

Marketing Tools to Support the Development of Bioenergy as a Factor in the Energy Sustainability of Local Communities During Martial Law

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Abstract: The article theoretically substantiates the role of marketing tools as a fundamental factor in ensuring the energy sustainability of local communities under martial law. It is proved that the traditional marketing concept is being transformed into a security management system, where the key elements of the value proposition are "energy viability" and the autonomy of territories. The study systematizes marketing tools by category (informational, communicative, incentivizing, digital) and develops a step-by-step algorithm for marketing support of bioenergy projects - from resource auditing to the branding of "energy safety zones." Particular attention is paid to leveling investment barriers through the synergy of the intellectual capital of agribusiness and predictive analytics based on machine learning. A strategy of "economic patriotism" is proposed to localize added value within communities. Unlike previous studies, this paper provides a critical analysis of risks, including financial capital intensity and the logistical vulnerability of biomass supply chains during the war. The authors substantiate the transition from commercial sales to strategic demand management for renewable resources. The proposed methodological approach allows communities not only to meet critical needs for heat and electricity during crises but also to create investment attractiveness for international donors through transparent digital monitoring platforms. The results confirm that marketing support acts as an integrating link that transforms the technological potential of bioenergy into a real asset of national security.

1 INTRODUCTION

In the context of ongoing martial law and the deliberate destruction of Ukraine's critical infrastructure, the issue of ensuring the energy security of territorial communities has become strategically important. The traditional model of centralized energy supply has demonstrated high vulnerability to external attacks, which has led to an urgent need to transition to distributed (decentralized) generation. In this context, bioenergy, based on the use of local renewable resources, emerges as a key factor in strengthening the energy sustainability of communities capable of functioning autonomously.

Previous studies show that the formation of a mutually beneficial model of interaction between energy cooperatives and intermediary entities will

make it possible to: - maximize profits and the scale of biofuel production; - ensure partial energy independence for households; - create additional jobs; - in rural areas; - give impetus to the production of domestic equipment for processing agricultural waste into solid biofuel [1].

At the same time, it is necessary to develop international cooperation in the field of biofuel production. After all, research shows that ten years after its launch, the Belt and Road Initiative has become a globally recognized public good and an important platform for international cooperation. Within the framework of the initiative, more than 3,000 projects have been created in the fields of transport and communications, electric power, oil and gas, coal, and alternative energy. These projects have attracted large-scale investments totaling more than \$1 trillion [2].

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The model developed by O. Kucher provides for the identification of priorities for bioeconomic development, such as eco-innovation, ecological development, ecological agriculture, renewable energy, environmentally friendly production technologies, and biotechnology [3].

We agree that in the post-war recovery strategy, the key areas of research are the adaptation of production to the requirements of the bioeconomy, the introduction of environmental technologies, and the development of effective and economically viable sales channels [4].

Previous studies have substantiated the need to develop biogas and digestate production at Ukrainian sugar factories, focused on the further sale of biomethane on the energy market and for their own needs, which will partially ensure the energy security of the state in conditions of martial law [5].

Research by individual scientists shows that Ukraine can use about 11-12 million hectares of arable land to grow energy crops for subsequent processing into biofuel [6].

As a result of research by Kaletnik G.M., it was established that the application of organic fertilizers can have a positive effect on soil restoration, since soil acidity changed from slightly acidic (5.4 pH) to close to neutral (6 pH) within one year of its application [7]-[8].

At the same time, domestic scientists have determined that the use of biogas plants is a promising means of solving waste disposal problems, improving the ecological situation, reducing energy dependence, and increasing soil fertility [9].

At the same time, previous studies have determined that the main aspect of the effectiveness of marketing tools in bioenergy is the development of the human and technological potential of agribusiness entities. Intellectual capital is a fundamental factor in the digitalization of agricultural enterprises, allowing them not only to implement innovations but also to effectively adapt to the requirements of the digital economy [10].

In the context of developing bioenergy in local communities, this means that the success of a marketing strategy directly depends on the ability of local specialists to operate with digital data, use GIS technologies to monitor biological resources, and create added value through intelligent management of energy hubs. Thus, the synergy of marketing communications and accumulated intellectual capital in the agricultural sector becomes a catalyst for energy transformation and strengthening the sustainability of communities.

In the context of forming sustainable energy systems for local communities, the introduction of intelligent decision-making support tools is of particular importance. As Al Shemarry notes, the use of predictive analytics based on machine learning is a critical factor in ensuring the sustainability of investments in renewable energy, as it minimizes risks and optimizes resource allocation in the long term [11].

Thus, the development of alternative energy and biomass as a resource for the agro-industrial complex is actively being researched by contemporary economists. However, in wartime, there is a need to rethink not only the technical aspects but also the marketing support for this industry. Today, bioenergy marketing cannot be limited to commercial sales alone; it must be transformed into a complex system of demand management, stakeholder trust building, and promotion of the ideas of "energy autonomy" as a core security value.

In view of the above, the aim of the study was to theoretically substantiate and systematize marketing tools that contribute to the development of the bioenergy sector as the foundation of energy sustainability in local communities. Particular attention is paid to the integration of marketing activities with state incentive mechanisms and the specifics of involving various stakeholder groups in conditions of economic crisis.

2 MARKETING SUPPORT TOOLS FOR BIOENERGY PROJECTS AS A BASIS FOR ENERGY AUTONOMY AND SUSTAINABILITY OF LOCAL COMMUNITIES

For the successful development of the alternative energy market, it is necessary to implement differentiated marketing strategies for different stakeholder groups: private households (prosumers), industrial enterprises, and local communities. Each segment requires specific tools - from financial consulting and calculating the payback period of investments to promoting the idea of energy autonomy for communities.

Modern marketing support involves the active use of digital platforms to monitor energy consumption and personalize services, which increases customer loyalty. Building a strong "green" brand for an energy supplier is becoming a critical factor in competitiveness, as intangible assets such as the reputation of an environmentally responsible company directly affect market share and investment attraction.

Marketing support for the industry must be integrated with government policy to promote renewable energy sources, creating a favorable information environment for foreign and domestic investors. Only through the synergy of marketing tools and government guarantees is it possible to

ensure the large-scale implementation of innovative technologies and achieve the goals of sustainable development of Ukraine's energy system.

It should be noted that marketing support is not a separate process, but works in close connection with state policy and the technological potential of the agro-industrial complex. Only the combination of economic incentives (loans, grants) with marketing tools (brand, communications, digital) creates the necessary conditions for achieving the strategic goal of sustainable development of Ukraine's energy system (Table 1).

Summarizing the research, it can be argued that the development of alternative energy, in particular the bioenergy sector, is a strategic priority for ensuring Ukraine's energy independence and environmental security. Using the significant potential of the agro-industrial complex for biofuel production allows not only to meet domestic market needs, but also to create a powerful export potential. However, the successful realization of this potential is impossible without comprehensive marketing support, which must be transformed from a simple sales tool into a comprehensive system of strategic demand management and the formation of environmental awareness in society.

The development of bioenergy in conditions of martial law has become not just an environmental trend for Ukrainian territorial communities (TC), but a strategic issue of survival and energy security. Marketing tools in this context are aimed at two key audiences: external investors/donors and internal stakeholders (local businesses, households) (Table 2).

Table 1: Systematization of marketing support for the development of alternative energy.

System component	Content and strategic focus	Expected result
Object basis (Bioenergy)	Utilization of the potential of the agro-industrial complex for the production of biofuels and gas oils; biomass processing.	Energy independence, creation of export potential, greening of energy.
State incentives	Funding for R&D, compensation for interest on loans, support for energy cooperatives.	Lowering financial barriers to market entry, developing innovative technologies.
Marketing concept	Transition to social and ethical marketing; shift in focus from price to environmental value.	Building high consumer loyalty and a new culture of energy consumption.
Communication strategy	Explaining the long-term benefits, overcoming psychological barriers and myths about RES.	Increasing demand for green energy among the population and businesses.
Stakeholder segmentation	A differentiated approach: households (prosumers), TG, industrial enterprises.	Personalization of offers and improving the effectiveness of interaction with each sector.
Digitalization tools	Use of digital platforms to monitor and manage consumption.	Operational management efficiency, market transparency, and improved service quality.
Brand management	Building a strong "green" brand for companies and capitalizing on reputation.	Attracting foreign investment, increasing competitiveness in the EU market.

Table 2: Systematization of marketing tools for the development of bioenergy in TC.

Category of tools	Specific marketing tools	Target audience	Role in ensuring sustainability
Information and analytical	Biomass investment atlases, GIS resource maps (agricultural waste, logging areas).	External investors, biomethane developers.	Transparency of resources allows for the rapid deployment of autonomous energy sources.
Communication	PR campaigns on energy independence, storytelling of successful cases in the media and social networks.	Local population, relocated businesses.	Building trust in alternative sources; reducing panic during blackouts.
Incentives (B2B/B2G)	Demonstration projects (showrooms), energy service contracts (ESCO), workshops for farmers.	Local farmers, municipal enterprises.	Creation of a closed cycle: "local raw materials - local heat," which does not depend on imports.
Branding	Territorial marketing: creating the image of a "Green Community" or "Eco-Safe Zone."	Donors (USAID, GIZ), international funds.	Increasing the chances of obtaining grants for cogeneration plants and bioboilers.
Digital (E-tools)	Energy monitoring platforms, online marketplaces for community biofuels.	Suppliers and consumers of raw materials (pellets, wood chips).	Efficient distribution of resources in real time in the event of network damage.
Social cooperatives	Energy cooperatives, crowdfunding platforms for local projects.	Community residents, microbusinesses.	Attracting domestic investment; social cohesion of the community around common security.

In the marketing communications system, the concept of decentralization is positioned as a transition from a vulnerable hierarchical energy supply structure to a sustainable network model. The main argument is the high degree of survivability of the energy infrastructure: unlike centralized thermal power plants (TPP), which are critically vulnerable to point kinetic attacks, a decentralized network of local biofuel boilers minimizes the risks of systemic collapse. This approach ensures territorial diversification of risks, where the failure of individual generation units does not lead to the loss of viability of the entire community's energy system.

In our opinion, it is advisable for local communities to use the marketing strategy of "economic patriotism" based on the concept of localizing added value and the principles of a circular (closed) economy. Instead of financial capital flowing out of the territorial unit to external monopoly suppliers of fossil fuels, the community keeps funds within its own gross domestic product. This stimulates the development of the local labor market through the creation of jobs in the biomass harvesting and processing sectors, ensures stable tax revenues to the local budget, and multiplies the economic self-sufficiency of the territory.

The marketing strategy of "economic patriotism" in the context of bioenergy and the development of territorial communities is a targeted

set of measures based on the priority promotion of local energy resources and the involvement of internal stakeholders to create a closed cycle of energy production and consumption within a specific territory. The use of marketing tools to promote technological adaptability requires the system to be able to respond quickly to changes in external factors by diversifying the fuel base. In scientific terms, this means creating multi-fuel energy hubs that can be quickly reconfigured depending on the seasonal availability of agro-industrial waste, logging residues, or energy crops. This strategy allows the community to mitigate logistical threats and market price volatility, ensuring uninterrupted energy supply through dynamic management of local bioresources.

Therefore, the effectiveness of marketing tools in a state of martial law directly depends on a radical transformation of the value proposition, where the main focus shifts from long-term environmental benefits and the global "green transition" to critically important aspects of physical and social security, such as ensuring "guaranteed heat" and "energy resilience" of territories.

The implementation of marketing support in local communities should be carried out according to a clearly defined algorithm that ensures a consistent transition from comprehensive analysis to the sustainable functioning of the energy system (Table 3).

Table 3: Algorithm for marketing support for the implementation of bioenergy projects in local communities.

Algorithm stage	Marketing activities and tools	Contribution to community sustainability
1. Resource audit and market analysis	Inventory of biological resources (forestry, agricultural waste), consumer segmentation, SWOT analysis of the energy system.	Determination of the real potential for autonomy and the most vulnerable points of energy supply.
2. Development of an anti-crisis value proposition	Focusing messages on "guaranteed heat," "safety," and "energy independence" instead of general greening.	Building psychological readiness among stakeholders to invest in local generation.
3. Communication campaign and stakeholder engagement	Workshops for farmers, PR support for successful cases, explanatory work with the population (prosumers).	Minimization of social resistance, community cohesion, and stimulation of local business.
4. Branding and fundraising	Creation of a community investment passport, positioning TC as an "Energy Safe Zone" for donors.	Attracting grants and external investments for the purchase of cogeneration plants.
5. Monitoring and adjustment	Digital platforms for consumption accounting, feedback collection, and economic efficiency analysis (ROI).	Operational management of energy balance and proof of model effectiveness for scaling.

The first stage of this process is to conduct a marketing audit of resources, which involves a thorough inventory of available biomass, in particular agro-industrial waste and forest resources, in parallel with detailed mapping of the energy needs of critical community infrastructure facilities.

The next link in the algorithm covers anti-crisis communication management, aimed at forming a sustainable understanding among key stakeholders of bioenergy as an indispensable tool for survival in crisis conditions, allowing marketing to address psychological barriers and create incentives for a gradual transition to local fuels.

The logical conclusion of the algorithm is the implementation of a 'territory of sustainability' branding strategy, which involves positioning the community as an energy-independent and secure cluster. Within this framework, the monitoring stage (Stage 5) utilizes predictive models to forecast biomass yield and seasonal energy demand, allowing the community to adjust its marketing incentives in real-time. This becomes a decisive marketing argument for attracting international donor funds, investment, and support for relocated businesses, strengthening the overall economic and energy capacity of the community.

It should be emphasized that the practical implementation of the above-mentioned tools allows for a multiplier economic effect: each unit of investment in local bioenergy generates additional tax revenues and stimulates the development of related

industries (logistics, technical services, equipment trade).

However, the successful implementation of marketing strategies in TG faces a number of specific barriers, in particular the high capital intensity of projects and security risks. That is why marketing tools should be supplemented with mechanisms of state and international investment insurance, which will lower the entry threshold for private capital.

Only through a comprehensive combination of community communication efforts, digital demand management, and financial guarantees from the state is it possible to transform the potential of the agro-industrial complex into a real factor of national security. Thus, marketing support acts not only as a means of promotion, but also as an integrating link that transforms the technological capabilities of bioenergy into a strategic asset for the sustainability of each individual community and the state as a whole.

Systematizing the barriers to the development of bioenergy and the corresponding marketing tools leads to the conclusion that, in conditions of martial law, marketing support is transformed from an auxiliary sales tool into a strategic security management mechanism. In particular, overcoming financial and investment barriers and high security risks is achieved through fundraising marketing and the active promotion of international insurance mechanisms, which allows external capital to be attracted even in crisis conditions (Table 4).

Table 4: Systematization of barriers to the development of bioenergy in TG and marketing tools to overcome them.

Type of barrier	Content and sources of risk	Marketing tools for overcoming	Expected outcome for energy sustainability
Financial and investment	High capital expenditures (CAPEX), budget deficits, high military risks for private capital.	Fundraising marketing: development of investment proposals for donors, marketing of war risk insurance mechanisms (MIGA, DFC).	Attracting external capital and grants for the purchase of cogeneration plants.
Raw materials and logistics	Instability of biomass supply chains, dependence on the seasonality of the agro-industrial complex, limited access to logging sites.	B2B marketing of long-term contracts: creation of digital marketplaces for community biofuels, logistics marketing of territories.	Guaranteed uninterrupted supply of raw materials for local boiler rooms.
Technological and human resources	Lack of specialists in the operation of bioenergy systems, low awareness of modern processing technologies.	Knowledge marketing (education-based marketing): workshops, training, intellectual capital development [Bondarenko et al., 2026].	Formation of an expert environment to support the operability of energy nodes.
Infrastructure	Worn-out heating networks, technical complexity of connecting local capacities to the general system.	Marketing of energy services (ESCO): involvement of professional operators in network modernization through public-private partnerships.	Technical readiness of the community to accept autonomous generation.
Socio-psychological	Conservatism of the population, distrust of alternative energy sources, myths about the low calorific value of biofuels.	Social and ethical marketing: storytelling of successful cases, visualization of autonomy as a factor of security during blackouts.	Change in consumer model and community support for the transition to biofuel.

Despite the high potential of marketing tools, their effectiveness is limited by a number of critical factors. High initial capital expenditures (CAPEX) for bioenergy equipment remain a major barrier for small communities. Furthermore, in the context of martial law, there is a risk of physical destruction of bioenergy infrastructure, which requires the inclusion of 'security of investment' as a primary element in the marketing communication strategy.

At the same time, raw material and logistical vulnerability is offset by the introduction of B2B marketing of long-term contracts and the creation of digital biofuel marketplaces, which ensures the stability of resource supplies from logging sites and the agro-industrial complex. Knowledge marketing aimed at developing intellectual capital is also important, which, together with social and ethical marketing, allows overcoming technological conservatism and forming a new culture of energy consumption in the community, where bioenergy is perceived as a guarantor of physical security and autonomy.

3 CONCLUSIONS

The study allows us to conclude that, in conditions of martial law, the marketing tools used to support

bioenergy are transforming from an auxiliary means of promotion into a strategic basis for the energy and economic stability of local communities. It has been established that the key factor in the success of bioenergy projects is a radical transformation of the value proposition - shifting the focus from environmental benefits to ensuring physical security, autonomy, and "energy viability" of territories.

Based on the systematization of marketing support, it has been determined that only a combination of differentiated strategies for different stakeholder groups with a step-by-step implementation algorithm (from resource auditing to "Energy Safe Zone" branding) allows communities to effectively convert the potential of the agro-industrial complex and forest areas into real energy resources. It has been substantiated that the application of the concepts of 'economic patriotism' and decentralization through a distributed network of biofuel boilers can significantly mitigate the risks of systemic infrastructure collapse as a result of military attacks.

Overcoming investment and technological barriers plays a special role in ensuring sustainability. The use of knowledge marketing to develop the intellectual capital of enterprises in synergy with predictive analytics tools based on machine learning creates a digital foundation for making informed

decisions and attracting international donors. Marketing support through fundraising and war risk insurance is critical to mitigating high levels of uncertainty.

Thus, the integrated use of marketing tools provides a framework for local communities to meet critical energy needs during the war, but also to lay the groundwork for post-war recovery based on the principles of the circular economy and technological independence.

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