

# STRATEGIC PRIORITIES FOR THE USE OF BIOMASS IN THE ENERGY SUPPLY SYSTEM OF UKRAINE

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The economic feasibility of the use of agricultural biomass in the energy supply system of Ukraine is investigated in the article. It has been determined that biomass of agricultural origin (cereal straw and rapeseed, by-products of corn for grain and sunflower, sunflower husk) remains the main component of biomass energy potential in Ukraine. It is established that the bioenergy potential of agricultural biomass is an efficient and affordable additional source of energy supply for Ukraine. According to the research, the potential of the bioenergy market was attributed to the great potential of biomass, the large stock of unused land that could be used for growing energy crops from the marketing side, it is also important to note the low competition in the industry. However, imperfect state policy on bioenergy development, outdated equipment, uncoordinated rules for selling electricity from biomass in the electricity market – all this suggests that the industry needs increased investment, borrowing experience from European countries for further development. It is proved that the political and economic situation in the country remains very difficult and unpredictable not only for the bioenergy industry, but for the country as a whole.

**Keywords:** biomass; bioenergy; biofuels; energy problem; agricultural raw materials for biofuel production

## Introduction

For Ukraine, as for most countries in the world, the development of bioenergy for energy, environmental and food security is extremely important. Active use of bioenergy resources can become one of the main decisions to strengthen Ukraine's energy security.

In the face of the objective threat of natural resources depletion as sources of fuel for human needs, the need to solve the problem of finding alternative sources to meet energy needs becomes more urgent. The issue of alternative fuels, the alternative of which to traditional ones, is, first of all, their ecological and biological nature, is of particular importance. Biomass is a virtually inexhaustible source of energy in modern conditions. The situation is complicated by the fact that the efficiency of production and use of biomass fuels is still lower than the efficiency of the use of traditional fuels, which is due to such factors as lack of state support for this direction of bioenergy development, insufficient development of material and technical base for realization of this direction and lack of possible – its improvement, as well as the dependence of this efficiency on traditional fuel prices. Therefore, the relevance of research into the problem of production and use of biomass as an energy source is extremely relevant.

Great attention has been paid to the research of theoretical principles and directions of practical use of alternative energy sources in the scientific works of many domestic and foreign scientists, in particular Ya., G. Kaletnik, M. Korchemnogo, B. Kochirko, H. Lins, M. Mkhitarian, P. Sabluk, V. Sitnik, L. Usenko, H. Shtrubenhoff, G. Shtrebel and many others.

## Material and methods

Methodological and theoretical basis of the research is the scientific provisions of fundamental and applied research in the field of economic theory, agrarian economy, economics of nature management, planning and forecasting, systems theory, and the work of domestic and foreign scientists

in various fields of economic science. The study used general scientific and special methods of research: analysis and synthesis, systematization, spatial, SWOT-analysis and PEST-analysis.

The methodological basis of the work is a set of techniques, principles, general theoretical, special, interdisciplinary methods of scientific research. To achieve this goal and solve certain tasks, the following methods are used: the method of theoretical generalization; statistical and comparative analysis; synthesis method, system analysis, historical, hierarchy method, structural and dynamic analysis, methods of grouping and systematization morphological analysis, SWOT analysis and PEST analysis.

The scientific-theoretical and methodological basis of the research was scientific works, publications of scientists, and materials of scientific conferences in the field of economic policy in the field of energy under conditions of European integration.

## Results and discussion

Ukraine is one of the European countries most dependent on natural energy resources, especially on natural gas. Ukraine has a great potential of the agricultural sector and to solve these problems we were chosen to determine the potential of agricultural biomass by region of Ukraine (I calculation method – all over Ukraine), to replace natural gas and energy natural resources. We calculated the highest economic energy potential of biomass in the following areas: Vinnytsia – 1,528 thousand tons, Zhytomyr – 1,851 thousand tons, Kyiv – 1,348 thousand tons, Odessa – 1,558 thousand BC, Poltava – 1,436 thousand BC, Sumy – 1,570 thousand BC, Khmelnytsky – 1,388 thousand BC, Chernihiv – 1,771 thousand so-called. The lowest economic energy potential of biomass is in the regions: Transcarpathian – 520 thousand tons, Ivano-Frankivsk – 524 thousand tons. and Lugansk – 512 thousand tons.

Today, agricultural biomass (cereal straw and rapeseed, by-products of corn for grain and sunflower, sunflower husk) remains the main component

of biomass energy potential in Ukraine. 1 Analysis of statistics on agricultural biomass potential in Ukraine in the period 2010–2017, from our previous studies in the third section, shows steady positive dynamics of growth, in 2010 the economic energy potential of biomass is 15,575 – thousand tons/year, and in 2017 – 25,499 thousand tons/year.

Ukraine has consistently high volumes of production of basic crops with the prospect of further growth, which is a powerful source of various types of waste and by-products.

According to 2017 data, the economic potential of these types of biomass available for energy production is almost 9 million tonnes, which is 43% of the total biomass potential (20.9 million tonnes), while data values are stable in recent years, the share of utilization of the total potential is only 11.5%, which confirms the problem of this study. The urgency of the energy use of agrobiomass is due to the fact that in Ukraine there is a large potential for waste and by-products of agriculture and without using this potential it is impossible to achieve the bioenergy goals set by the Energy Strategy of Ukraine for the period until 2035.

The development of green technologies can be a key development strategy for countries that are nowadays forced to adapt to fluctuations in the oil market and to be dependent on natural gas. According to various sources, renewable energy sources account for between 13% and 20% of the world's energy, of which three quarters is combustible renewable energy (biomass

and waste) and only one quarter is hydro and geothermal energy, solar, wind, tides and waves. The largest share of green energy is produced in the countries of the European Union.

It is known that in 5 to 10 years, oil exploration will be depleted by 60–65%, production will be reduced by 30–40%, and the need for consumption will increase. In addition, scientists estimate that the world's proven reserves of natural gas will last only 50–60 years, oil – 25–30, coal – 500–600 years. Therefore, there is an increasing need to make attractive non-traditional energy sources based on bioenergy raw materials (biofuels) (Galchynska and Maciejczak, 2015).

One of the key steps in building an effective strategic development plan is to determine the real state of the environment in which the system operates. SWOT and PEST analyses have become the methodological basis for assessing this status. First, let's look at and apply a SWOT analysis to help you identify which development strategies are best against your existing strengths and weaknesses.

According to the research, the potential of the bioenergy market was attributed to the great potential of biomass, the large stock of unused land that could be used for growing energy crops from the marketing side, it is also important to note the low competition in the industry. However, imperfect state policy on bioenergy development, outdated equipment, uncoordinated rules for selling electricity from biomass in the electricity market – all this

**Table 1** Utilization of biomass energy potential of Ukraine in 2017

Biomass type and direction of use	Potential available for energy (thousand tons)	Volume already used for energy needs		Share of total capacity utilization (%)
		thousand tons	ths.	
<b>Cereal/rapeseed straw:</b>	12,258	371	130	3.0
– burning (bales)		200	68	1.6
– production and burning of pellets		155	55	1.3
– production and export of pellets		0.97	0.35	0.01
– production and burning of briquettes		15	5.5	0.1
<b>Stems, corn rods</b>	12,828	15	5.0	0.1
<b>Stems, baskets of sunflower</b>	9,299	0	0	0.0
<b>Wood biomass:</b>	10,117	10,037	2,713	99.2
– burning (firewood)		7,040	1,848	69.6
– burning (cod)		1,405	340	13.9
– firewood/wood chips export		850	223	8.4
– production and burning of pellets		240	97	2.4
– production and export of pellets		332	135	3.3
– production and burning of briquettes		170	69	1.7
<b>Sunflower husk:</b>	2,374	1,500	626	63.2
– burning		650	271	27.4
– production and burning of pellets		300	125	12.6
– production and export of pellets		450	188	19.0
<b>Sugar beet pulp (W 13%)</b>	4,410	200	10.2	4.5
<b>Corn silo (green) **</b>	27,000	15	1.9	0.06
<b>Livestock manure and poultry manure</b>	30,020	335	12.9	1.1
<b>Total</b>	108,306	12,473	3546	in average: 11.5%

\*\*Subject to cultivation of 1 million hectares of unoccupied agricultural land

Source: Generated by the author on the basis of (Geletukha and Zhelezna, [www.uabio.org/activity/uabio-analytics](http://www.uabio.org/activity/uabio-analytics); Handreichung Biogasgewinnung Und Nutzung <http://www.thuringen.de/de/tl;Galchinskaya, 2017>)

**Table 2** SWOT analysis of the bioenergy market in Ukraine

Strengths	Weak Sides
<ul style="list-style-type: none"> <li>■ great biomass potential (up to 25,499 thousand tons in agricultural enterprises)</li> <li>■ a lot of grain waste</li> <li>■ availability of timber and a large amount of agricultural industrial waste</li> <li>■ high cost of traditional energy sources</li> <li>■ relatively low competition in the industry</li> <li>■ positive dynamics of bioenergy sector development</li> <li>■ an effective support tool is the “green” tariff</li> <li>■ favourable natural and climatic conditions for agricultural biomass production</li> <li>■ high potential of low-productive land for growing energy crops</li> <li>■ implementation of foreign experience in the construction and production of biogas complexes</li> <li>■ availability of domestic wood burning equipment on the Ukrainian market</li> <li>■ protection and maintenance of soil reproduction</li> <li>■ preservation of the ecology of environment due to the absence of harmful emissions</li> <li>■ increasing employment and development of rural areas</li> <li>■ existing demand for environmentally friendly fuels</li> </ul>	<ul style="list-style-type: none"> <li>■ inadequate institutional support and low level of state support for agricultural development</li> <li>■ unsatisfactory financial situation of agricultural enterprises as potential subjects of bioenergy development</li> <li>■ low internal consumption of bioenergy products</li> <li>■ significant amounts of biomass production are exported as raw materials (wood, rapeseed, sunflower seeds, soybeans) and not as biofuel products</li> <li>■ unstable supplies and lack of long-term contracts for the supply of raw materials for biomass production</li> <li>■ insufficient financial resources and investments</li> <li>■ seasonal shortage of raw material supply for biomass production</li> <li>■ high costs of transportation and logistics services</li> <li>■ subsidizing the state with gas and heat prices for the population; – low level of state support for scientific and technical research in bioenergy</li> <li>■ underdevelopment of the management and marketing system in agricultural enterprises</li> <li>■ lack of approved methods of checking the quality of delivered biofuels</li> <li>■ lack of developed infrastructure for storage and processing of agricultural biomass</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>■ high level of interest in bioenergy in the foreign market</li> <li>■ development of domestic demand</li> <li>■ certification of products in accordance with EU requirements</li> <li>■ entry into the domestic and international export markets of certified bioenergy products</li> <li>■ support for participants in financing bioenergy projects</li> <li>■ creation of clusters or agricultural production/service cooperatives</li> <li>■ credit lines, technical assistance and pilot schemes financed by international financial institutions</li> <li>■ transfer of experience in the field of biomass management and the necessary knowledge of the value chain organization</li> <li>■ state support for the development of producers of bioenergy products</li> <li>■ creating an image of Ukraine as a producer and exporter of high quality bioenergy products</li> <li>■ diversification of agricultural production and diversification of biofuel supply routes</li> <li>■ increasing the investment attractiveness of the agricultural sector of the economy</li> <li>■ introduction of modern technologies of cultivation of crops and breeding of animals</li> <li>■ gradual development of waste-free production</li> <li>■ saving of natural energy resources and natural gas</li> <li>■ participation in international and domestic exhibitions of bioenergy fuel</li> <li>■ reduction of migration of rural population to metropolitan areas</li> <li>■ improvement of the general welfare of the citizens of the state</li> </ul>	<ul style="list-style-type: none"> <li>■ shortcomings in the legislation</li> <li>■ a strong lobby in the gas, oil and coal industries</li> <li>■ problems with the sale of electricity from biomass in the electricity market</li> <li>■ growing competition in the international market for solid biofuels</li> <li>■ risks inherent in the agricultural and forestry business (bad weather, crop failure)</li> <li>■ unstable quality of biofuels</li> <li>■ market conditions for the production and use of bioethanol have not been established</li> <li>■ subsidizing the state with gas and heat prices for the population</li> <li>■ unstable political situation</li> <li>■ reorientation of biomass suppliers towards more profitable activities</li> <li>■ failure of agricultural enterprises to introduce innovative technologies due to the lack of financial resources</li> <li>■ increase of influence of natural factors (drought, flood)</li> <li>■ insufficient public awareness of the benefits of biofuels and their impact on the environmental component</li> <li>■ slowing down of the market growth rate due to lower living standards</li> <li>■ demographic and social crisis of rural areas</li> </ul>

Source: Developed by the author

suggests that the industry needs increased investment, borrowing experience from European countries for further development. Let's consider in more detail the most influential factors of SWOT analysis of bioenergy.

Another favourable factor for the development of this industry and the relevant market is the geographical characteristics of our country. Ukraine has three natural and climatic zones (Steppe, Forest-steppe, Polesie and Carpathians). With the change of the average annual temperature and the amount of accumulated heat, these agroclimatic zones shift. According to forecasters, they are gradually migrating north. Increasing the temperature by 1 °C shifts the boundary of the agro-climatic zones by an average of 100 km to the north, and the temperature rises by as much as 2 °C, so that the boundary of the climatic zones has shifted by as much as 200 km, which means that it is much worse for the cultivation of crops. Therefore, for the Steppe zone, half of the unsuitable lands would be expedient to be used for planting energy crops, in particular miscanthus; according to experts, for Polesie and Carpathians 75% of unfit land is better planted with poplar and alder, and 25% – miscanthus (Klimchuk, 2018; Galchynska, Maciejczak and Orlikowskyi, 2015).

The amount of low-productive land is 463,290 ha, degraded – 368,534 ha, technogenically contaminated 34,005 ha, disturbed lands – 143,719 and open wetlands – 977,200 ha, which means that the potential for growing energy crops is quite high. One of the energy perennials is

Miscanthus Giant, which can provide both an energy component (biofuels for sale) and provide extremely important additional processing products – cellulose, paper, raw materials for construction materials and MDF.

A miscanthus hybrid has been invented in Ukraine, which gives greater yield and adaptability to Ukrainian soil. This perennial plant produces 3–4 tonnes of biomass per 1 hectare for 2 years of planting, and it is already possible to harvest up to 20 tonnes of biomass in the third year, with 1 hectare/6 kg of cellulose. For the further development of energy crops, we propose to differentiate products, create a value chain and receive the final product, both biofuels and pulp, paper, and MDF raw materials.

For a more detailed study of the industry and the implementation of marketing strategies for the development of bioenergy consider the cross-matrix SWOT analysis (Table 3).

To study the macroenvironment of the bioenergy market, the PEST analysis method was applied. The purpose of the PEST analysis is to monitor changes in the macroenvironment in four nodal directions and to identify trends, events that are not controlled by the enterprise, but those that affect the results of strategic decisions. Consider the main factors and determine the proportion of each (Table 3). According to the study, it can be argued that the political and economic situation in the country remains very difficult and unpredictable not only for the bioenergy industry, but for the country as a whole. The final score on political factors is 3.75 points, and on economic

Table 3 Bioenergy Market SWOT Matrix in Ukraine

	Opportunities (O)	Threats (T)
	<ul style="list-style-type: none"> <li>■ high level of interest</li> <li>■ development of domestic demand</li> <li>■ certification of products</li> <li>■ access to international export markets</li> <li>■ support of participants</li> <li>■ creation of clusters</li> <li>■ credit lines</li> <li>■ transfer of experience</li> <li>■ state support for development</li> <li>■ image creation</li> <li>■ production diversification</li> <li>■ investment growth</li> <li>■ introduction of modern technologies</li> <li>■ saving of natural energy resources and natural gas</li> <li>■ participation in international and domestic exhibitions</li> </ul>	<ul style="list-style-type: none"> <li>■ shortcomings in legislation</li> <li>■ strong lobby in the gas industry</li> <li>■ unstable quality of biofuels</li> <li>■ unstable political situation</li> <li>■ reorientation of biomass suppliers towards more profitable activities</li> <li>■ lack of financial resources</li> <li>■ increasing influence of natural factors</li> <li>■ insufficient awareness of the population</li> <li>■ demographic and social crisis of rural areas</li> </ul>
	<p><b>SO strategies</b></p> <ol style="list-style-type: none"> <li>1. Creation of value chain for certain types of biofuels</li> <li>2. Involvement of existing consumers and companies that are currently supplying biofuels with the new timber supply chain</li> <li>3. Creating examples of real cooperation between farmers and industry</li> <li>4. Search for potential partners and financing opportunities</li> <li>5. Creating clusters to bring together small and medium players in this market</li> </ol>	<p><b>ST strategies</b></p> <ol style="list-style-type: none"> <li>1. Increasing the level of knowledge regarding the correct technology for production and storage of biomass</li> <li>2. Stimulation of biofuel production</li> <li>3. Formation of marketing support for promotion of bioenergy products</li> <li>4. Involvement of regional/regional/local decision-makers at political level to promote energy sector promotion and protection activities.</li> <li>5. Overcoming barriers and obstacles hindering the creation of innovative value chains</li> <li>6. Combating the shadow timber market.</li> <li>7. Establishment of a network of logistic centers and a regulated exchange for the sale of biofuels of different types with quality monitoring and guarantee of security of supply</li> </ol>
	<p><b>Strengths (S)</b></p> <ul style="list-style-type: none"> <li>■ great biomass potential</li> <li>■ a lot of grain waste</li> <li>■ availability of wood</li> <li>■ high cost of traditional energy sources</li> <li>■ relatively low competition in the industry</li> <li>■ positive dynamics of the sector development</li> <li>■ "green" tariff</li> <li>■ favourable natural and climatic conditions</li> <li>■ high potential of cultivation of energy crops</li> <li>■ implementation of foreign experience in the construction and production of biogas complexes</li> <li>■ protection and maintenance of soil reproduction</li> <li>■ preservation of the ecology of the environment</li> <li>■ increasing employment and development of rural areas</li> </ul>	
	<p><b>Weaknesses (W)</b></p> <ul style="list-style-type: none"> <li>■ imperfect institutional support</li> <li>■ unsatisfactory financial conditions</li> <li>■ significant biomass production is exported as raw material</li> <li>■ unstable supplies</li> <li>■ seasonal shortage of biomass</li> <li>■ high costs of logistics services</li> <li>■ low level of state support</li> <li>■ underdevelopment of the marketing system in agricultural enterprises</li> <li>■ lack of approved methods of checking the quality of delivered biofuels</li> <li>■ lack of developed infrastructure for storage and processing of agricultural biomass</li> </ul>	<p><b>WO strategies</b></p> <ol style="list-style-type: none"> <li>1. Determining the best business model and optimizing its functioning</li> <li>2. Marketing research on the introduction of new business in the field of bioenergy</li> <li>3. Establishment of centers for training of professionals regarding the specificities of the sector and transfer of experience in the future</li> <li>4. Awareness raising on the potential benefits of biomass energy use both among farmers/agricultural enterprises and among potential consumers, companies that can expand their biofuel procurement and supply activities and communities</li> <li>5. Wide dissemination of information to create a positive image among all stakeholders, potential players in the supply chain and members of the community</li> </ol>
		<p><b>WT strategies</b></p> <ol style="list-style-type: none"> <li>1. Development of new technical capabilities to achieve the economic value of raw materials</li> <li>2. Exploring the possibility of using biomass for the production of alternative products such as organic fertilizer, biocomposites, biofilters, compost, etc.</li> </ol>

Source: Own development by the author

4.05 points; this study confirms information that high inflation, high rates on loans, changes in foreign exchange rates, hostilities in the east – these factors create a barrier for the development of bioenergy. However, not only the two previous factors have an impact and a high overall score, the development of technology in this field is extremely important. Improvements in biomass technologies are constantly being made, providing energy in an advanced form to the consumer and with the highest possible efficiency.

## Conclusions

For Ukraine, bioenergy is one of the strategic directions for the development of the renewable energy sector, given the country's high dependence on imported energy and the great potential of biomass available for energy production. Unfortunately, the pace of bioenergy development in Ukraine is still far behind European ones.

Ukraine has significant potential for biogas production, the most available agricultural resources are cattle manure, pig manure, chicken manure, various wastes (from plants, slaughterhouses, food industry, wastewater, etc.), silo, cake, bard, sugar beet, yoghurt, fiber, milk whey and others. With regard to poultry farms, the livestock and biogas production potential increased by 13,300 tonnes during the study period, indicating that enterprises that function in the composition of agro holdings or other integrated unions are more competitive in the market through the production of large volumes of production quality.

The energy potential of straw and vegetable waste totalled 14,718 thousand tons in 2017, up 5876 thousand tons in 2017 less than in 2010 and by 354 thousand tons AD than in 2013. The predominant species of biomass in the studied period were wheat straw, soybeans, corn stalks and sunflowers.

Therefore, setting up biomass energy resources will not only provide sufficient biofuels, but will also prevent soil erosion and improve the environment.

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