UDC 351.778.5:628.477
JEL H80, O29, Q21

STRATEGIC DEVELOPMENT OF SOCIAL ENTREPRENEURSHIP MECHANISMS AND REGULATION IN BIOMASS WASTE MANAGEMENT

Viktoriya Gura
Taras Shevchenko National University of Kyiv,
Kyiv, Ukraine
ORCID iD: 0000-0002-4870-4037

Andrii Sambulov *
Taras Shevchenko National University of Kyiv,
Kyiv, Ukraine
ORCID iD: 0009-0001-1533-333X

Oleksandr Vaschenko
State University of Information and Communication Technologies,
Kyiv, Ukraine
ORCID iD: 0000-0003-2830-0227

Yevhenii Ponomarenko
Higher Educational Institution "Podillia State University",
Kamianets-Podilskyi, Ukraine
ORCID iD: 0009-0004-5845-2509

*Corresponding author
E-mail: sambulovandre@gmail.com

Received: 08/09/2025
Revised: 14/11/2025
Accepted: 05/12/2025

DOI: 10.61954/2616-7107/2025.9.4-3

Introduction. The environment, which is polluted by biomass waste, high unemployment, primarily in agriculture, and the need for alternative energy sources, requires the search for new organisational forms in the circular economy. Therefore, the issue of social entrepreneurship in biowaste processing is relevant. Research on social entrepreneurship has unique potential for effective biomass waste management, serving as a key catalyst for simultaneously achieving a circular economy and energy transition.

Aim and tasks. The study aims to investigate the strategic development of social entrepreneurship in biowaste management, considering the relationships between financial policy and social and environmental effects, and to develop a model for integrating social enterprises in the biomass management chain.

Results. European social enterprises have developed various innovative business models for biowaste utilisation. Simultaneously, Ukraine is not ready to introduce social enterprises into the waste processing industry. However, correlation analysis confirmed significant multidimensional relationships between the policy of financing biowaste processing and social and environmental effects. The correlation coefficient between biomass fuel consumption and the reduction of carbon dioxide emissions into the atmosphere is 0.985; between the installed capacity of bioenergy equipment and the number of additional jobs is 0.942; and between the volume of recovered biowaste and the level of employment in the industry is 0.978. The low level of social entrepreneurship development in biomass management in Ukraine has led to the development of a model that allows a social enterprise to position itself in the chain of collection, sorting, and logistics of biowaste.

Conclusions. Increased logistics costs and current costs for the collection and disposal of biowaste led to a 15.6-fold reduction in investments in biowaste processing compared with 2015. As a result of a 3.8-fold reduction in the employment growth rate in this sector and a 4.6% reduction in the proportion of biowaste disposal, the importance of social initiatives for the strategic development of entrepreneurship in biowaste management is increasing. The involvement of local communities contributes to the growth of the social effect, and social entrepreneurs can adapt the use of European financial and technical support instruments for the strategic development of social entrepreneurship in biowaste management.

Keywords: Social Entrepreneurship, Biomass, Waste Management, Circular Economy, Environmental Safety.

1. Introduction.

Social entrepreneurship places social and environmental goals at the forefront of its activities, unlike businesses that seek to maximise profits. Social enterprises aim to address social issues, improve the environment, and generate financial returns. Therefore, EU countries focus on waste management to implement circular economy principles (European Commission, 2019; 2024). The value of biomass is growing, along with changes in the energy sector, due to the emergence of new technologies that enable the use of organic waste as a valuable resource for industry, energy, and agriculture.

This reduces waste and creates new opportunities for developing small- and medium-sized businesses with a social orientation. Biomass, a key resource for achieving energy transition and circular economy goals, requires effective management to minimise waste and ensure resource reuse. Since economic results are not the primary goal of social entrepreneurship in biowaste processing, its activities depend on state support. Regulatory frameworks, tax incentives, and public initiatives form an ecosystem for implementing waste management practices.

The opportunities and obstacles to Ukraine's implementation of EU practices, the assessment of biomass waste management sector strategies in Ukraine, and the introduction of social enterprises' choice of position in the chain of collection, sorting, delivery, and processing of biowaste remain insufficiently studied. The relevance of this study lies in the need to examine the role of social entrepreneurship in implementing circular economy principles, particularly in biomass waste management, and to analyse the impact of regulation on its development.

2. Literature Review.

Academic studies have analysed the role of social entrepreneurship in biomass waste management as a component of the circular economy. The analysis identifies key areas as legislative support, social entrepreneurship as a mechanism for ecological transformation, and the European experience in biowaste.

A review of the literature on social entrepreneurship in the field of waste management and the article by Andersson et al. (2019) indicate the need to expand the research view of the study of ecological systems of the circular economy by identifying a direction called “socio-technical (ST)” research, which includes the application of social enterprises in this area. Andersson et al. (2019) indicate that this is due not only to the task of involving society in solving the problems of the circular economy but also to the need for new tools to influence the expansion of state structures’ participation in waste management.

Thus, according to Rahman (2025), social entrepreneurship has the potential to integrate social and environmental goals. However, the lack of necessary institutional and structural support hampers the realisation of this potential in environmental protection.

Schipfer et al. (2022) indicate that the rational use of biomass residues differs from the utilisation of other types of waste, since the diversity of their types and supply chains cannot ensure the sustainability of processing. This increases the feasibility of social entrepreneurship in this area, as it provides greater flexibility in processing management. Yosep et al. (2024) also indicated the feasibility of using small and medium-sized social enterprises to process tapioca waste, since this contributes to the dispersion of processing structures and increases employment in rural areas. Yosep et al. (2024) demonstrate the effectiveness of the RESOLVE-SF decision support system for simultaneously solving economic, environmental and social problems in the practical activities of social enterprises. Al-Obadi et al. (2022) noted the importance of an integrated approach to biomass waste management, which should be based on preventing an increase in volume and applying social innovations for processing. Circular economy strategies are built on this basis, particularly expanding the use of the social entrepreneurship mechanism to provide communities with biowaste energy.

A key finding of Santander et al. (2022) is that waste management social entrepreneurship should not be limited to specific regions or small communities.

e-ISSN 2786-8958
ISSN-L 2616-7107

Government regulations should expand the scope of social experimentation in waste management network development strategies and practices. This strategy should also implement a group of goals, with achieving a certain level of processing profitability not being the primary goal of the strategy. It is also important to reduce the area of landfills, solve the problems of localising energy production, and reduce the costs of extending electricity supply lines. Bahrololoum et al. (2022) indicate that strategies, which relied on social entrepreneurship in the productive use of biomass, were ineffective due to the predominant focus on economic indicators.

Therefore, a strategy is proposed to solve environmental problems primarily by providing subsidies for introducing startups to use their innovative potential and for the sustainable operation of such enterprises. Zięty et al. (2022) indicate that only regulating legal norms regarding waste management can solve this area's complex environmental, economic and social problems. In particular, the gaps in national legislation and EU law lead to the illegal incineration of waste in Polish landfills as a forced alternative to recycling. State support for social entrepreneurship to reduce waste in the "temporary storage" mode is one of the directions (European Biogas Association, 2024).

One of the main risks for the energy transition through the utilisation of organic waste is identified in the article by Zajemska et al. (2024) as the lack of a comprehensive legal system that would make it possible to implement a technological chain between waste generation facilities and a developed infrastructure for their processing, particularly with the inclusion of social initiatives.

The presence of such a legal system will allow institutional structures to use the socio-economic potential in the field of waste-to-energy processing. Mitzinneck et al. (2019) focus on the social effect of environmental initiatives and, in their study of social enterprises in the direction of the use of renewable energy sources (RESCoops) for the use of biowaste, indicate new effects from the expanded application of the compromise strategy in their activities.

This is useful given that social enterprises aimed at achieving the goals of the circular economy are short-lived because the value orientations of individual team members are levelled in the work process (Mitzinneck et al., 2019). Therefore, achieving both temporary and structural compromises in social enterprise teams is important. Simultaneously, it is noted that team sustainability is achieved only with a comprehensive approach to applying compromise strategies (Bahrololoum et al., 2022).

Hondroyiannis et al. (2024) highlight the importance of supporting biomass waste institutions, among which institutional policies are fundamental, meaning that support measures must be coordinated and comprehensive.

The regulatory framework is combined with financial incentives and socially oriented business models, creating sustainable development conditions. The literature review indicates the high effectiveness of combining regulatory, financial, and social mechanisms to stimulate social entrepreneurship in biomass management. It is relevant to study the strategies of the biomass waste management sector in Ukraine, build a holistic model of adapting European experience to Ukrainian realities, consider local socio-economic conditions, create flexible financing instruments, and form effective intersectoral interaction in Ukraine.

3. Methodology.

A mathematical model of multi-criteria optimisation in waste processing is proposed. For this purpose, sets of variables at the time of economic (A_t), environmental (B_t) and social (C_t) indicators are distinguished. Interconnected, time-controlled functional dependencies that describe these sets of variables, respectively: economic $F(A_t)$, environmental $\varphi(B_t)$ and social $\gamma(C_t)$ are defined. Then a model of the dependence between the arrays of combination configurations is formed by the values of the specified objective functions $F(A_t)$, $\varphi(B_t)$ and $\gamma(C_t)$, which can be represented as follows:

$$\Upsilon(F(A_t), \varphi(B_t), \gamma(C_t),\ S_n^k(A_t, B_t, C_t)):\ opt(A_t, B_t, C_t) | (A_t, B_t, C_t) \in \underline{S}_n \quad (1)$$

where,

$n \ni p, m, h$ – total number of variable arrays: A_t^p,B_t^m, C_t^h;

$\underline{S}_n$ – vector of relationships among variables.

Vector $\underline{S}_n$ can depend both on regulatory factors and on functional dependencies that describe subarrays:

$$\underline{S}_n = \Psi\{F[F^1(A_t^1), F^2(A_t^2), F^3(A_t^3) \dots]\} \quad (2)$$

The relationships between the variables of the specified arrays were checked using the level of correlation between their factors. Thus, the Pearson correlation coefficient between the consumption of biomass fuel and the reduction of carbon dioxide emissions into the atmosphere is 0.985. Between the installed capacity of bioenergy equipment and the number of additional jobs it is 0.942. Between the volume of recovered biowaste and the level of employment in the industry it is 0.978. Between the volume of investments in biowaste processing and the number of jobs in this industry it is 0.995. This confirms the presence of significant multidimensional relationships between the policy of financing biowaste processing and its social and environmental effects. When presenting the problem in graph theory, the problem of finding the vertex of a multidimensional hypercube arises.

The relationships between the variables of the specified arrays can be represented as subgraphs using the transposition method. In all graphs, the extreme values of the objective functions are recorded as interval indicators of their change.

The values of the specified functions were determined in descending order using the permutation method. Next, a directed graph is formed as follows:

$$G = F^1 \cap F^2 \dots \cap \varphi^1 \cap \varphi^2 \dots \cap \gamma^1 \cap \gamma^2 \quad (3)$$

which, under the existing mathematical constraints on changes in significant parameters, allows finding the optimum of the economic $F(A_t)$, environmental $\varphi(B_t)$ and social $\gamma(C_t)$ objective functions.

This approach allows for solving global problems and sub-problems using mathematically formalised geographical, economic, and social ones. For example, under certain financial constraints, it is possible to reduce the landfill load in the area and provide jobs for a certain number of citizens. Moreover, what place in the biowaste chain of collection, sorting, and logistics is appropriate for a social enterprise? The mathematical model was implemented using an example of wood and agricultural plant residues in bioenergy plants. Fig. 1 presents indicators of the volume of investments in the industry compared to 2015, the rate of change in employment annually, and the share of crop residues in the total utilisation volume.

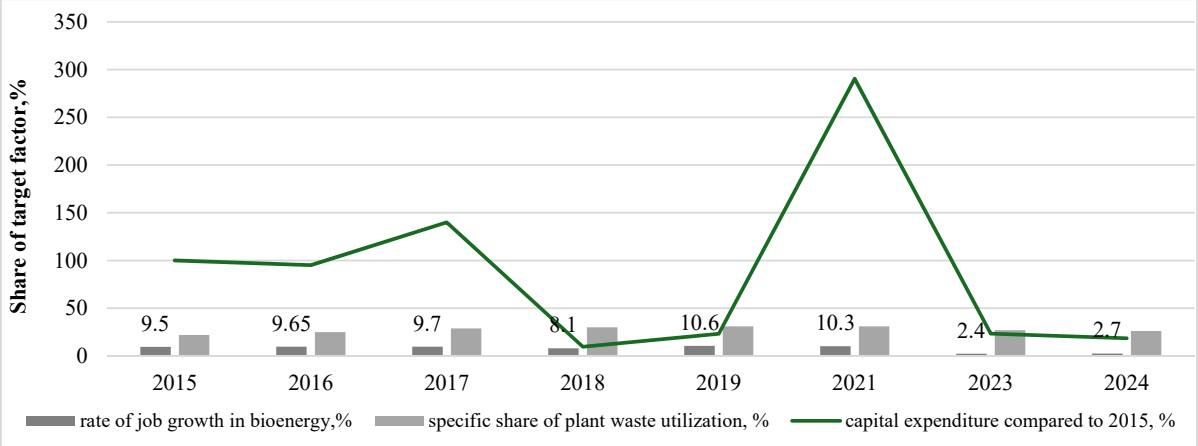

Fig. 1. Bioenergy Investment, Employment Growth, and Residue Utilisation*.

* the indicator of capital investments in bioenergy is given in relation to the indicator of 2015, %

Source: based on data from Bioenergy Association of Ukraine (2025); Karbovska et al. (2024); SALAR International (2024); and State Statistics Service of Ukraine (2025).

e-ISSN 2786-8958
ISSN-L 2616-7107

With the reduction of labour resources due to mobilisation and migration, as well as the increase in the wage fund and logistics costs, the current costs of collecting and disposing of bio-waste will increase. This will lead to an increase in the payback period of investments, which already amounts to a significant amount, 6-7 years, with significant uncertainty due to economic and political instability. This has already led to a reduction in capital investments compared to 2021 by 15.6 times, which resulted in a reduction in the employment growth rate in this area by 3.8 times and a decrease in the specific weight of the biowaste disposal by 4.6%. Therefore, investments in using wood and agricultural plant residues in bioenergy will tend to decrease in the short term (Fig. 1), which will have environmental consequences, particularly an increase in the load on waste landfills by 3%. Under such conditions, the importance of social entrepreneurship in this area will grow, and this factor will further determine the results of the multi-criteria optimisation of biowaste utilisation (Harfadli et al., 2025).

4. Aim and tasks.

The aim is to study the conditions for developing social entrepreneurship in biowaste management and identify ways to overcome obstacles and use opportunities. This study sets out to achieve the following objectives: to determine successful forms of social enterprise practices in the field of biowaste utilisation in EU countries and areas of their institutional support; to assess the strategies of the biomass waste management sector in Ukraine; to develop a model for the optimal achievement of social, economic, and environmental goals by social entrepreneurship in biowaste management; and to develop proposals for increasing the effectiveness of state policy in biowaste management.

5. Results.

The experience of EU countries indicates that effectiveness in this area is due to the high adaptability of social enterprises in implementing biowaste management strategies and their inclusive use (European Regions Research and Innovation Network, 2025).

As the experience of Italy, France, Germany, and Belgium shows, this is facilitated by the combination of efforts of municipalities, NGOs, farms, and local business structures (European Environmental Bureau, 2024). This ensures employment and adequate funding for social projects (Interreg Central Europe, 2025).

This is proven by the example of the social enterprise “Compost Citoyen” (France), where those who have been unemployed for a long time are involved in the disposal of bio-waste (European Compost Network 2024). German models of partner energy hubs based on local cooperatives confirm that a clear diversification of raw material sources, partnership with university science, and involvement of the public sector significantly increase both the economic viability of projects and their acceptance at the local level (European Regions Research and Innovation Network, 2025).

Adaptive flexibility is critical, similar to the need to gradually correct actions in modern marketing strategies to achieve intermediate and long-term goals. Simultaneously, cases from Belgium, where social enterprise networks organically combine job creation for people from vulnerable groups, educational initiatives, and environmental campaigns, vividly illustrate the benefits of diversified financing and multi-level partnerships (Interreg Central Europe, 2025).

Combining social and environmental components with a transparent decision-making system ensures the long-term sustainability of such models. Ukraine lags significantly behind EU countries regarding the volume of biowaste processed. Thus, if 43% of the total waste generated from biological origins in EU countries is recycled (Karbovska et al, 2024), it is less than 7% in Ukraine (Table 1). Simultaneously, Ukraine is approaching EU indicators regarding the use level of individual waste types. The specific weight of recycling wood and agricultural plant residues is 85%. As of 2020, approximately 1,000 social enterprises were operating in Ukraine, of which only 90 were engaged in waste collection, sorting, logistics, and recycling (EU4Youth, 2020). There are approximately 560 waste management facilities in Ukraine (Karbovska et al., 2024).

Table 1. Graphic Matrix "European practices - Ukrainian Barriers and Opportunities".

European practices	Ukrainian Barriers/Opportunities		
	High Probability	**Medium Probability**	**Low Probability**
Collaborating with across recycling firms to transfer waste streams	-	-	Low-High
Waste banks and community-based waste management	-	-	Low-High
Involve a group of communities in creating a waste supply chain	High-High	-	-
Using biowaste to sustainably provide heat and electricity to local community	-	Medium-High	-
Use of E-platforms for waste trading	-	-	Low-High
Gathering and sorting of biowaste for community processing into pellets, high-protein animal feed, etc.	High-High	-	-

Source: based on data from Al-Obadi et al (2022).

Table 2 presents successful models of social entrepreneurship implementation in biowaste utilisation according to their organisational forms and other key features. The models implemented in leading European countries demonstrate the importance of a systemic balance of flexibility, inclusiveness, and comprehensive support in achieving tangible socio-economic and environmental impacts in biomass management.

It is important to emphasise that successful European models of social enterprises in the biomass sector share a multivector approach to solving social and environmental problems. This is analogous to the need for an iterative approach to adaptive marketing strategies. Optimising plans and resources in response to external factors is key to systemic effectiveness at each stage of social enterprise development.

Table 2. Key Characteristics of Successful Social Enterprise Models in Europe.

Country - Model	Type of organization	Key partnership mechanism	Social impact	Environmental impact	Features of institutional support
Italy – Biogas Cooperatives	Cooperative	Farmer, municipality integration	Youth employment, support for local projects	Reducing emissions, reusing organic waste	National green programs, regional funds
France – «Compost Citoyen»	Consortium / NGO	Local cooperation platforms	Inclusion of migrants, social reintegration of the unemployed	Reducing landfill load	City co-financing, state grants
Germany – Energy Hub	Cooperative	Partnership with universities, NGOs	Civic engagement, educational programs	Local energy independence, reducing CO_2	Federal funds grants, research grants
Belgium – Network of Social Enterprises	Enterprise	Diversified funding	Jobs for vulnerable groups, educational campaigns	Engaging the population in recycling materials	Multi-source funding, educational projects

Source: based on data from the European Regions Research and Innovation Network (2025).

Thus, the models of European social enterprises in the biomass sector demonstrate that multilevel partnerships and constant adaptive management ensure flexibility and resilience to external influences, and the priority of inclusiveness and social responsibility does not conflict with the desire for economic efficiency; on the contrary, it stimulates the competitiveness of such enterprises.

The synergy between public policy, public activism, and business innovation creates a favourable environment for developing social entrepreneurship in biomass use. A study of the European experience shows that the effectiveness of the transformation of the biomass management sector directly depends on the regulatory mechanisms implemented by each EU member state.

The study of the European Community's regulatory framework allows for identifying the main areas that contribute to developing social enterprises in biomass processing. Significant documents in this area are, first of all, the EU Directive 2018/851 on waste, the EU Strategy for the Circular Economy and national roadmaps for resource management (European Environmental Bureau, 2024).

These regulatory documents introduce the basic principles of a specific area of activity. They, in particular, provide for the introduction of incentives for social enterprises, such as grant programs, tax credits, and support for partnership initiatives between government agencies, the private sector, and public organisations. The parallel between these measures and the evolution of marketing strategies in response to unpredictable external influences is the need for the mutual complementarity of regulatory instruments to ensure effectiveness. Regulatory documents also determine the need to implement adaptive policies that ensure the flexibility of waste management ecosystems.

Thus, the key European regulatory frameworks are distinguished by an integrated multilevel structure (from directives to local implementation platforms), a systematic approach to stimulating social entrepreneurship through special support programs, an emphasis on transparency of management and monitoring of results, and a gradual transition from administrative control to a partnership model of interaction between the state, business, and the public sector.

Ultimately, for countries with markets that are only transitioning to a circular economy model, it is critically important to implement European legislation formally and ensure its adaptability to local conditions, considering the market structure, level of education, and access to resources. This multi-factor system creates favourable conditions for developing innovative bio-waste management models, allowing social enterprises to choose forms and areas of activity from a wide range of alternatives. Despite significant resource capabilities in Ukraine, obstacles, challenges, and threats hinder the development of social entrepreneurship in the biowaste processing sector.

The regulatory and legal framework of Ukraine in this area is fragmented, the coordination of institutional structures is insufficient, and the infrastructure for the collection, transportation, and processing of various types of biowaste is almost absent (Nefco, 2021; Mirzoieva et al., 2022).

A significant drawback of the regulatory framework is the generalised approach to managing household and industrial waste, with biomass considered only one of the groups in the general classification. Unlike other waste, the peculiarities of biomass are the seasonality of formation, regional differences in the structure of its production, and differences in its logistics.

This leads to the inefficiency of existing methods of segmented planning and management of utilisation and reduces the prerequisites for implementing specialised regional strategies. In addition, the dynamics of external influences determine the market's state and regulatory environments. In particular, the need to implement the obligations assumed by Ukraine in connection with the state's European integration policy and large-scale military operations increases the need for changes in the regulatory framework and management algorithms. As adaptive marketing strategies that respond to unexpected external changes through short correction cycles, the biomass waste management system seems appropriate for forming scenarios for responding to crises in advance.

Investment and financial aspects are important. The existing infrastructure and technological base are concentrated mainly in extensive agricultural holdings, cities and regional centres. At the same time, small communities and farmers have limited access to financing and expert support for implementing local solutions in bioenergy or composting.

Furthermore, dynamic changes in the supply and demand for products, the results of utilisation processes, and the impact of external crisis factors, particularly military actions and population migration, complicate processing management. This increases the impact of uncertainty on biomass utilisation activities. This requires social entrepreneurship to transition to new strategic planning models.

These models should adaptively combine strategic and operational planning and introduce step-by-step changes to long-term plans. Therefore, dividing each stage of the strategic plan into smaller substages allows for a quick review of the goals, tools, and methods for achieving them. From this perspective, the level of substantiated deviations from planned indicators should be considered an indicator of the flexibility and effectiveness of the decision-making system. Therefore, strategies in this activity area should be analysed to increase the effectiveness of biomass waste management in Ukraine (Table 3).

Table 3. SWOT Analysis of Biomass Waste Management Sector Strategies in Ukraine.

	Strengths (S) 1. A significant amount of agricultural biomass. 2. - Ability to integrate modern European recycling practices 3. Gradual integration of European integration norms. 4. Activation of local communities in the field of waste management 5. Growing demand for renewable energy.	**Weaknesses (W)** 1. Fragmentation of the legislative and regulatory framework, low level of specialization in biowaste - insufficiently developed infrastructure for biomass collection, transportation and processing. 2. Weak coordination between municipalities, business and the agricultural sector. 3. Lack of systematic digitalization of biomass flow monitoring. 4. Limited access of small businesses and communities to financing and expert support.
Opportunities (O) 1. Obtaining investments and grants within the framework of European programs. 2. Introduction of innovative digital management platforms. 3. Formation of partnership ecosystems involving the public community, business and the state. 4. Development of the market for ecological products and bioenergy.	Strategy "maxi-maxi": Using opportunities to enhance strengths O1→ S3 O2→ S2, S3 O3→ S3 O4→ S4	Strategy "maxi-mini": Preventing weaknesses while exploiting opportunities O1→ W2, W5 O2→ W3, W4 O3→ W1, W3, W5 O4→ W2, W5
Threats (T) 1. Market and logistics instability due to military operations. 2. Threat of environmental incidents due to lack of control. 3. Migration processes and reduction of labour resources in rural areas. 4. Lack of long-term strategic vision at the state level.	Strategy "mini -maxi": Using strengths to minimize threats S1, S5→ T1 S2, S3→ T2 S2, S4→ T3 S3, S5→ T4	Strategy "mini - mini": Use of protective strategies to minimize threats W1, W3→ T4 W3, W4→ T2 W2, W5→ T3 W1 → T4

The analysis of the biomass waste management sector in Ukraine confirmed that the availability of significant bioresources and the potential for developing modern processing technologies create a strategic basis for the accelerated growth of this segment of the economy. Simultaneously, the preservation of the fragmentation of the legislative framework, underdeveloped infrastructure, and insufficient integration of market participants remain constraining factors.

This prevents the realisation of the industry's full potential. The most promising opportunities are harmonising Ukrainian regulations with European standards, developing partnership ecosystems with the participation of the state, business, and the public, and implementing innovative digital solutions for monitoring and managing biomass flows. It is important to develop international investment and grant programs at the state level (Kalak, 2023).

This can compensate for the funding shortfall for social initiatives. To achieve an appropriate level of sustainable development in biomass waste management in Ukraine, it is advisable to implement an iterative approach to strategic planning, use systematic monitoring, and adapt modern EU practices to Ukrainian realities. The analysis of barriers and opportunities in the biomass processing management sector in Ukraine, presented in Table 4, indicates that regulatory, infrastructure, and personnel limitations significantly reduce the pace and efficiency of this area of activity management.

Thus, the state of the regulatory and legal framework does not allow for introducing clear "rules of the game" for social initiatives. This reduces the attractiveness of investments in such activities. Simultaneously, developing a system of expert and financial support focused on local communities and small businesses will provide additional opportunities for increasing environmental and economic performance in the long term. Special attention should be paid to the digitalisation of biowaste monitoring and management processes, can significantly increase community involvement and improve the quality of decision-making at all levels.

Table 4. Structural Barriers and Opportunities in Biomass Sector of Ukraine.

Structural Component	Barriers	Opportunities
Legal framework	Insufficient detail on biomass, fragmentation of standards	Harmonisation with EU directives, creation of specialized strategies
Infrastructure	Lack of a developed processing and logistics network in the regions	Implementation of modern technologies, development of local enterprises
Human and expert potential	Shortage of specialists, low level of specialised education	Educational programs, cooperation with universities, international exchange
Funding	Limited access to investment and credit, especially for SMEs and communities	Attracting grants, creation of state and regional support funds
Motivation and community involvement	Passivity of local initiatives, low level of awareness	Increasing participation through information campaigns and innovative partner ecosystems
Technology and digitalisation	Low level of digital management solutions, lack of monitoring	Integration of digital platforms, automation of process monitoring
Environmental control	Insufficient quality control of biowaste management	Harmonisation of national standards with European ones, multi-actor control

Opening access to international grants and creating multifunctional partnership platforms expands the horizons of integrating the Ukrainian biomass sector into the European and global contexts. It should be considered that for Ukrainian social enterprises, tools for expanding the domestic market familiar to European management (in particular, marketing segmentation or standardised financing schemes) often lose their relevance due to military or economic risks. Therefore, more attention needs to be paid to the permanent monitoring and analysis of the factors of the domestic market, dominant consumer trends in the consumption of biowaste products, and determining the directions of their changes. This can ensure the proper level of competitiveness of social projects, even under conditions of uncertainty (Geletukha et al., 2020).

It is also important for social enterprises in the biomass sector to introduce flexible organisational structures and use innovations not only in the processing process but also in the logistics process and permanent monitoring of all related areas of activity. Ultimately, the study's results confirm that the progressive development of social enterprises is possible only through a comprehensive response to unpredictable external influences, rapid reformatting of tools, and close integration of strategic planning and operational monitoring stages.

This determines their resilience and readiness to use new market opportunities. Table 5 shows the potential opportunities of social enterprises in the biomass sector in Ukraine (European Center for Not-for-Profit Law, 2021).

Table 5. Potential Opportunities for Social Enterprises in the Biomass Sector of Ukraine.

Type of Social Enterprise	Core Capabilities	Incentives & Resources	Conditions for Implementation
Agricultural Residue Processing	- Production of biogas, bioethanol, and compost. - Expansion of farmers' cooperative services.	- Government and international grants. - EU support programmes.	- Access to raw materials. - Partnerships with local farmers.
Green Energy Production	- Development of local biomass CHP plants. - Generation of clean electricity for communities.	- Green tariffs. - Tax incentives. - Investment in renewables.	- Energy market connectivity. - Tariff regulation.
Organic Waste Processing	- Compost and bio-soil production. - Fertiliser supply for smallholders and communities.	- Municipal composting schemes. - Support from local authorities.	- Separate waste collection. - Ongoing public education.
Eco-Education and Training	- Delivery of environmental training for youth. - Platforms for education and idea incubation.	- Partnerships with international donors. - National initiatives.	- Collaboration with educational institutions. - Expert involvement.
Social Cooperation Platforms	- Organisation of small-scale producers and processors. - Joint marketing and service delivery.	- Grants for cooperative models. - Support from business incubators.	- IT infrastructure. - Coordination via sectoral associations.
Urban Initiatives ("Urban Farms")	- Urban greenhouses, composting sites, and green zones. - Reduction in landfill pressure.	- City partnerships. - Urban development programmes.	- Access to urban land. - Cooperation with local authorities and businesses.
Digital Monitoring & Logistics	- Platforms for managing biomass flows. - Outsourcing logistics for enterprises and communities.	- Funding from tech incubators. - Government pilot programmes.	- Development team availability. - Integration with public/municipal data.

The analysis of opportunities for different types of social enterprises in Ukraine's biomass sector confirms that the market is characterised by a significant diversity of prospects depending on the profile, scale, and level of integration of organisations into regional or national ecosystems.

Across each segment, from renewable energy production and composting to digital services and educational initiatives, unique opportunities can be realised under rapid adaptation to market and regulatory environmental changes. Additional important drivers of the development of social entrepreneurship are state and municipal support programs, the availability of targeted grants and preferential investment, and the projected growth in demand for environmentally friendly products and energy.

6. Conclusions.

Significant multidimensional relationships between the policy of financing biowaste processing and social and environmental effects were confirmed. Thus, the correlation coefficient between biomass fuel consumption and the reduction of carbon dioxide emissions into the atmosphere is 0.985; between the installed capacity of bioenergy equipment and the number of additional jobs is 0.942; and between the volume of recovered biowaste and the level of employment in the industry is 0.978. Simultaneously, investments in biowaste processing have decreased by 15.6 times compared to 2015, resulting in a 3.8-fold reduction in the rate of employment growth in this industry and a 4.6% reduction in the proportion of biowaste utilisation. Therefore, the importance of social entrepreneurship in this area is increasing.

It has been established that local community involvement contributes to the growth of social effects. The use of European financial and technical support instruments that Ukrainian social entrepreneurs can adapt is proposed in this study. The institutional plan indicates the need for strategic interaction with European partners to scale up national social initiatives in the country. This indicates that social entrepreneurship is a significant tool for introducing a circular economy in Ukraine.

The analysis indicated the uneven development of the biomass waste management sector by region, form of organisation, and activity model. The reasons for this state of the industry are identified in this study. At the same time, significant volumes of unused bioresources are indicated, which allows for the prediction of the deployment of new, inclusive, and sustainable ecosystems.

The EU experience is analysed through the introduced organisational forms, models, and financial instruments for supporting social initiatives in biowaste utilisation. Adapting this experience to Ukrainian conditions will increase employment opportunities, reduce the burden on the environment, and accelerate the introduction of innovative technologies. Obstacles to this are identified in this study. In particular, the lack of a separate legal status for social enterprises, the lack of infrastructure for both processing and logistics of biowaste, limited access to financial support, and the lack of awareness among local communities about the possibilities of such activities were indicated. In this regard, recommendations for sector development policy should be aimed at forming legislative and programmatic mechanisms to support social entrepreneurship in biomass use and its management.

REFERENCES

Al-Obadi, M., Ayad, H., Pokharel, S., & Ayari, M. A. (2022). Perspectives on food waste management: Prevention and social innovations. Sustainable Production and Consumption, 31, 190–208. https://doi.org/10.1016/j.spc.2022.02.012

Andersson, M., Ljunggren Söderman, M., & Sandén, B. A. (2019). Adoption of systemic and socio-technical perspectives in waste management, WEEE and ELV research. *Sustainability,* 11(6), 1677. https://doi.org/10.3390/su11061677

Bahrololoum, S., Kermani, M. M. M., & Koohzadi, F. (2022). Ecopreneurs and agricultural waste management. Journal of Global Entrepreneurship Research, 12(1), 47-51. https://doi.org/10.1007/s40497-022-00311-7

Bioenergy Association of Ukraine. (2025). Prospects for the development of the biomass market in the EU and Ukraine. https://uspp.ua/assets/doc/uspp-biomass.pdf

EU4Youth. (2020). Social entrepreneurship in Ukraine: economic and legal analysis. EU NEIGHBOURS east. https://euneighbourseast.eu/news/publications/social-entrepreneurship-in-ukraine-economic-and-legal-analysis/

European Biogas Association (2024). Statistical Report: 2024 European Overview. https://www.europeanbiogas.eu

European Center for Not-for-Profit Law (2021). Promoting Social Entrepreneurship in Ukraine. https://ecnl.org/

European Commission. (2019). The European Green Deal. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

European Commission. (2024). Circular economy strategy. https://research-and-innovation.ec.europa.eu/research-area/environment/circular-economy/circular-economy-strategy_en

European Compost Network. (2024). Compost Citoyen. https://www.compostnetwork.info

European Environmental Bureau. (2024). Circular Economy. https://eeb.org/work-areas/circular-economy/circular-economy

European Regions Research and Innovation Network (2025). Year in review 2024. https://errin.eu/system/files/2025-02/ERRIN%20Year%20in%20review%202024_2.pdf

Geletukha, G., Zheliezna, T., Matveev, Y., Kucheruk, P., & Kramar, V. (2020). Roadmap for bioenergy development in Ukraine until 2050. UABIO Position Paper № 26 — Kyiv: Bioenergy Association of Ukraine. https://uabio.org/wp-content/uploads/2020/11/uabio-position-paper-26-en.pdf

Harfadli, M. M., Ulimaz, M., Ramadan, B. S., Rachman, I. & Matsumoto, T. (2025). Understanding the informal waste sector for sustainable waste management using the pressure-state-response framework: a case study in Balikpapan, Indonesia. Journal of Material Cycles and Waste Management, 27, 761–776. https://doi.org/10.1007/s10163-024-02079-2

Hondroyiannis, G., Sardianou, E., Nikou, V., Evangelinos, K., & Nikolaou, I. (2024). Waste generation and macroeconomic drivers: a panel study for European countries and regions. Management of Environmental Quality, 35(5), 1118–1136. https://doi.org/10.1108/meq-08-2023-0297

Interreg Central Europe. (2025). RREUSE. Social and Circular Outlook 2020–2025. https://programme2014-20.interreg-central.eu/Content.Node/SURFACE/Circular-Outlook.html

Kalak, T. (2023). Potential Use of Industrial Biomass Waste as a Sustainable Energy Source in the Future. Energies, 16(4), 1783. https://doi.org/10.3390/en16041783

Karbovska, L., Mazur, J., Zhelezniak, K., Kozlova, A., Melnyk, B., & Skryptsov, S. (2024). Formation of the waste management system in the agricultural sector of the economy of Ukraine: organizational and financial aspects. Financial and Credit Activity Problems of Theory and Practice, 5(58), 367–379. https://doi.org/10.55643/fcaptp.5.58.2024.4462

Mirzoieva, T., Tkach, N., Nitsenko, V., Gerasymchuk, N., Tomashevska, O., & Nechyporenko, O. (2022). Development of the correlation model between biogas yield and types of organic mass and analysis of its key factors. C – Journal of Carbon Research, 8(4), 73. https://doi.org/10.3390/c8040073

Mitzinneck, B. C., & Besharov, M. L. (2019). Managing value tensions in collective social entrepreneurship: The role of temporal, structural, and collaborative compromise. Journal of Business Ethics, 159(2), 381-400. https://doi.org/10.1007/s10551-018-4048-2

Nefco. (2021). Opportunities for utilisation of biomass residues in the renewable sector in Ukraine. https://www.nefco.int/wp-content/uploads/2021/03/Finland-Ukraine-TF_Fact-sheet-Utilisation-of-biomass-residues-with-Annexes.pdf

Rahman, A. (2025). Exploring the role of social enterprises in a just transition to the circular economy: A case study of waste management and recycling sector in Indonesia. Open Research Europe, 5(111), 111. https://doi.org/10.12688/openreseurope.19485.1

SALAR International. (2024). WM4U - Waste Management for Ukraine (2024–2027). https://salarinternational.se/salar/whatwedo/allprojects/projects/wm4uwastemanagementforukraine20242027.78433.html

Santander, P., Sanchez, F. A. C., Boudaoud, H., & Camargo, M. (2022). Social, political, and technological dimensions of the sustainability evaluation of a recycling network. A literature review. Cleaner engineering and technology, 6, 100397. https://doi.org/10.1016/j.clet.2022.100397

Schipfer, F., Pfeiffer, A., & Hoefnagels, R. (2022). Strategies for the mobilization and deployment of local low-value, heterogeneous biomass resources for a circular bioeconomy. Energies, 15(2), 433. https://doi.org/10.3390/en15020433

State Statistics Service of Ukraine. (2025). Capital investments on environmental protection, by type of economic activity and environmental domain. https://www.ukrstat.gov.ua/

Yosep, Y., Mulkhan, U., Hasanudin, U., & Iryani, D. A. (2024). Unleashing the Sustainable Transition of Circular Economy: A Case Study of SMEs Tapioca Industry in Lampung, Indonesia. Circular Economy and Sustainability, 4(4), 3119-3138. https://doi.org/10.1007/s43615-024-00358-6

Zajemska, M., Korombel, A., & Ławińska, O. (2024). Risk Factors for Poland to Achieve the European Commission's Recycling and Landfill Targets and Their Effects on Waste-to-Energy Conversion: A Review. Energies, 17(5), 1171. https://doi.org/10.3390/en17051171

Zięty, J. J., Olba-Zięty, E., Stolarski, M. J., Krzykowski, M., & Krzyżaniak, M. (2022). Legal Framework for the Sustainable Production of Short Rotation Coppice Biomass for Bioeconomy and Bioenergy. Energies, 15, 1370. https://doi.org/10.3390/en15041370