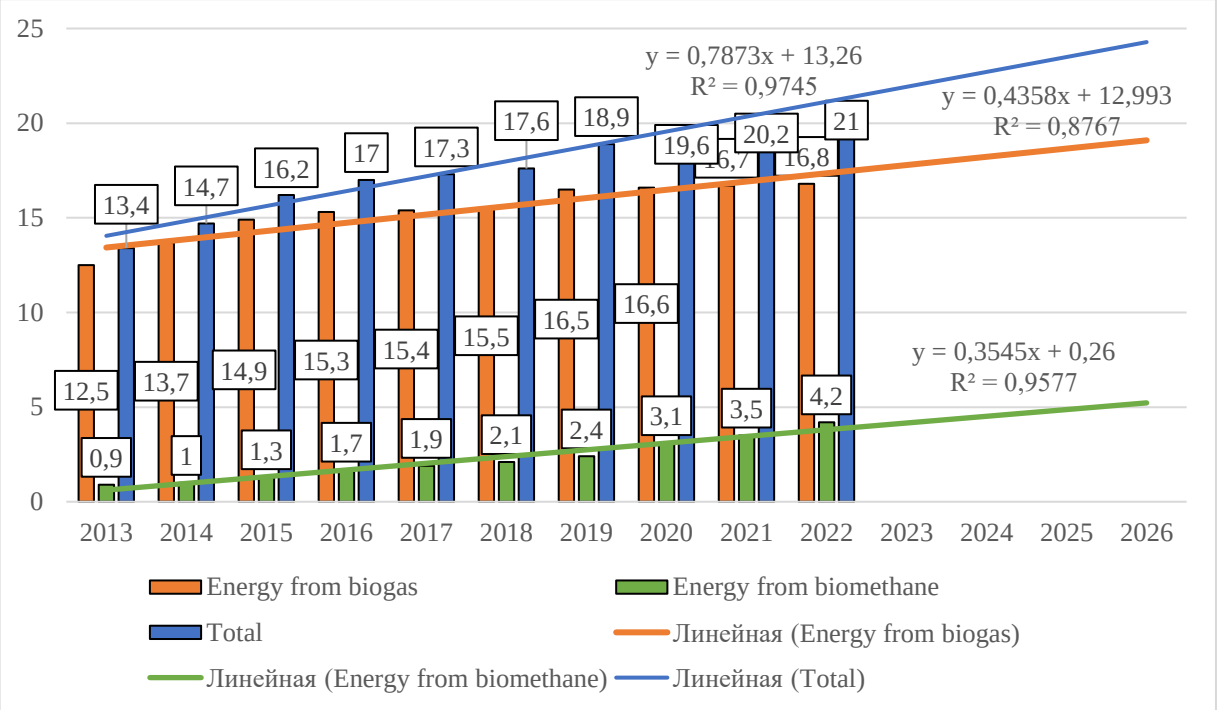

Fig. 3. Trend model for forecasting energy production from biogas and biomethane in Europe, billion m³/year

Obtaining biogas from organic residues of the economy's agricultural sector is essential for developing renewable energy. Ukraine's potential for the development of biogas production is enormous since it has a well-developed agriculture, the waste from which provides an excellent raw material base. The energy obtained from biomass becomes a real replacement for «classic» hydrocarbon fuel.

Biogas is the only type of renewable energy that can be used in several ways. It can be burned in heating plants, and heat can be obtained for heating. In enriched form, it is used in automobile engines as fuel. In cogeneration plants, you can get electricity sold or used in production. To produce biofuel, you need a biogas complex - an engineering and technical facility in which organic waste is processed into biomethane. Ukraine has excellent raw material opportunities, so biogas is a promising direction for developing renewable energy (Table 2) [12]. One of the promising types of raw materials for biogas production is cover crops, which do not compete with food and feed crops and are grown in the interval between two annual crops. According to the European Biogas Association (EBA), more than a quarter of the potential for biomethane production can be ensured by using cover crops. Using the harvested mass of such crops for biogas, with the subsequent return of the digestate to the same fields, allows for the significant expansion of the potential for attracting arable land resources to the energy sector without harming agricultural production [13].

Table 2

Main sources and types of raw materials for biogas production. 1 million m3 CH_4/year [2]

Sources of raw materials		Types of raw materials	CH_4 yield per unit of raw materials	Amount required to produce 1 million m^3 of CH_4/year
Industrial animal husbandry	Cattle Farms	Cattle manure	1 head → 780 l CH_4/day	3,600 head
	Pig Farms	Pig manure	1 head → 207 l CH_4/day	13,500 head
	Poultry Farms	Chicken droppings	1 head → 11 l CH_4/day	250,000 head
Industrial crop production	Energy Crops	Corn silage	1 ton → 100 m^3 CH_4	250 hectares
	Crop Residues	Wheat straw	1 ton → 230 m^3 CH_4	1,700 hectares
		Corn stalks	1 ton → 180 m^3 CH_4	1,350 hectares
	Cover Crops	Rye	1 ton → 100 m^3 CH_4	400 hectares
Food, feed and beverage production	Sugar Refineries	Pulp	per 1 ton of beets → 28 m^3 CH_4/day	6,800 tons of sugar
	Distilleries	Bard	per 1 dal of alcohol → 3,5m^3 CH_4	0.4 million dal. alcohol
	Breweries	Grounds	for 1 dal of alcohol → 0,15m^3 CH_4	7 million dal. alcohol

Using high-quality compost or digestate to replace mineral nitrogen, phosphorus and potassium fertilizers reduces the impact on the environment by avoiding the production of primary mineral fertilizers [14]. Forming effective methods of managing agricultural waste and converting it into biomass energy available to people can effectively protect the environment and, at the same time, significantly contribute to reducing carbon emissions [6]. The use of the organic fraction of industrial and household waste is a significant reserve for improving the country's energy supply through their processing into biogas. At the same time, the issue of enhancing the fertile properties of agricultural soils through their fertilization with high-quality organic biofertilizers formed after the processing of these wastes into biogas is positively resolved [13].

The availability and use of biogas production energy capacities by enterprises of Ukraine as of 1.01.2023 is presented in Table 3.

Table 3

Availability and use of biogas production capacity in 2023 [15]

Enterprises	Power, MW	Installed capacity utilization factor, %	Enterprises	Power, MW	Installed capacity utilization factor, %
LLC «Demetra Bioenergy»	0,5	81	LLC «LNK»	5,3	44
LLC «Korsun Eco Energy»	7,5	74	LLC «Clear Energy-Kherson»	2,7	42
LLC «Agrofirma im. Chkalov»	6,0	72	LLC «Energo Sich»	1,12	39
LLC «Vinnytsia Poultry Farm»	12,0	68	LLC «Teofipol Energy Company»	26,1	38
LLC «Yuzefo Mykoliivska Biogas Company»	5,2	66	LLC «Gorodishche-Pustovariv-skaya Agrarian Company»	14,7	42
LLC «Biogas Energy-Ternopil»	0,7	66	LLC «Zahid Agroenergoinvest»	1,1	80
LLC «Lankkast»	2,1	64	LLC «Clear Energy»	3,5	50
LLC «Clear Energy-Odesa»	5,0	61	LLC «Biogas-Ukraine»	3,2	28
LLC «Biogas Energy»	0,7	56	LLC «AEU Energo»	1,0	27
PJSC «Oril-Leader»	5,7	55	LLC «International Center for Gas..»	0,7	26
LLC «Clear Energy-Kremenchuk»	1,8	53	LLC «Clear Energy-Chernihiv»	1,1	24
LLC «Goodwell Ukraine»	1,2	48	LLC «Masterenergo Invest»	0,7	18
PP «MPP Latex»	0,6	45	SPRAT «Ukraine»	0,4	12

The analysis of biogas use (Table 4) showed that in 2023, the volume of electricity production from biogas would be 580 million kWh, 7.25 per cent of its total production from renewable sources [16].

In the EU, biogas is mainly used for electricity and heat generation, and biogas is also converted into biomethane, which is injected into the natural gas network or used as biofuel in vehicles. In this regard, implementing an effective policy to promote the use of biomethane for public and private transport deserves

attention [17]. To strengthen the development of biomethane production in Ukraine, in October 2021, the Verkhovna Rada adopted the Law "On Amendments to Certain Laws of Ukraine Regarding the Development of Biomethane Production". The law aims to ensure the possibility of verifying purified biogas (biomethane), the physical and chemical characteristics of which must be similar to those of natural gas. It is also envisaged to introduce a mechanism for developing the biomethane market, which is aimed at using the capabilities of the Ukrainian GTS, which is connected to the GTS of European countries [18].

Table 4

Electricity production from renewable energy and biogas, 2023 [16]

Indicators	Electricity generation from renewable sources	Electricity generation from biogas	Electricity from biogas to total production, %
RES facilities/installations	1767	68	3.85
Installed capacity. MW	8773	135	1/54
Installed capacity utilization rate, %	x	49	x
Facility/installations received a «green tariff» in 2023	65	43	66.15
Total production of «green energy»	8 million MW*H.	580 million kWh.	7.25
Generation facilities have a surcharge for the local component	181	12	6.63

The Chairman of the Board of the Bioenergy Association of Ukraine, Heorhiy Geletukha, noted that Ukraine has favourable conditions for biomethane production. Several agricultural enterprises have built biomethane plants to operate on their raw materials. Given the existing opportunities and prospects, in 2021, the Hals Agro company in the Chernihiv region decided to produce biomethane at the plant. The first biomethane module in Ukraine was installed and connected to the distribution networks of JSC Chernihivgaz in January 2023. The plant's capacity was up to 3 million cubic meters of biomethane annually. Biomethane can be pumped into the Ukrainian GTS and used as natural gas. The basic raw materials for the plant in the Chernihiv region are sugar beet pulp after sugar production, beet molasses, plant residues, energy plant silage, food and feed production waste, and cattle manure. [19, 20].

Gals Agro plans to expand production, having already built capacities to produce up to 30 million cubic meters of biomethane annually. The company has built six biogas plants in four locations in Chernihiv and Kyiv [10].

In the Khmelnytskyi region, Vitagro's biomethane plant was put into operation in 2023, and it has a capacity of 3 million cubic meters/year of biomethane. Five more enterprises are also planned to open in Ukraine by the end of the year. In the event of a successful export of bioethanol in 2025, we can expect a doubling of capacities [20, 21].

According to the Bioenergy Association, in Ukraine, the Myronivskyi Khliboproduct (MHP) plant in the Dnipropetrovsk region has been added to the already existing Vitagro and Gals Agro plants. If the annual capacity of the first two is 3 million cubic meters of biomethane, then the MHP plant has 11 million cubic meters. Therefore, it will already be possible to have about 2 million cubic meters of biomethane underground storage. [22].

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The Bioenergy Association of Ukraine estimates the potential for biogas production in Ukraine to be 21.8 billion cubic meters per year by 2050 (Table 5). Ukraine has a developed system of gas networks (GTS and GDS), and the structure of agricultural enterprises is favourable for biomethane production. Priority areas for connecting biomethane plants are where the concentration of raw materials is near main gas pipelines, branches from them and loops, near some hydraulic fracturing, gas distribution zones with the possibility of "redesign" and large industrial consumers [23].

Table 5

Biogas production potential in Ukraine [23]

Biogas, billion m3/year	
Biogas from livestock waste	0.9
Biogas from crop residues	5.2
Biogas from food processing industry by-products	0.7
Biogas from municipal solid waste	0.5
Biogas from sewage sludge (municipal treatment plants)	0.1
Energy crops: biogas from corn silage (from 1 million hectares)	3.8
Biogas from cover crops (20% of arable land)	9.8
Biogas from BM obtained by thermal gasification (10%)	1.0
BIOGAS/BIOMETHANE, total	21.8

To regulate the procedure for customs clearance of biomethane exports from Ukraine, the Law of Ukraine No. 3613-IX of March 20, 2024 (draft law No. 9456) was adopted, which should contribute to the development of the production of this type of fuel and expand export opportunities [24]. In Ukraine, there is a technical possibility of connecting biomethane producers to medium and low-pressure gas distribution networks for the local supply of biomethane as a substitute for natural gas since biomethane is its analogue in terms of chemical properties [25].

According to UABIO calculations, the prospects for producing and consuming Ukrainian biomethane until 2050 are presented (Table 6).

Table 6

Prospects for the production and consumption of Ukrainian biomethane [19]

	2027	2030	2035	2040	2045	2050
Biomethane production, billion m^3	0.25	1.00	2.1	4.5	9,5	20
Biomethane export, billion m^3	0.13	0.50	1.05	2.25	4.8	10
Domestic market consumption, billion m^3	0.13	0.50	1.05	2.25	4.8	10
Number of biomethane plants, units	50	200	420	900	1900	4000
Required investments, billion €	0.5	2.0	4.2	9.0	19.0	40
Reduction of GHG emissions, million t CO^2-eq.	0.6	2.5	5.3	11.3	23.8	50
Jobs created, thousand units	3.1	12.5	26.2	56.2	118	250

Considering the feasibility of using biofuels in transport, the Verkhovna Rada of Ukraine adopted the Law «On Amendments to Certain Laws of Ukraine on the Mandatory Use of Liquid Biofuels (Biocomponents) in the Transport Sector». According to the document dated May 1, 2025, the mandatory biofuel component in gasoline should be at least 5%. This concerns biobutanol, bimethane, biodiesel, bioethanol, biohydrogen, etc. [26].

The Government of Ukraine and the European Commission, following joint consultations with the College of the European Commission, signed two essential documents in the field of renewable gases.

1. Memorandum between Ukraine and the EU on a Strategic Partnership in Renewable Gases, Biomethane, Hydrogen and Other Synthetic Gases. The partnership aims to deepen cooperation in developing renewable energy, particularly environmentally friendly, sustainable gases and their derivatives. This is another step in promoting renewable gas production, transportation, storage and use.

2. The Agreement on Ukraine's participation in the EU Single Market Programme was signed [27].

To promote the development of biogas production, the Cabinet of Ministers of Ukraine approved the National Waste Management Strategy until 2030. The strategy envisages increasing the volume of waste directed towards recycling by up to 50%. An action plan has been developed to reduce the volume of municipal waste landfilling, put waste sorting lines into operation, and introduce projects for the biological recycling of mixed municipal waste [28]. Biogas technologies fit well into the UN doctrine of sustainable development of society. Modern production technologies should be interconnected so that the final cycle of one becomes the beginning of the second cycle [29].

Marketing management is critical to the overall management system for developing the economy's biogas sector. Its main task is to achieve the best possible coordination of the country's internal capabilities with the external and internal environment requirements. The fundamental basis of marketing management is methodology. The main provisions of the methodology are the doctrine of structure, logical organization, methods and means of activity. Therefore, mastering the marketing methodology is key to implementing marketing management and making scientifically sound marketing decisions based on principles, methods, models and management techniques. This is a methodological complex, a toolkit that includes marketing and marketing research tools [30].

When characterizing the methodological complex, it should be noted that marketing principles belong to the conceptual, general methodological level and include the following elements: marketing concepts, approaches, paradigms, marketing categories, conceptual models, and management principles. This list can be supplemented with other necessary elements (Figure 4) [31].

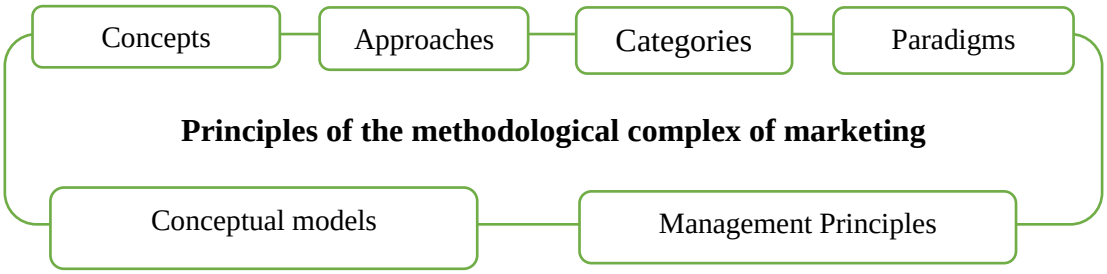

Fig. 4. Principles of methodological marketing complex

Marketing has existed for over 100 years. As a result of the development of the economy and:

1. An essential place in the system of marketing principles is given to marketing concepts, which reflect the main point of view, a constructive approach to various types of activity. Any entrepreneurial activity should begin with developing a marketing concept, which will help determine what measures must be applied to achieve specific results.

Marketing concepts reflect a system of views, production capabilities, and advertising activities aimed at satisfying buyers' needs, considering the market's economic situation. This is a way of understanding, interpreting, and highlighting the phenomena under study, as well as ideas about the sources, driving forces, directions, and prospects for the development of marketing [32].

To achieve the goals of the biogas market development, companies must satisfy the needs and desires of selected target groups of consumers. This concept is understood as a way of presenting the process of organizing and implementing any activity. World science and practice suggest using a set of measures within the framework of marketing concepts. Marketing concepts are aimed at forming an approach to the organization of production and sales activities based on the main idea, effective marketing strategy and specific tools for achieving specific goals; this is a consumer- and profit-oriented business philosophy [33].

Marketing concepts are the general goal of all enterprise activities. According to the marketing concept, the enterprise must satisfy the needs of consumers that do not contradict the long-term needs of society through a coordinated set of marketing activities. To achieve the goals of biogas market development, it is necessary to carry out a set of activities within the framework of marketing concepts. Manufacturers, in their marketing activities, can use the concept of production improvement (production), the concept of product improvement, the concept of intensification of commercial efforts (sales), the concept of marketing and the concept of socially and ethically (socially responsible) marketing [34].

Using the concept of production improvement, manufacturers need to consider that buyers will prefer the offered goods due to their wide availability and relatively low prices. In this concept, the determining factor of orientation is production. The idea is based on the need for constant improvement of technology and organization of production, as well as an increase in volumes and a decrease in costs. All attention is focused on internal production capabilities to make the product more accessible

For the development of biogas production, this approach is typical when using waste from the forestry and wood processing industry as biomass. The wood stock in the forests of Ukraine is estimated at 2.1 billion cubic meters. There is a gradual increase in the stock, which confirms forests' significant economic and environmental potential. The potential stocks and capabilities of Ukrainian forests are substantial and, according to specialists and international experts, are not fully used. Annual growth is within 60%, and in European countries, annual growth is 70-80%.

The conducted studies have shown that it is possible to use about 12 million cubic meters of wood biomass for energy needs by 2020 to reach the volume of wood replacement of 3.0 billion cubic meters. m of natural gas annually [35].

In 2018, the State Agency for Energy Efficiency, with the participation of local governments and experts from specialized associations, studied the prospects for installing biogas facilities at solid waste landfills. It was found that building biogas facilities at landfills with a total amount of waste of more than 1 million tons is economically feasible. [36].

Marketing determines the production and sales orientation of the enterprise, the type of product that needs to be released to the market, establishes the types and sources of necessary resources, and ensures public recognition of its activities.

The marketing concept of product improvement puts the product at the top of the list. The company's activities should be focused on its continuous improvement and development of a sufficient number of modifications with the best consumer properties. Such a product in biogas production can be biomethane. The problem of decentralized electricity and heat production from biogas is often the lack of heat removal. Enrichment of biogas to biomethane can solve this problem. Using enrichment technology, biogas can be purified and brought to the quality of natural gas. A significant advantage of biomethane, compared to other renewable energy sources, is the use of existing infrastructure, which does not require the creation of new storage systems. Existing natural gas networks, which have enormous capacities, offer an effective and economical solution for storing and supplying biomethane with insignificant capital costs [37].

One of the directions for implementing the marketing concept of a product for obtaining biomass is the cultivation of energy crops for energy production. These crops require less maintenance and resources, are cheaper and more sustainable, and are ideal for restoring degraded and unproductive lands.

To this end, pilot projects were launched in 2016 in three regions of Ukraine with different climatic and soil characteristics: Zakarpattia (in the far west of the country), Ivano-Frankivsk (western Ukraine), and Poltava (central Ukraine) regions. One of the most common energy crops, energy willow, was planted in three experimental plots of 5 hectares each. These pilot projects demonstrated that biomass planting is a realistic and feasible process worth supporting, can be scaled up commercially, and can play an essential role in contributing to Ukraine's energy and heating needs [38].

Three pilot projects implemented by the United Nations Development Program (UNDP) have demonstrated the potential for energy crops and have provided valuable input into developing «Regional Biomass Programmes». These are the pilot regions' medium- and long-term regional energy policy documents. At the national level, the pilot projects have demonstrated that biomass planting is a realistic and feasible process that should be supported, can be scaled up commercially and has the potential to play a significant role in meeting Ukraine's energy and heating needs. Currently, each pilot region has an additional 20,000 hectares for energy willow cultivation. [39]

The intensification of commercial efforts (sales) assumes that buyers will buy goods in sufficient quantities if certain efforts are constantly made to promote the goods on the market and stimulate their sales. The basis of the sales concept is the act of selling. This concept orients producers to the possibility of success by developing convincing methods and effective sales organization. Enrichment of biogas to biomethane expands sales opportunities. Due to the same quality of biomethane and natural gas, biomethane can be used in existing technical devices (household, industrial, transport). At the same time, enriched biogas can be used directly on-site or fed into the existing natural gas network [40].

The marketing concept is the dominant form of production and sales activities in countries with a market orientation. It focuses on producing goods and services in which the consumer is interested, that is, maximum adaptation of production to consumer requirements and profit from this. The need to develop the market for renewable energy sources, particularly the biogas market, corresponds to the main tasks of the marketing concept. The desire for profit is a standard guideline for the activities of enterprises. However, the path it chooses to achieve the set goal sometimes acts contrary to moral norms and the long-term interests of society. The marketing concept in the context of environmental degradation, limited natural resources, and other ecological complications cannot always solve the problems of balancing the interests of enterprises, consumers, and society as a whole in the long term. This expands the classical marketing concept with an orientation towards social responsibility [41].

The socially and ethically responsible marketing concept involves identifying customer needs and satisfying them, considering universal public interests. In its marketing activities, the enterprise performs three tasks: it considers public interests, satisfies consumer needs, and increases profit.

The social orientation of the energy market of Ukraine is reflected in the development of renewable energy through the production of electricity and heat from biomass. Socially responsible activities are only methods of achieving goals that do not harm people, nature, and society [42].

The socially responsible direction of biogas production contributes to improving the local economy. Household waste for biogas production significantly reduces emissions of pollutants, and the biogas is converted into electricity and heat at a CHP. Biogas and biomethane production from local resources creates new jobs in rural areas. The environmental effect of biogas production is climate neutral since the biomass used removes carbon dioxide from the atmosphere throughout the growing season, which is then rereleased when biogas or biomethane is burned. To achieve the goals of biomass market development, it is necessary to implement a set of measures within the framework of marketing concepts (Figure 5) [43].

A pilot project on the cultivation of energy willow demonstrated the socially responsible direction of biomass production. Energy produced from energy willow is considered carbon-neutral since the amount of carbon released during combustion corresponds to the amount of carbon absorbed by the crop during growth.

Five hectares of plantations (a standard plot) can absorb more than 1 thousand tons of CO_2 over three years and provide about 35-75 tons of dry matter annually. This amount allows you to produce about 925 GJ of energy, equal to 25.8 thousand m3 of natural gas. In addition, fallen leaves and willow roots help enrich the soil with minerals and nutrients, and rooted branches effectively protect the upper layer of soil from erosion and landslides. Like other energy crops, energy willow can be grown on slopes or degraded lands, preventing further degradation and promoting long-term restoration. Larger-scale biomass harvesting will allow forests to be preserved and degraded lands to be restored, providing a cheaper and more environmentally friendly alternative to natural gas. Biomass is not only relatively ecologically friendly, but energy production using biomass from energy willow is a means to improve the standard of living in rural areas of Ukraine. Socially responsible marketing is the highest level of marketing concepts to be targeted.

Socially responsible marketing is the highest level of marketing concepts to be targeted.

The proposed model of biomass fuel market development (Fig. 2) takes into account the factors that create obstacles to achieving the required level of development of this renewable energy sector. In addition to classical marketing concepts, in modern conditions, it is advisable to use the concept of interaction, which involves the development of long-term relationships between partners. The main idea of the marketing concept of interaction is that the object of production management is not a set of decisions but relationships with the buyer and other participants in the purchase and sale process. As a result of effective interaction, relationships become a product in which intellectual and information resources are integrated as the main factors of the continuity of market relations. Interaction increases the importance of individual, personal contacts in the system of effective communications in the development of biogas production [44].

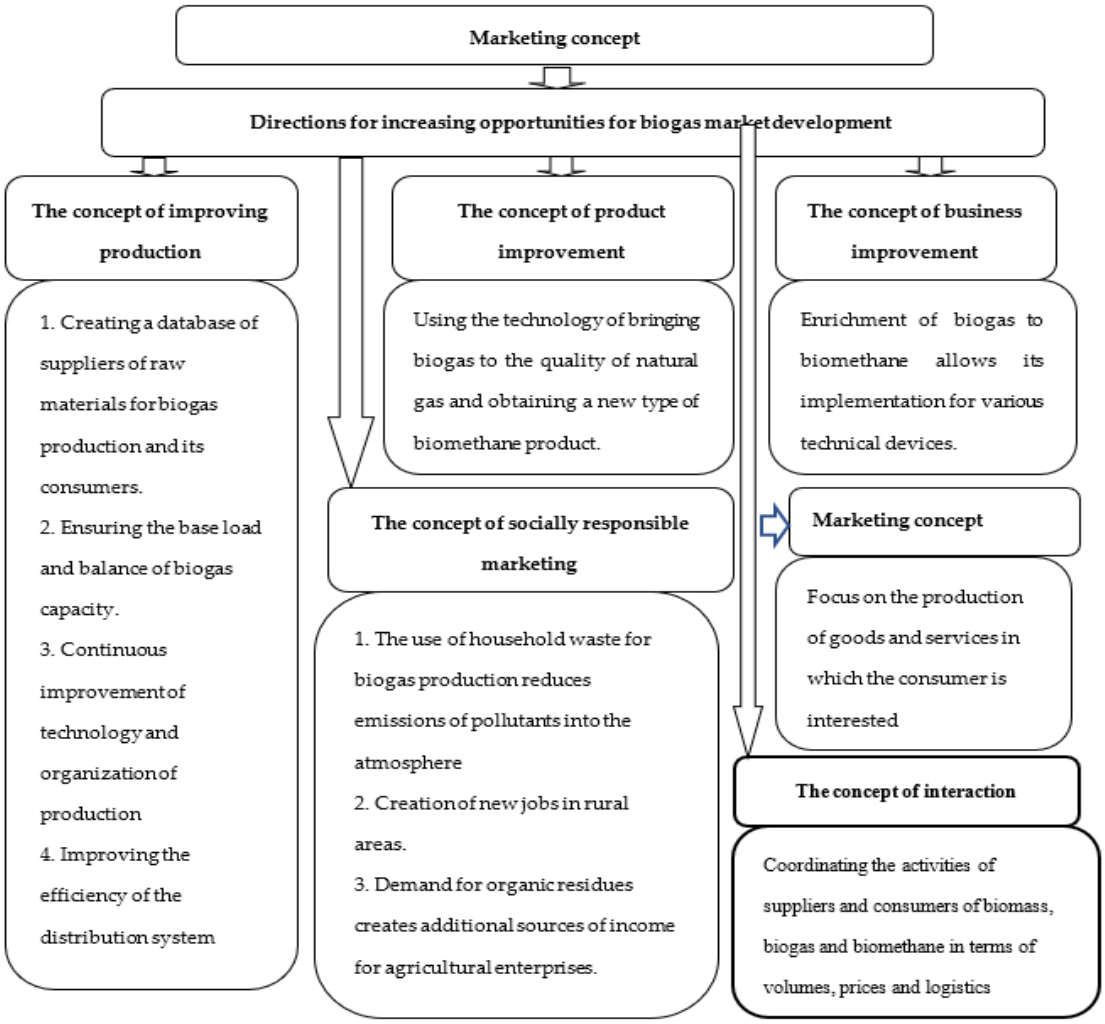

Fig. 5. Conceptual model of biogas market development. Source: own elaboration [43].

The production and energy use of biogas has several justified and confirmed world practice advantages. Biogas plants are characterized by the possibility of modern waste-free production in the agricultural sector, as they allow partial or complete use of organic farm waste while reducing harmful emissions of greenhouse gases into the environment. Biogas projects create new jobs, provide cheap heat, reduce the need for imported natural gas, and reduce methane emissions. Biogas plants can also be installed

as wastewater treatment plants on farms, poultry farms, distilleries, sugar factories, and meat processing plants. A biogas plant can replace a veterinary and sanitary plant, meaning dead animals can be recycled into biogas instead of producing meat and bone meal. (Eenergy, 2017) [45].

Biogas is used to produce electricity, heat, steam, or automotive fuel. Each new biogas complex reduces dependence on purchased fuel and indirectly affects the country's economy. Therefore, the economic effects of biogas production and the advantages of its use are:

– obtaining fuel that can be used for electricity production, heating, and other industrial and domestic needs of production complexes that are suppliers of biosubstrates;

– biogas plants are often used as part of treatment facilities;

– minimum costs for raw material delivery - biofuel plants are usually installed directly near the raw material supplier;

– installation of biogas equipment essentially solves the issue of waste disposal; that is, instead of the costs of their removal and disposal, the company receives additional profit;

– biosubstrate residues can be used as fertilizers.

Of great importance is the environmental effect of biogas production, which consists of the environmentally safe processing of biomass, organic waste and by-products of animal origin due to methane fermentation. As indirect environmental effects, we can single out the prevention of pollution of groundwater-surface water and soil. Electricity production from biogas combustion in cogeneration plants allows maximum use of the obtained thermal and electrical energy. However, the most significant environmental effect is that biogas plants solve the problem of agricultural waste disposal.

The conversion of organic residues into biogas occurs due to complex biochemical transformations (biomass fermentation). The fermentation residues formed in biogas production in biogas plants are high-quality fertilizers that can be sold or used instead of mineral fertilizers. These are pure liquid or solid biofertilizers that do not contain weed seeds, nitrates, or other harmful components.

Raw materials of animal origin exert the most significant environmental impact. Thus, currently, in Ukraine, there is an acute issue of utilization and safe processing of waste products from poultry, pig, and cattle farms. On the other hand, anaerobic processing of livestock waste can be considered the best of the available technologies because waste processing at biogas plants partially reduces environmental problems and has significant economic advantages in the form of decentralized production of renewable energy (Table 3). In addition to ecological and economic effects, social impact is essential, which consists of improving the population's health and expanding the opportunities for the population of rural areas to provide them with appropriate benefits. The social effects and essential advantages of biogas power plants are the creation of a large number of new jobs, the improvement of the skills of employees, and the development of local economies as additional sources of revenue for local budgets and increasing the population's income. Bioenergy creates the most significant number of jobs per 1 MWh of electricity generated from renewable sources, including a considerable part in related areas such as raw material and biofuel procurement, mechanical engineering, logistics, etc. The relevance of biogas technologies lies in preventing fires during droughts since they are used as raw materials and fuel, precisely those forest and agricultural wastes and residues that lead to mass fires. Biogas technologies are also one of the most rational ways to process agricultural waste into organic fertilizers (State Enterprise «Derzhzovnishinform» 2020) [36].

Also, the socio-economic effect of implementing biogas projects is that the heat from cogeneration plants is directed to heating schools and administrative buildings. Therefore, biogas plants are an effective way to solve the problems of using agricultural waste, including by-products of animal origin. Thus, the economic, environmental and social aspects of biogas production and use characterize the positive aspects and the need to develop and implement biogas technologies (Table 7). Thus, implementing biogas plants operating on household and agricultural waste is relevant and economically feasible and contributes to strengthening the country's energy security and economic development of regions.

In the modern world, goods are becoming increasingly standardized, and services are becoming unified. As a result, the marketing solutions of different firms are increasingly duplicated. Under such circumstances, it has become challenging to retain the consumer. The urgency of this problem has led to the introduction of new innovative concepts - relationship marketing and partner marketing [48].

Relationship marketing involves the focus of the firm's marketing activities on establishing long-term, constructive, privileged relationships with potential customers. The focus on creating long-term relationships between customers, suppliers, and intermediaries explains expanding the range of marketing functions. In addition to market research, planning, and sales promotion, the function of interaction with the buyer appears [44].

The concept involves establishing long-term and mutually beneficial cooperation with buyers and partners. This is a continuous process of identifying and creating new values with the direct participation of the individual consumer, as well as the subsequent joint receipt and distribution of benefits from this activity

among all participants in the interaction. This new concept involves uniting the enterprise, its partners, and consumers into a single integrated group with further interaction to provide an individualized marketing complex for each client and offer the most favourable conditions for partner cooperation [49].

Table 7

Effects from the implementation of biogas projects.

Types of Effect	Advantages of Using Biogas
Economic	Strengthening the country's energy security; – savings on the purchase of imported natural gas; – energy supply of farms in non-gasified areas; – production of high-quality fuel; – development of biotechnology and mechanical engineering; – income from the production of heat and electricity out of waste and economic activity leftovers; – smoothing of peak loads in power grids; – growth of tax revenues.
Ecological	Reducing the use of fossil and other natural resources for energy purposes; – use of renewable energy sources; – reduction of greenhouse gas emissions; – solving the problem of waste disposal; – reducing the volume of landfills for household waste; – prevention of groundwater and surface water pollution; – formation of organic fertilizer for the production of environmentally friendly products.
Social	Creation of new jobs; – advancement of employees' skills; – increase of income per capita; – improving the quality of life and meeting social needs; – development of rural areas and their infrastructure.

Source: own research, based on data from 46, 47

The concept is relevant for cases when the company cannot get ahead of its opponents only with the help of marketing tools. The organization's activities should aim for long-term cooperation, considering all the nuances of relationships with buyers and partners. This concept requires the formation of permanent connections and strong relationships between the manufacturer and the customer, the buyer and the seller. That is, the priority is not to conclude a large number of one-time agreements, but to form strong, long-term and mutually beneficial cooperation.

Further complications of the operating conditions proved that the philosophy of relationships did not always ensure achieving the desired effect. The specifics of innovations determined the marketing features of enterprises in the markets. Therefore, for the rapid recognition of innovative products on the market, it is necessary to implement and apply information technologies since traditional marketing research methods do not always give the desired results. Business intelligence methods have become more effective. As a result, conditions have been formed in the market to develop the concept of collaborative marketing to retain consumers and partners [49].

By establishing relationships with various partners, enterprises create favourable conditions for avoiding dangerous situations. In some cases, focusing on maximizing profits and minimizing costs gives way to making economically promising decisions that will reduce risks and uncertainty in the market. Therefore, forming partnerships is becoming increasingly important, as it ensures increased efficiency of the enterprise's market activities. The next element of the principles of the methodological complex of marketing is the approach to marketing management. Methodological approaches to the study of marketing management systems in the biogas sector of the economy determine the direction of its development. Among them, the most common are process, system and situational approaches. The process approach in biogas production management is built on a set of interconnected actions, which are characterized as management functions, and the entire management process is the sum of all functions. This is a network of interacting processes that occur within the industry's organisational structure and ensure a positive result of its activities.

The process approach assumes that marketing management uses information technologies and is focused on optimizing internal information flows associated with collecting, processing, storing and using marketing information [50].

The process approach is the most progressive, as it allows you to determine the cause-and-effect relationships of problems, find out where and when the situation arose and what its cause is. This approach is one of the ways for the organization to remain competitive. It forces company managers to analyze the interaction of process participants because the untimely resolution of the problem causes a tremendous loss of information and time, which directly leads to financial losses [20].

The methodology of the systems approach has been applied in many areas of science and production, and one of the most striking examples is the application of the systems approach to enterprise and personnel management. The systems approach to management involves managing the organization as a single system, where any managerial influence on one part of the system affects its other parts, which implies that it is necessary to manage the entire organization as a whole [51].

As a management method, the systems approach is based on understanding the object of management as an integrity, on identifying the diversity of its internal and external relationships; as a set of related, coordinated methods and means of managing the economy, industry, enterprise, division, etc.

Managing an organization using a systems approach makes it possible to analyze objects that are different in nature and complexity from a single point of view while identifying the most important characteristic features of the system's functioning and considering the most significant factors that influence its development. At the same time, the subordination of the goals and results of subsystems to the overall system goal is assumed. The undoubted advantage of the system approach in developing biogas production is the focus on poorly structured problems and the search for the optimal solution [51].

Despite the large number of approaches to management, the most appropriate in the modern biogas business environment is the situational approach, which is based on the fact that the situation determines the priority of management methods.

The situational approach considers specific conditions with the allocation of factors that created a particular situation and are the most influential, as well as determining the disadvantages and advantages, limitations and consequences of the problem, and choosing specific techniques and management methods for a specific situation. The use of different management methods is due to a particular set of circumstances that significantly affect the organisation's position.

Unlike other approaches, the situational approach involves not only determining the factors that contributed to the emergence of a particular situation but also establishing their priority, the strength of influence, and studying possible consequences and threats. The main task in the situational approach is the selection of specific management methods and making management decisions in accordance with the specifics of the current situation. The situational approach tries to link particular techniques and concepts with certain specific conditions to achieve the goals of the industry.

The situational approach to management requires the manager to have «situational thinking», which helps to better determine the most favourable techniques for achieving the organization's goals. Implementing the situational approach requires managers to have deep and broad knowledge and the ability to quickly navigate a changing environment, organize subordinates, and approach the matter creatively. The effectiveness of management decisions made with the situational approach depends on the professionalism of managers and the correctness of their understanding of the situation. [52].

A wide range of marketing activities at the enterprise involves a comprehensive approach. This is a generalized set of studies on identifying target markets, studying consumer needs in these markets, developing products, setting prices for them, and choosing methods of promotion and distribution of products to achieve the desired result of the enterprise's activities.

The success of an enterprise in the market depends on properly organized activities. Therefore, an organizational approach is essential since the marketing management system of enterprises is aimed at timely adaptation to the conditions of a changing marketing environment, satisfying consumer needs and ensuring long-term commercial success on this basis [53].

Each of the above approaches has practical use. Often, two techniques are used in parallel in enterprise management. Recently, attention has been drawn to the importance of communications in enterprises' market activities. Therefore, a communication approach is essential, which involves the formation of an information flow focused on establishing constant feedback with the biogas market in real-time, which will contribute to the separation and coordination of tasks and business processes of marketing management, as well as the implementation of priority tasks taking into account the characteristics of the activity [54].

A critical component of the principles of the methodological complex of marketing is a paradigm, which is characterized as an example, a model or a set of prerequisites that determine scientific research. These are recognized scientific achievements, an initial conceptual scheme, a model of problem formulation and their solution, and relevant research methods at this stage of development. This is a system of basic scientific achievements - theories and techniques, according to which the research practice of scientists in a specific field of knowledge is organized in a particular historical period [55].

The new paradigm has become the role of environmental marketing under the latest threats of the 21st century. and ecological problems in the world. Consumer interest in environmental issues is high in Ukraine and countries with a mature economy and a more extended history of environmental activity. Many experts have begun to note the need to change the conceptual approach to marketing management, which would allow for solving emerging problems. Such an alternative was «environmental marketing». Environmental marketing is not only a new conceptual approach to the formation of demand for goods and services, but it should also become an integral part of the development and creation of new, improved, and environmentally safe products and systems for their consumption and disposal. Environmentally sustainable marketing means showing respect for future generations [56].

Recently, renewable energy sources have become one of the crucial criteria for energy security worldwide. The main reasons are the expected depletion of organic fuel reserves, a sharp increase in energy prices, uncertainty about the stability and reliability of their supply, and the harmful impact on the environment, the consequences of which are increasingly worrying society. In current conditions, biogas and biomethane production significantly increase the security of energy supply and improve social, economic, and environmental conditions. Ukraine is one of the countries that are dependent on energy imports. Therefore, the development of the biogas energy sector is an essential factor in increasing its energy security and has become a new marketing paradigm. The innovative nature of the marketing paradigm in the management system of the modern economy is provided by the development of the bioeconomy, the primary goal of which is the optimal use of renewable biological resources and the creation of sustainable production systems for new types of products based on them [57].

2. The fundamental issue regarding the organization of enterprise management is creating a conceptual model for forming such management mechanisms that would ensure its effective functioning. Thus, the construction of enterprise management on the principles of marketing is one way to solve this problem. Conceptual models combine principles, the application of which is mandatory in any study but is not related to data processing. In modern conditions of the functioning of enterprises on the market, a necessary prerequisite for ensuring competitiveness and strengthening the market positions of the enterprise is the use of a marketing approach to managing its innovative activity. Marketing management of the innovative activity of an enterprise is the process of implementing a well-thought-out policy for developing creative potential and initiating marketing opportunities to implement innovative strategies to meet customers' needs effectively. Therefore, the conceptual model of an effective mechanism for marketing management of the innovative activity of an enterprise assumes the presence of the following key elements: orientation on market needs; formation and effective use of innovative opportunities; timeliness of identification of risks of creative activity and development of measures to level them; interaction with the consumer, motivational support, a comprehensive systemic approach to implementing innovative activity based on marketing [58].

Currently, electronic commerce has developed rapidly. It requires the formation of comprehensive theoretical and methodological support to determine the management strategy. Determining the management strategy for electronic commerce enterprises is a fundamental component of the sustainable development and functioning of the enterprise in the market, which requires the development of a conceptual model for determining the appropriate strategy. The fundamental idea of the conceptual model is to form, combine, and reflect a list of sequential actions to determine the management strategy for electronic commerce at different strategic levels. Conceptual approaches have been formulated to determine the management strategy for an enterprise's electronic commerce: systemic, comprehensive, logical, logistical, marketing, dynamic, structural, target and process [59].

The effectiveness of market entities in the rapidly changing conditions of the modern economy depends on the effectiveness of marketing activities. Solving management tasks requires processing vast amounts of information in a short time. The main direction of solving this problem is the modernization of marketing management at the enterprise by implementing a marketing information system, thanks to which enterprise managers can receive marketing information from the external business environment through the functioning of the marketing research system. Considering this, a conceptual model of an automated information system at the enterprise was developed based on computerised information technology. According to the model, the information system helps the manager solve various types of management tasks that arise while operating the enterprise since it includes a marketing research system through which enterprise managers can receive marketing information from the external business environment [60, 61].

Scientists also consider a modern approach to marketing management using the conceptual model of cybernetic marketing. This model differs from existing information technologies based on regression-correlation models, linear programming methods and rigid decision-making algorithms and uses formalized cybernetic principles and will further allow the use of categorical-functional models, set theory to automate the solution of marketing problems both directly at the enterprise and in the market. This will increase the competitiveness of enterprise products and bring them up to the level of European standards [59].

A critical component of the principles of the methodological complex of marketing is the principles of management. As a special business activity, marketing is based on the objective laws of the market economy. Still, it has specific laws, patterns and principles, including general rules and provisions that must be followed. Marketing principles are based on the general direction of marketing activities at the enterprise and reflect its essence [62].

Having considered the positions of different authors and compared them, we will highlight the following fundamental principles:

- the need for complete and reliable information about the external conditions of the enterprise's functioning;
- the orientation of production and sales activities to meet the needs of existing and potential consumers;
- the manufacturer's flexible response to changing customer needs and adaptation to them;
- the manufacturer's targeted and active influence on consumer demand;
- sales promotion and provision of forms and methods of after-sales service;
- influence on the market, on the buyer using all available means, primarily advertising;
- ensuring profitability for the enterprise;
- mandatory control of marketing activities (control is carried out to provide information on how effective what is done for marketing activities is).

The marketing principles assume that achieving the enterprise's goals depends on determining the needs and requests of target markets, as well as on more effective consumer satisfaction compared to competitors. Therefore, essential principles of marketing activities are program-based management, an innovative approach, a logistics model of the organization, electronic marketing, and priority personnel provision [63].

The principle of management continuity is also applied in marketing, which means that the management process must be carried out constantly, and not only when adjusting goals and objectives, which involves constant monitoring of the parameters of the management system and the external environment. The most important management principle is the feedback principle formulated in management science, according to which the management process requires the use of information about the results of management, which means the impact of the results of system management on the process of this management, the comparison of goals and results [64].

Conclusions. To achieve the goals of biogas market development, it is necessary to put in place a set of measures within the framework of marketing concepts. The main object of the marketing concept is to establish a comprehensive study of buyers of enterprises' goods with their requests and needs. Manufacturers must build all their activities with the expectation of maximum actor satisfaction instead of making the appropriate profit. Thus, the starting point of the concept is the theory of consumer sovereignty. Considering the idea of marketing in the historical context, there are five global, fundamental concepts that any firm interested in making a profit should use. Based on the study, the production and use of biogas in Ukraine have excellent prospects due to favourable climatic conditions and great potential for developing biogas production. It should be noted that the study reveals the state of development of the biogas market in Ukraine based on available statistical materials. An obstacle to a more detailed analysis of the state of production and use of biogas, the management system for producing and selling finished products, and the strength of relationships with raw material suppliers and consumers of biogas were the limited available statistics covering the production dynamics. However, mining the available sources has allowed the researchers of this paper to gain new knowledge about this problem. Suppose we summarize the results of the study of the principles of the methodological marketing complex in developing the biogas market in the EU countries and Ukraine. In that case, we can highlight the following key positions:

– the conducted studies of the methodological marketing complex showed that the key to making scientifically sound marketing decisions in the implementation of marketing activities is mastering the marketing methodology;

– the article examines the elements of the principles of the methodological marketing complex in the context of the development of bioeconomic processes;

– the relevance of applying each element of the methodological complex, its purpose, main guidelines, key idea and guarantees of success are characterized.

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ІННОВАЦІЙНІ ПІДХОДИ ДО ПРОФЕСІЙНО СПРЯМОВАНОГО НАВЧАННЯ ФАХІВЦІВ АГРАРНО-ТЕХНІЧНОЇ ГАЛУЗІ

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Вступ. Сучасний аграрний сектор перебуває в стані динамічного розвитку, що зумовлюється глобальними викликами, такими як зростання населення, зміни клімату, інноваційні технології та необхідність підвищення ефективності використання природних ресурсів. У зв'язку з цим виникає потреба у висококваліфікованих фахівцях аграрно-технічної галузі, які володіють не лише глибокими теоретичними знаннями, а й практичними навичками, що відповідають сучасним вимогам ринку праці.

Професійно спрямоване навчання є ключовим фактором у підготовці конкурентоспроможних спеціалістів, які здатні впроваджувати новітні технології, управляти складними виробничими