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## The development of the state strategy for biofuel production from agrobiomass in Ukraine

**ABSTRACT:** The energy strategy of Ukraine until 2035 forecasts that 12% of energy production will be from biomass. Currently, the share of biomass energy in the total structure of energy supplies in Ukraine is only 2%. After the Russian invasion of Ukraine, the diversification of the energy sector became extremely important. Rising fuels prices, problems with the fuel supply and the availability of agricultural biomass make biofuels an attractive alternative to fossil fuels. Ukraine has the potential to develop the production and use of all types of biofuels: solid, liquid and gaseous. Currently, the existing capacity and feedstock potential of biofuel production in Ukraine have not been fully realized. The experience of leading countries in the field of biofuel production shows that at the basis of the governments' growing commitment to developing the biofuel sector is a desire to diversify the energy supply, create new jobs, improve energy security and reduce carbon dioxide emissions and other gases that contribute to global warming. The aim of the study is to construct the theoretical and practical principles of the implementation of the strategy for biofuel production from agrobiomass in Ukraine. We came to the conclusion that the trigger for the development of

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the bioenergy industry is the adoption at the state level of the strategy for the production of biofuels from agrobiomass. The implementation of the strategy for biofuel production will help to increase the production and use of biofuels that will strengthen Ukraine's energy sector, help to stabilize fuel prices and will have a positive impact on the economic development of the country.

KEYWORDS: waste management, biofuels, feedstock, agrobiomass, economics and strategy

## Introduction

Considering the ongoing condition of Ukraine's economic development, identified by strengthening its own energy independence and diversification of the fuel and energy sector with an emphasis on the integration of renewable energy, much attention has been given to the growth of the bioenergy potential of the agricultural sector. Ukraine has the availability of arable land and favorable climate conditions that helps to ensure both the food demand of the population and export potential of the country, and can ensure a powerful resource for bioenergy production. The importance of solving the problem of rising prices on traditional energy resources, strengthening energy independence, improving the environmental situation and creating an additional product is not in doubt, and the experience of advanced countries in using the potential of agrobiomass as a feedstock for biofuel production has been proven in practice.

It should be noted that Ukraine has significant potential for strengthening the energy sector of the country by developing the industry of biofuels. Considering the current economic conditions, the energy dependence of Ukraine and the Russian invasion and aggression biofuels are very important in guaranteeing the sustainable development of the domestic agricultural and energy sectors.

Currently in Ukraine, the situation with waste management faces a number of critical issues that need to be addressed immediately and radically (Tokarchuk et al. 2021). The agricultural sector has great potential to provide feedstock for the production of biofuels.

The Ukrainian agrarian sector is quite energy intensive. The dream of every Ukrainian entrepreneur, and especially those who are engaged in agriculture, is to become energy independent from oil and gas exporting countries. As highlighted by Shpykuliak and Bilikinna (2019), in order to make the transition to "green" energy more sufficient it is necessary to pay attention to such forms of cooperation as "green" energy cooperatives.

The domestic biofuel industry can offer liquid, solid and gaseous types of biofuels. Each of these types of biofuels is produced in Ukraine to one degree or another. However, the enormous potential of bioenergy that Ukraine has is not being fully exploited. Compared to the EU countries, Ukraine is still approaching the full use of its own resources. This is especially important during the spring-autumn fieldwork, as Ukraine imports most of its oil products, and their prices depend on the exchange-rate fluctuations of the dollar and on seasonality.

Replacing petroleum products with biofuels is becoming not only economically feasible, but also an important measure on the path to the sustainable development of the economic system.

Therefore, the growth and further development of the biofuel market is impossible without the development and implementation of a clearly coordinated strategy for the production of biofuels of various types in Ukraine and the creation of effective and transparent legislation that will determine the main directions for promoting the biofuel industry.

The aim of the study is to construct theoretical and practical principles of the implementation of the strategy for biofuel production from agrobiomass in Ukraine, which can be achieved by:

- 1) generalization of theoretical approaches to the formation of biofuel production strategy;
- 2) analysis of factors and components that impact biofuel production and consumption in Ukraine;
- 3) defining the mechanism of the implementation of the strategy;
- 4) providing proposals on the stages of the implementation of the strategy;
- 5) building a conceptual model of strategy formation.

## 1. Literature review

The European Union has already taken a huge step towards reducing its greenhouse gas emissions while supporting economic development. In 2018, the amount of harmful emissions was 23% lower than in 1990 while the Union's GDP grew by 61% in the same period. Nevertheless more measures should be taken. Considering the previous successful experience, the EU is leading the way in creating a green and recycling economy. The European Green Deal Investment Plan will assemble EU funding and construct an enabling framework to facilitate and stimulate the public and private investments needed for the transition to a climate-neutral, green, competitive and inclusive economy. The European Union is committed to becoming the first climate-neutral bloc in the world by 2050.

The increased use of energy from renewable sources or 'renewable energy' constitutes an important part of the package of measures needed to reduce greenhouse gas emissions. In RED II, the overall EU target for the consumption of renewable energy sources by 2030 has been raised to 32%. The commission's original proposal did not include a transport sub-target, which has been introduced by co-legislators in the final agreement: Member States must require fuel suppliers to supply a minimum of 14% of the energy consumed in road and rail transport by 2030 as renewable energy (EU 2018).

As noted by Klochkovska et al. (2017), current economic development needs to undertake innovative and efficient measures in order to increase the state of prosperity as the basis for the socio-economic development of the state.

Muradin (2020) proved that it is particularly important to perform principles of sustainable development and to also take active measure in order to approach the economy in such a way that would help to reduce the global exploitation of the Earth and the mitigation of negative human activities.

Tomchuk et al. (2018) note that the main factors in increasing the production of liquid biofuels are price (in the last decade, there has been a significant increase in world prices for oil and petroleum products) and environmentally friendly products (liquid biofuels, even when used as additives to conventional gasoline and diesel fuel, has obvious environmental advantages over traditional fuels, the attractive environmental characteristics of liquid biofuels form the basis for government support for its production and use even at low prices for petroleum products and biological feedstock).

The solution to the problem of efficient waste management is often slowed down by the lack of public and commercial interests. Therefore, this problem requires separate regulation and organizational and economic provision. Berezyuk et al. (2019) highlight the importance of using the potential of waste as a promising feedstock for biofuels production.

Kaletnik et al. (2021) emphasize that during the past few years, the volume of bioethanol production in Ukraine remains at the level of 8% of the installed capacities. Meanwhile, Ukraine possess a huge feedstock potential for the production of bioethanol without threatening food security. Bioethanol production using the full capacities of the distilleries could restore the operation of a significant number of enterprises, improve the financial condition of the industry and increase revenues.

Pryshliak and Tokarchuk (2020) proved that the development of the renewable-energy sector will help to reduce reliance on energy imports and also enhance the economic stability and environmental situation. The agricultural sector has been increasingly considered as a source of electricity, heat and biofuels for biomass utilization in recent years.

Also, the interpretation by Kolesnyk et al. (2018) is worth attention: “the development of priority directions for ensuring the sustainability of the agrarian sector development has necessitated the use of a systematic approach to the analysis of problem situations in the agrarian sector, which allowed to formulate criteria that expresses the target quality benchmarks (industrial, social, economic and innovative) for the development of the agrarian sector and indicators that characterize the quantitative measure of approaching these landmarks”.

Considering the intensification of environmental issues that require instant actions to achieve ecological balance, biofuels can become a suitable solution Kaletnik and Lutkovska (2021).

According to the reports of the International Energy Agency, in 2019, the global energy demand increased by only 0.9% (120 million tonnes of oil equivalent). Starting from the end of 2019, there was a decrease in the demand of both conventional and renewable energy that was caused by the measures taken to prevent the Covid-19 infection.

Janiszewska et al. (2020) believe that biofuels can be used as a sufficient substitution to conventional fuels and they are able to fulfill energy needs, including generating electricity, heating homes, fueling vehicles, and providing process heat for industrial facilities.

As noted by Klochkovska et al. (2017), in order to achieve the high level of socio-economic development of the state to increase the level of population welfare, it is important to search for advanced approaches of developing each economic sector, and the energy and agriculture sector are a top priority.

Methods of strategic analysis of macro- and micro-environment factors have been used to form the state strategy of biofuel production from agrobiomass in Ukraine. This process involves the analytical assessment of the parameters of the external and internal environment using general scientific and applied methods of strategic analysis.

Analysis of the scientific literature has shown that there is a need to use an environmentally friendly approach in the production of biofuels by developing and implementing an environmental management system. However, the peculiarities of establishing an efficient framework for the implementation of the strategy for the production of biofuels from agricultural crops and waste remain insufficiently studied.

## 2. Results and discussion

In order to create conditions for eliminating the environmental pollution and improving the quality of life of the population, strengthening energy security, we propose to adopt a strategy for the production of biofuels from agrobiomass at the state and regional levels. The key components in the formation of the strategy should be a reasonable choice of priority areas of development and the effective implementation of the innovation plan. Nevertheless, the success of all participants in the production process depends on the successful selection of the most optimal strategy. In particular, it is important to consider the following conditions and components of implementation: financial resources; management system; state regulation; new technologies; terms; investment climate; performers; social infrastructure; environmental friendliness of technology application; stages of the work program (Boryshkevych et al. 2018).

In order to formulate an effective strategy for the production of biofuels from agrobiomass, it is necessary to take a number of steps, including: the resumption of loans to stimulate the production of biofuels from organic feedstock; measures to simplify the process of alternative energy production; ensuring the implementation of an effective state program that can ensure the efficient development of renewable energy; strengthening the environmental policy. All of the above will allow Ukraine to become a strong player in the biofuel market, improve the environment, create new jobs and accelerate and improve the economic development of rural areas.

When choosing a strategy, the greatest attention is paid to the relationship between the weaknesses of the internal environment and threats to the external environment. The combination of such a relationship can lead to the cessation of the production process and loss in exchange for the expected profit. During the process of the conversion of organic feedstock in agricultural enterprises, the unrealized opportunity may turn into risk factors (threats). The most attractive are the strategies that emerge at the intersection of the fields of strength and opportunity.

The methodology of forming the strategy of biofuel production, in our opinion, is a set of basic research approaches, which are the system and integrity of scientific and practical methods of cognition. In order to ensure the objectivity and complexity of the study, it is important to es-

establish the basic methodological concepts of forming a development strategy by combining well-known principles and individual approaches in the specifics of agricultural enterprises. Among the most relevant scientific and methodological foundations for ensuring the establishment of a strategy for the production of biofuels to obtain competitive advantages at the present stage, the following factors have been identified as the most important elements (Fig. 1).

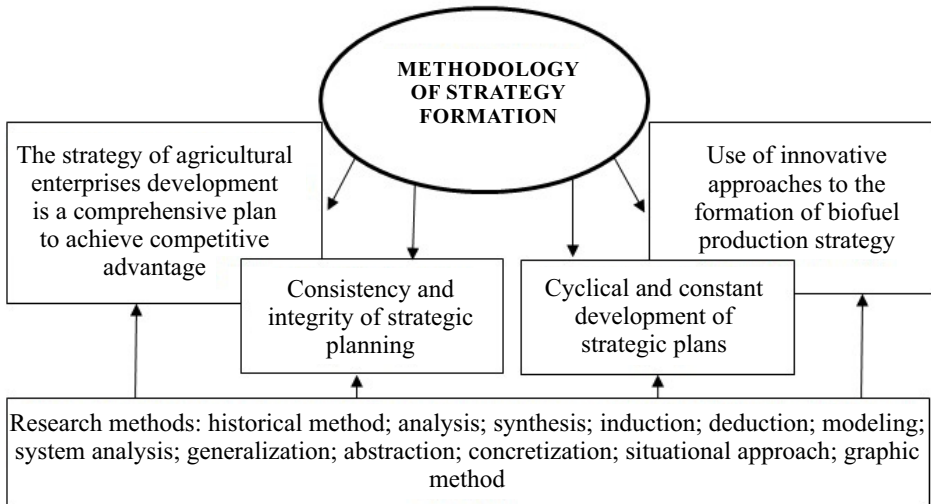


Fig. 1. Elements of methodology for forming a strategy for biofuel production  
 Source: formed by the authors based on Boryshkevych 2018

Rys. 1. Elementy metodyki tworzenia strategii produkcji biopaliw

Considering the factors influencing biofuel production from crops and waste, we have formed a table of external and internal factors. The components of the factors that impact the biofuel production using the PESTELI-FAMIL (Y) – analysis are represented in Figure 2. The acronym PESTELI-FAMIL (Y) – analysis is a constituent abbreviation of the first letters of the name of the following factors: (P) – political, (E) – economic, (S) – social, (T) – technological, (E) – ecological, (L) – legal, (I) – informational, (F) – Financial, (A) – administrative, (M) – marketing, (I) – innovational, (L) – logistical and (Y) – risk-factor (Table 1).

Strategic analysis of each of these components should be systematic. All factors are interdependent and characterize the various hierarchical levels of society, presenting them as a system as a whole. When conducting PESTELI-FAMIL (Y) – analysis, it was found that there are a number of rules that must be followed.

The conducted PESTEL-FAMIL (Y) – analysis confirmed that the establishment of biofuel production from agrobiomass in Ukraine is exposed to a number of favorable and unfavorable factors that can reflect positive and negative effects on this process. Furthermore, as a result of the analysis, a number of positive aspects can appear due to the establishment of production and the use of biofuels in Ukraine, in particular:

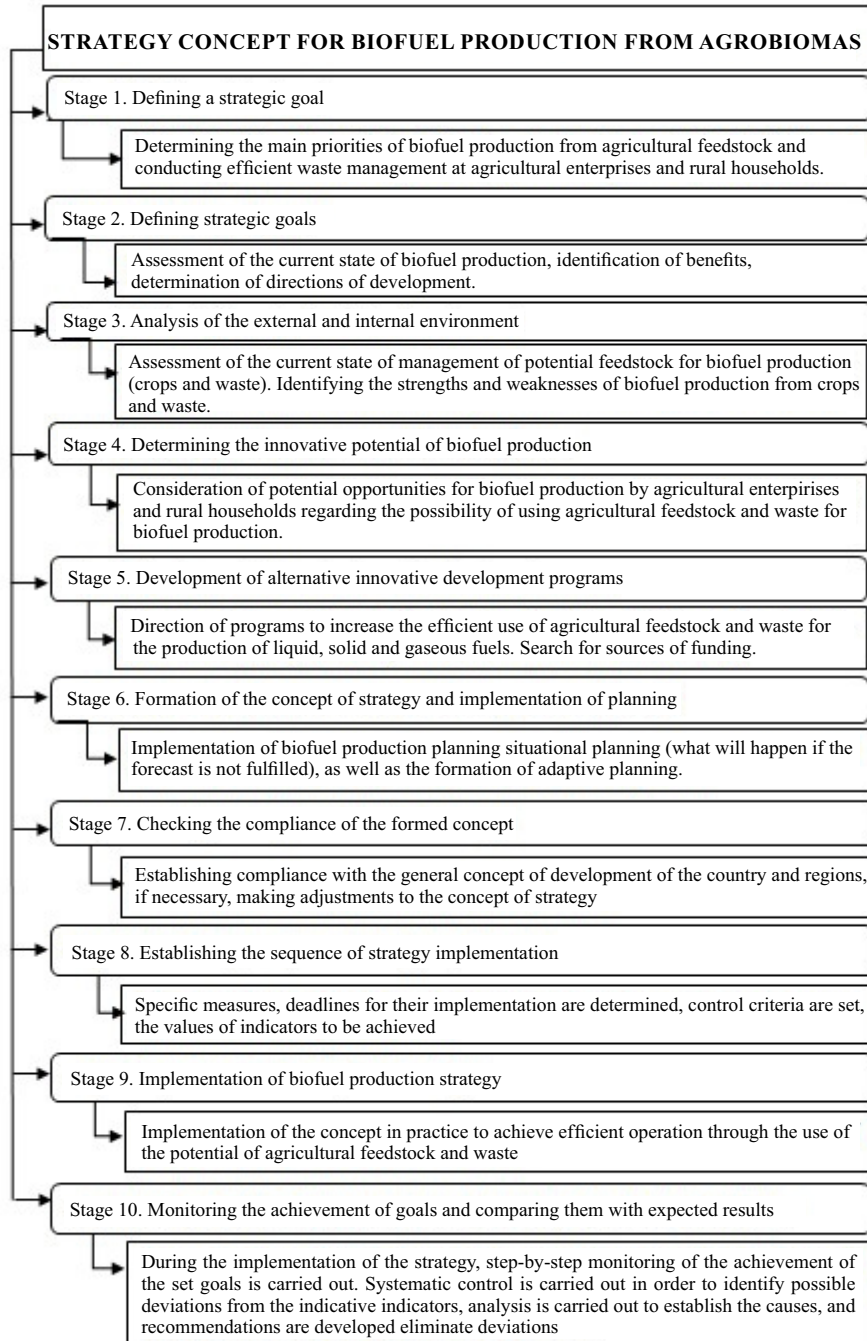


Fig. 2. The mechanism of implementation of the strategy for the production of biofuels from agrobiomass

Source: formed by the authors

Rys. 2. Mechanizm realizacji strategii produkcji biopaliw z biomasy agro

- ◆ guaranteeing energy independence of agricultural enterprises and rural households;
- ◆ strengthening energy security by increasing the share of energy produced from own renewable sources;
- ◆ the transition to a closed-loop economy;
- ◆ the reduction of negative impact on the environment and a reduction of the threat of climate change by reducing emissions of harmful greenhouse gases;
- ◆ the creation of new jobs, especially in rural areas and the suspension of the process of labor migration abroad;
- ◆ the use of available bio-raw materials for conversion into biofuels with the involvement of labor resources and the possibility of obtaining additional funds;
- ◆ the development of the innovative potential of agricultural enterprises and rural areas;
- ◆ the expansion of opportunities for the export of finished biofuels to EU countries, which are characterized by a steady increase in the demand for such fuels, which may lead to the conclusion of long-term contracts.

PESTELI-FAMIL (Y) – analysis enabled the outlining of the following main problems of biofuel production from crops and waste in Ukraine which will be addressed by the proposals of the strategy for biofuel production from agrobiomass:

- ◆ inconsistency of legislative requirements in the renewable energy sector in Ukraine in accordance with European requirements;
- ◆ low level of population awareness about the possibilities and advantages of biofuel production from bio-feedstock, as well as the processing or reuse of agricultural waste;
- ◆ low level of awareness among heads of agricultural enterprises about the possibilities of producing new products from agricultural crops and waste, in particular biological fuels;
- ◆ low level of state support and state funding programs in the field of research on technologies for the production and use of biofuels;
- ◆ lack of an effective mechanism for attracting private investment in the development of bio-energy projects;
- ◆ low efficiency of waste management in the agricultural sector;
- ◆ lack of effective mechanisms of state influence and state support for the development of bioenergy;
- ◆ underdeveloped logistics for the supply of agricultural feedstock and waste as a feedstock for the production of biofuel;
- ◆ insufficient scientific, technological and methodological support of biofuel production and agricultural waste management on an innovative basis of development.

Thus, when forming a strategy, exceptional attention should be paid to the strategic objectives of the development of agricultural enterprises aimed at achieving energy autonomy through the processing of crops and waste. The analysis performed by the PESTEL-FAMIL (Y) confirmed that the efficient use of agrobiomass and agricultural waste is an important factor in the development of biofuel production in Ukraine. Additionally, the PESTEL-FAMIL (Y) -analysis made it possible to determine the main problems of the system of organizing the production and use of biofuels in Ukraine, which will be addressed by the proposals of the strategy for the production of biofuel from agrobiomass.



The next step is to develop an effective step-by-step mechanism for implementing the strategy. We propose the following stages for the implementation mechanism of the strategy for the production of biofuels from agrobiomass (Fig. 2).

The mechanism of the stages of implementation of the strategy of biofuel from agrobiomass which we have presented is aimed at achieving the primary objective – increasing the volume of the production and consumption of biofuel in Ukraine and strengthening the energy security of our state. The first step in the presented concept of strategy formation is setting goals. Initially, a global goal is being formed to increase biofuel production, which reflects the relevance and role of society and the producers and consumers of this product. After setting the goal, it is necessary to determine specific strategic directions for the use of crops and waste for biofuel production, based on a specific goal. At this stage, the current state of agricultural production and the accumulation of agricultural waste is assessed, the potential for biofuel production without a threat to food security and export potential is determined and priority areas for biofuel production are determined. Next, it is necessary to identify the strengths and weaknesses of biofuel production from crops and waste and to consider the potential for biofuel production in existing agricultural enterprises and in households.

After the stage of systematization of measures to achieve the goals, the stage of determining the innovative potential of biofuel production becomes important and relevant. At this stage, the potential opportunities for the production of biofuel by agricultural enterprises and rural households are considered with regard to the possibility of using agricultural feedstock and production waste.

The next stage is the development of alternative innovative development programs, which aims to direct programs to increase the efficient use of agricultural biomass and waste for the production of liquid, solid and gaseous fuels. Additionally at this stage, the search for sources of finance is carried out in the direction of establishing the production and use of biofuels. To this end, an analysis of the possibility of attracting own funds of biofuel producers is carried out, diagnostics of their financial, economic and technical and technological state is performed as well as a search for external sources of attracting investments (government programs, foreign investors, international financial and credit institutions, grant programs).

At the stage of the formation of the concept of the strategy and the implementation of planning, there is gradual planning of biofuel production, situational planning (what will happen if the forecast is not fulfilled); the possibility of adaptive planning is also considered.

The next step is to check compliance with the existing concept. Where the compliance with the general concept of development of the country and regions is established, if necessary, adjustments are made to the concept of the strategy.

Further, the sequence of the implementation of the strategy is determined, specific measures are determined, the timing and control criteria are set, the values of indicators that must be achieved.

At the next stage, the concept of biofuel production is implemented, in other words, it is embodied in practical activities in accordance with the established stages of implementation. At this stage, the concept is translated into practice to achieve maximum efficiency in biofuel production due to the use of the potential of agricultural feedstock and waste.

The final stage in the formation of the strategy for the production of biofuel from agrobiomass is to monitor and control the achievement of the goals in accordance with the obtained results, which will allow conducting effective monitoring of the implementation of the strategy and making the necessary additions, amendments, changes and improvements.

Monitoring and control is a necessary and important step, which includes the use of monitoring and verification of compliance with the strategy for biofuel production from agrobiomass to established norms, standards and other indicative indicators, defined plans and programs as well as the detection of deviations from decisions.

Adherence to the proposed stages of the strategy for the production of biofuels from agrobiomass enables the creation of the necessary conditions to achieve the main goal, which also reflects its key feature – ensuring energy, environmental and food security in the long run by means of innovative development through the formation and implementation of competitive advantages in areas of the effective use of the potential of crops and waste. The formed strategy will allow the gradual implementation of the set tasks, which as a result will give a positive effect, both for the producers and consumers of biofuels, and for the whole population and the state as a whole. The implementation of the strategy for the production of biofuels from agrobiomass should comply with the following principles:

- ◆ production of biofuels from crops does not threaten the food security of the state;
- ◆ biofuel production is a trigger for reinforcing the energy security of the country;
- ◆ environmental friendliness, which provides for the reduction of greenhouse gas emissions through the production and use of biofuels;
- ◆ accessibility, which presumes the reduction of the possible risks of waste pollution and waste conversion close to the place of formation;
- ◆ forming the hierarchy of waste management of agricultural enterprises which guarantee the efficient measures regarding waste management in the next sequence – the processing of waste in bioreactors, the use of waste as a secondary energy resource and the use of recycled waste as biofertilizer;
- ◆ transformation to a closed-loop economy, which presumes that the amount of products, materials and resources is applied in the economy as long as possible and that waste generation is kept at a minimum;
- ◆ caution, which in the case of environmental danger means taking relevant precautions;
- ◆ joint responsibility, participation of public authorities, local governments and economic entities together with the public in decision-making to achieve environmental policy goals;
- ◆ extended producer responsibility, which provides for the responsibility of agricultural producers for the safe processing and disposal of waste;
- ◆ self-managing, which requires the formation of an integrated adequate framework of facilities for the production, sale and use of biofuels.
- ◆ Considering the complex nature of the interaction of the components of the development of production and consumption of biofuels in Ukraine, we propose the implementation of the strategy in three main stages. The stages of the strategy implementation are shown in Figure 3.

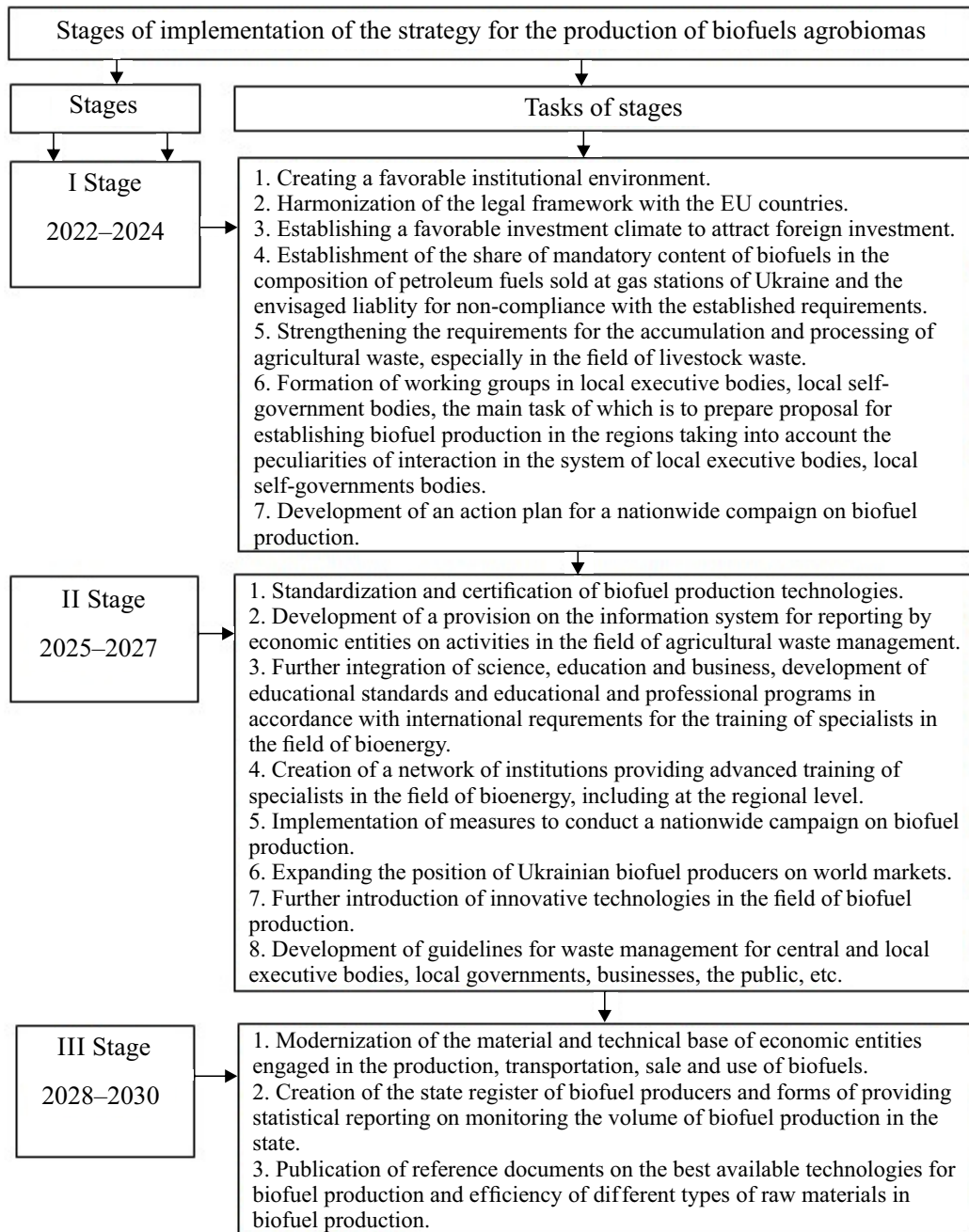


Fig. 3. Stages of implementation of the strategy for the production of biofuels from agrobiomass

Source: suggested by the authors

Rys. 3. Etapy realizacji strategii produkcji biopaliw z biomasy agro

The defined mechanism of the implementation of the strategy of biofuel production from agrobiomass enabled the formation of a conceptual model of development of production and the consumption of biofuels from crops and waste in Ukraine (Fig. 4).

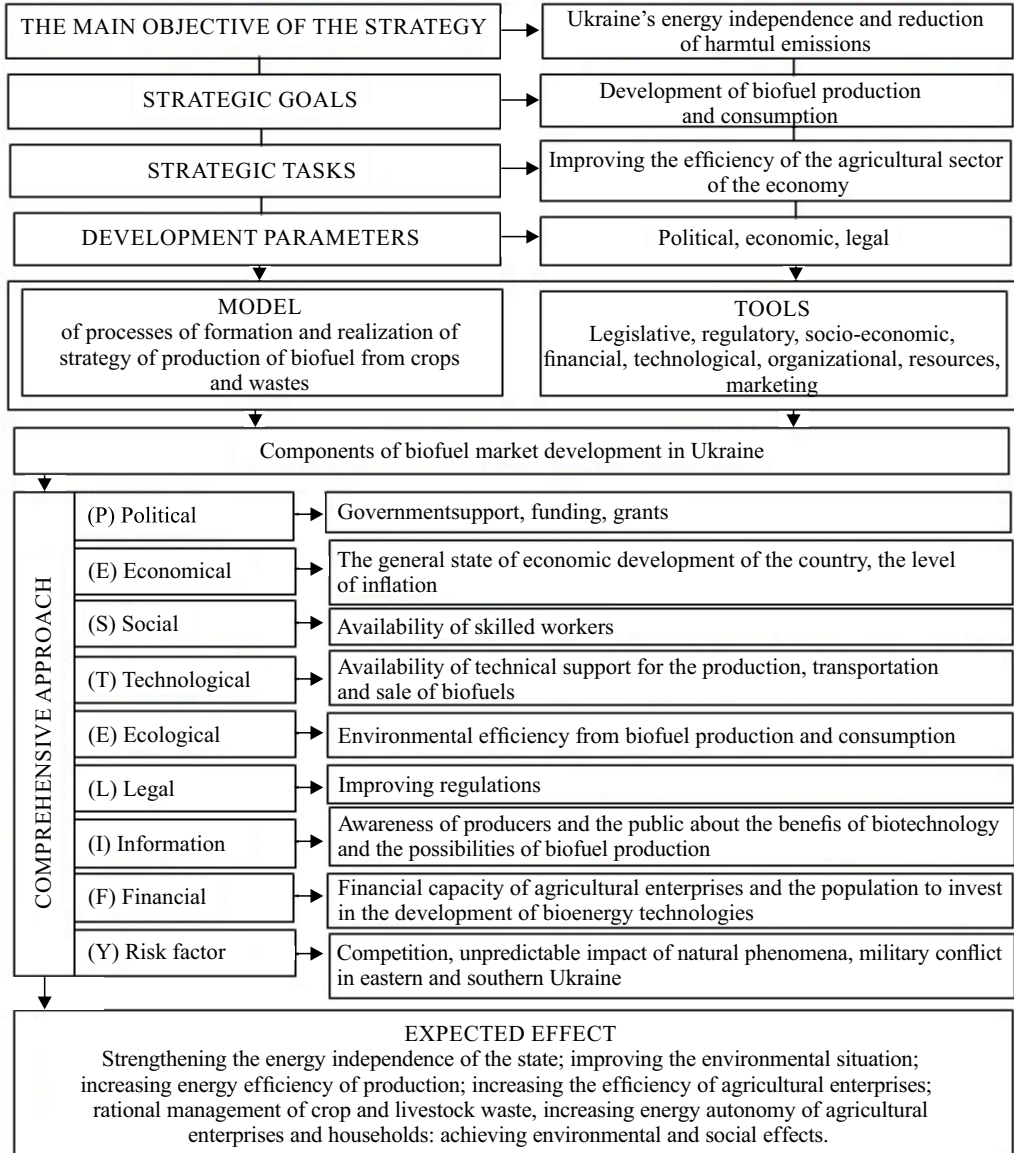


Fig. 4. Conceptual model of the strategy of biofuel production from agrobiomass in Ukraine

Source: developed by the authors

Rys. 4. Model koncepcyjny strategii produkcji biopaliw z biomasy agro w Ukrainie

The analysis showed that this conceptual strategy for the production of biofuels from agrobio-mass in Ukraine is characterized by the interdependence of all components of the proposed model. Furthermore, adherence to logically formed relationships will ensure the efficient use of the agricultural potential as well as increasing the management of agricultural waste, which will confirm the expected effects and results.

## Conclusions

Considering the current political and economical conditions in Ukraine, agricultural operating facilities are experiencing an important strategic mission: to guarantee profitable business activities and to subsequently create efficient paths based on the efficient use of resources.

The development of a strategy for the production of biofuels from agrobiomass is the main direction in developing effective measures for the long term, which will help agricultural enterprises and households to not only obtain additional financial resources from the production, sale and use of biofuels but also to ensure energy autonomy through their energy use.

Thus, the strategy of biofuel production is aimed at obtaining the desired economic result from production activities, the efficient use of production capacity and potential, and the maximum satisfaction of market needs. Therefore, the formation of a strategy for biofuel production is possible only with a comprehensive approach, taking into account the overall, competitive strategy, product, resource and other functional strategies, and the choice of a particular type depending on the characteristics of the enterprise, the production capabilities, consumer orientation and the market.

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## Opracowanie państwowej strategii produkcji biopaliw z biomasy agro w Ukrainie

### Streszczenie

Strategia energetyczna Ukrainy do 2035 roku przewiduje, że 12% produkcji energii będzie pochodzić z biomasy. Obecnie udział energii z biomasy w ogólnej strukturze dostaw energii w Ukrainie wynosi zaledwie 2%. Dywersyfikacja sektora energetycznego stała się niezwykle ważna po rosyjskiej inwazji na Ukrainę. Rosnące ceny paliw, problemy z zaopatrzeniem w paliwo oraz dostępność biomasy rolniczej sprawiają, że biopaliwa są atrakcyjną alternatywą dla paliw kopalnych. Ukraina ma potencjał do rozwoju produkcji i wykorzystania wszystkich rodzajów biopaliw: stałych, ciekłych i gazowych. Obecnie istniejące moce i potencjał surowcowy produkcji biopaliw na Ukrainie nie są w pełni zrealizowane. Doświadczenia wiodących krajów w dziedzinie produkcji biopaliw pokazują, że u podstaw rosnącego zaangażowania rządów w rozwój sektora biopaliwowego leży chęć dywersyfikacji dostaw energii, tworzenie nowych miejsc pracy, poprawa bezpieczeństwa energetycznego oraz redukcja emisji dwutlenku węgla i innych gazów, które przyczyniają się do globalnego ocieplenia.

Celem tej pracy jest skonstruowanie teoretycznych i praktycznych zasad realizacji strategii produkcji biopaliw z biomasy agro na Ukrainie. Doszliśmy do wniosku, że impulsem do rozwoju branży bioenergetycznej jest przyjęcie na szczeblu państwowym strategii produkcji biopaliw z biomasy agro. Realizacja strategii produkcji biopaliw przyczyni się do zwiększenia produkcji i wykorzystania biopaliw, które wzmocnią ukraiński sektor energetyczny, pomogą ustabilizować ceny paliw i wpłyną pozytywnie na rozwój gospodarczy kraju.

SŁOWA KLUCZOWE: gospodarka odpadami, biopaliwa, surowce, biomasa agro, ekonomia i strategia

