

4.3. DEVELOPMENT OF ENTREPRENEURIAL COMPETENCE OF FUTURE SPECIALISTS IN THE ENERGY SECTOR OF UKRAINE

Liudmyla Yershova

Doctor of Pedagogical Sciences, Professor,
Deputy Director for Research and
Experimental Work of the Institute of
Vocational Education of the
NAES of Ukraine,
<https://orcid.org/0000-0002-2346-5842>
yershova67@ukr.net

Volodymyr Artyushenko

Director of the educational and
methodological center of vocational
education in Luhansk region, Postgraduate
student of the Institute of Vocational
Education of the NAES of Ukraine,
<https://orcid.org/0009-0003-1897-8701>
artyushenko.volodymyr@gmail.com

The article addresses the issue of forming entrepreneurial competence among future specialists in the energy sector of Ukraine's economy, with a particular focus on renewable energy sources, in the context of strategic transformations within the national energy industry and the urgent needs of the labor market. It analyzes the regulatory, legal, and methodological framework, as well as innovative educational initiatives aimed at training qualified professionals. Special attention is given to examining the structural components of entrepreneurial competence of future renewable energy specialists through the lens of professional and educational standards. The article proposes scientifically grounded methodological recommendations for enhancing the preparation of specialists in alternative energy sources for entrepreneurial activities.

4.3. РОЗВИТОК ПІДПРИЄМНИЦЬКОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ ФАХІВЦІВ ЕНЕРГЕТИЧНОГО СЕКТОРУ ЕКОНОМІКИ УКРАЇНИ

Людмила Єршова

доктор педагогічних наук, професор,
заступник директора з науково-
експериментальної роботи
Інституту професійної освіти
НАПН України,
<https://orcid.org/0000-0002-2346-5842>
yershova67@ukr.net

Володимир Артюшенко

директор навчально-методичного
центру професійно-технічної освіти у
Луганській області, аспірант
Інституту професійної освіти
НАПН України,
<https://orcid.org/0009-0003-1897-8701>
artyushenko.volodymyr@gmail.com

У статті в контексті стратегічних трансформацій вітчизняної енергетичної галузі й загальних потреб ринку праці розкрито проблему формування підприємницької компетентності майбутніх фахівців енергетичного сектору економіки України, зокрема, у сфері відновлювальних джерел енергії. Проаналізовано нормативно-правове й методологічне забезпечення, інноваційні освітні ініціативи з підготовки кваліфікованих робітників. Особливу увагу приділено вивченню структурних компонентів підприємницької компетентності майбутніх фахівців з відновлювальної енергетики крізь призму професійних та освітніх стандартів. Запропоновано науково-методичні рекомендації щодо вдосконалення підготовки фахівців з альтернативних джерел енергії до підприємницької діяльності.

Keywords: *entrepreneurial competence, renewable energy, alternative energy sources, professional education, educational process, structure of entrepreneurial competence.*

Ключові слова: *підприємницька компетентність, відновлювальна енергетика, альтернативні джерела енергії, професійна освіта, освітній процес, структура підприємницької компетентності.*

Energy security is a key component of national security for every state, particularly when a country has limited domestic energy resources and relies on imported energy carriers. In this context, energy policy transcends being merely a sectoral strategy and becomes a fundamental condition for the sovereign existence and development of the state. Leading global powers identify renewable energy as a top priority in their energy strategies. This approach enables the simultaneous resolution of a wide range of strategic issues: enhancing energy independence, reducing the environmental impact of energy production, preserving fossil fuel reserves for future generations, and utilizing these resources more rationally in non-energy industrial sectors. The multifaceted nature of renewable energy development demands a comprehensive approach to addressing these challenges (Kudria, 2024).

The European Union exemplifies the most systematic and innovative approach to shaping energy policy. This policy rests on three core principles: ensuring reliable energy supply, maintaining affordable prices for consumers, and mitigating environmental harm through the advancement of renewable energy. The experience of European countries demonstrates that transitioning to renewable energy sources is not solely a matter of implementing energy-efficient technologies. "Green energy" is gradually evolving into a robust economic sector that successfully competes with traditional forms of power generation, such as coal, oil and gas, and nuclear power plants.

Ukraine's energy sector is undergoing a period of profound transformation. On one hand, the industry is experiencing technological modernization, the adoption of cutting-edge energy technologies, and integration into the European energy framework. On the other hand, it faces significant challenges: ensuring energy security, restoring infrastructure damaged by military actions or shelling, improving energy efficiency, and pursuing decarbonization in line with global sustainable development trends.

According to the Office for Investment Attraction and Support, UkraineInvest (2024), prior to the full-scale invasion, the total capacity of renewable energy sources (RES) in Ukraine reached 9.9 GW. By early 2024,

despite ongoing hostilities, RES capacity stood at 8.7 GW. Notwithstanding the challenging wartime conditions, the sector continues to grow: in 2023 alone, over 1,400 new renewable energy facilities were connected to the national grid. During this period, 182.3 MW of wind power plants and approximately 500 MW of solar power plants were commissioned. Investment activity also remains significant – Ukrainian businesses invested around USD 150 million in solar energy development in 2023. Additionally, since 2009, the "Green Tariff" has been in place, incentivizing private owners to install their own electricity-generating capacities and sell surplus power to the state. Private companies are able to deploy alternative energy sources such as solar panels, wind turbines, and small hydropower plants, thereby contributing to the sustainable development of Ukraine's energy sector.

The current development of renewable energy is guided by strategic priorities outlined in the "Concept of Ukraine's 'Green' Energy Transition to 2050," which aims to increase the share of RES to 70% of the country's energy mix by 2050, aligning with European climate goals. The concept encompasses phasing out coal-based generation, transitioning to a circular economy, limiting the share of nuclear energy, and integrating into the European energy space (Vseukrayinska enerhetychna Asambleya, 2020).

Meanwhile, as noted in a Forbes Ukraine study (2024), following the destruction of all major thermal power plants (TPPs) and hydroelectric power plants (HPPs) due to war crimes committed by the Russian Federation, renewable energy has shifted from a promising prospect to a strategic priority for energy security. Ukraine's national system operator, Ukrenergo, is developing a model for the future energy system based predominantly on renewable energy sources. This strategy sets ambitious targets: a fivefold increase in wind power capacity, a fourfold expansion of biofuel-based TPPs, a 60% boost in solar generation, and the establishment of 0.8 GW of energy storage systems within the next 2–3 years.

The rapid development of renewable energy in Ukraine, accompanied by an increase in production capacities and the introduction of related technologies (such as energy storage systems and balancing capacities), has created an urgent need for qualified personnel. The country requires a comprehensive system for training specialists across various fields and professions: from engineering and technical staff to skilled technicians in installation and maintenance, equipped with knowledge of energy management principles. Studies indicate that between 2016 and 2021, there

was a significant rise in job opportunities for non-traditional "green" professions: sustainable development managers (+30%), wind turbine technicians (+24%), solar energy consultants (+23%), and ecologists (+22%). These shifts reflect a fundamental transformation of the labor market within the energy sector (Semyhina & Markevych, 2022). Experts particularly value entrepreneurial skills in future professionals in this field, driven by the unique nature of renewable energy, which offers distinct opportunities for innovation and startups. The modern energy sector demands specialists capable not only of addressing technical challenges but also of identifying market opportunities, developing business models, and efficiently managing resources.

An analysis of the source base concerning the formation of entrepreneurial competence among future energy sector specialists related to alternative energy sources reveals considerable interest in this topic within the scientific community. The issue of preparing young people for entrepreneurial activities is increasingly addressed in the works of domestic and international researchers, regularly discussed at scientific events of various levels, and reflected in regulatory and legal documents governing the education sector. The theoretical and methodological foundations for developing entrepreneurial competence have been elaborated in studies by S. Alekseieva (2020), L. Bazyl (2021), V. Baydulin (2022), I. Hrytsenok (2024), L. Yershova (2024), D. Zakatnov (2024), V. Orlov (2022), and N. Vanina (2024). These researchers have substantiated the essence of entrepreneurial competence, defined its structure, and proposed approaches to its development within the professional education system.

Of particular significance to this study are scientific investigations into the didactic and methodological foundations of integrating an entrepreneurial component into the educational process (Alekseeva & Yershova, 2020; Bazyl & Orlov, 2023). The importance of these contributions lies in their combination of a theoretical justification for the need to foster entrepreneurial competence with the development of practical mechanisms for its implementation within vocational (technical-vocational) education institutions. Scholars have substantiated a set of pedagogical technologies and methods that facilitate the development of entrepreneurial thinking within the context of professional training. The methodological approaches proposed by these authors, which include diagnostic tools, techniques for developing business skills, and criteria for evaluating outcomes, are particularly valuable and can be adapted to the specifics of the

energy sector to create a comprehensive model for fostering entrepreneurial competence among future specialists in the field.

An analysis of the energy segment of the national economy as an environment for the professional activities of future specialists in alternative energy sources confirms that its transformation (market liberalization, decentralization of energy systems, and the growth of renewable energy sources) significantly alters the requirements for professional training. Industry experts emphasize the increasing demand for professionals who can not only effectively address technical tasks but also demonstrate entrepreneurial initiative, assess the economic feasibility of technological solutions, and develop and implement innovative projects in the energy sector (Ukrainian Clean Generation, 2023).

At the same time, an analysis of scientific sources reveals a significant gap in the study of the specifics of entrepreneurial skills among graduates of vocational (technical-vocational) education institutions whose professional activities will be directly linked to renewable energy sources. This issue gains particular importance in the context of the demonopolization of Ukraine's energy market, which creates new opportunities for small and medium-sized enterprises in the sector. The rapid development of technologies that enable consumers to simultaneously act as electricity producers – a hallmark of "green" energy – fundamentally alters the structure of the energy sector and fosters the emergence of innovative business models. An additional factor highlighting the urgency of this issue is the growing international funding for energy efficiency and renewable energy projects, tied to the restoration processes of the country's energy system, which was devastated by Russian aggression. This demands specialists capable of developing investment proposals and effectively managing such projects. Another key trend is the servitization of the energy sector, which requires professionals to possess advanced customer-oriented skills and marketing acumen. Consequently, there is a need to refine the structure of entrepreneurial competence for energy specialists, taking into account the sector's specific characteristics. The methods for integrating an entrepreneurial component into the professional training of energy specialists, aligned with industry trends and labor market demands, remain insufficiently explored. There is also a lack of comprehensive pedagogical technologies aimed at fostering entrepreneurial competence that consider the profile of professional activities related to alternative energy sources.

The purpose of this study is to conduct a detailed analysis of the current state and development trends of renewable energy in Ukraine, identify professional and qualification challenges within the energy sector associated with alternative energy sources, provide a theoretical and methodological substantiation of the process of forming entrepreneurial competence in future skilled workers, taking into account strategic transformations in the domestic energy industry and current labor market needs, and address the development of its structural components in line with modern regulatory and methodological frameworks.

To achieve this objective, a range of methods were employed, including: theoretical analysis, which involves a critical review of regulatory and legal documents and a systematic study of scientific sources to identify conceptual approaches to the professional training of future energy sector specialists and the formation of their entrepreneurial competence; praximetric methods, aimed at diagnosing progressive pedagogical practices through a thorough analysis of educational and training programs for specialists, as well as innovative methodological strategies and approaches to developing entrepreneurial competence; and methods of generalization and forecasting, applied to systematize positive experiences, diagnose problematic aspects of training, and develop strategic recommendations for improving educational practices and initiatives in the field of vocational education for specialists in alternative energy sources.

The current state of business education in Ukraine reveals a structural mismatch between the theoretical content of educational programs and the practical competencies demanded by the energy market, particularly in the context of renewable energy sources. The depth of this issue is substantiated by statistical data and expert assessments of the training of specialists for the energy sector. Today, Ukraine has a unique opportunity to build a more efficient, environmentally friendly, reliable, and competitive energy system, to implement European regulations and policies, and to create conditions for significantly improving energy efficiency. However, achieving this goal is hindered by a shortage of qualified personnel. According to expert studies (UN Global Compact Network in Ukraine, 2022), 97% of energy companies acknowledge the existence of a "specialty crisis" in the energy sector. Demand is particularly growing for specialists in electrical engineering, electrotechnics, electromechanics, thermal energy, and renewable energy sources. The transformation of the energy market amid sector decentralization and the development of small-scale generation has created

a new segment where technical competencies are inseparable from entrepreneurial thinking. Yet, an assessment of the educational level of training reveals an alarming trend: only 10% of graduates demonstrate a high level of proficiency, 31% possess a sufficient level, and 59% exhibit a low level.

An analysis of the reasons behind this state of professional training identifies systemic issues in the interaction between education and business. Energy companies note that the primary obstacles to collaboration with educational institutions include the inflexibility of these institutions (29%), a lack of financial autonomy that diminishes their interest in genuine cooperation with companies (20%), and inadequate communication between education and business – education "does not hear" the voice of business (15%). This institutional gap between education and the energy sector prevents graduates from developing an entrepreneurial vision of industry processes. At the same time, representatives of energy companies acknowledge their own responsibility in this situation, pointing to insufficient state support for collaboration processes between businesses and educational institutions, as well as the business sector's low willingness to bear the financial and organizational costs of training future employees.

The development of "green" entrepreneurship is a strategically important direction of Ukraine's economic policy. However, the existing approaches to fostering entrepreneurial competence among future energy professionals require improvement to adequately prepare them for such activities. The potential of young students, their ambitions, and their readiness to implement innovations could become a vital resource for transforming the energy sector, enhancing its competitiveness, and addressing pressing energy supply challenges.

The formation of entrepreneurial competence among future energy sector specialists holds strategic importance at the state level, as evidenced by several regulatory and legal documents. Notably, the Cabinet of Ministers of Ukraine's Resolution No. 761-r of August 13, 2024, "On the Approval of the National Action Plan for Renewable Energy until 2030 and the Implementation Plan," emphasizes the importance of creating conditions for the training and retraining of Ukrainian professionals in the field of renewable energy sources and alternative fuels. State support for the professional training of energy specialists is driven by objective market needs, as significant growth is projected in renewable energy production volumes, the installed capacity of renewable energy facilities, energy storage

systems, and balancing capacities. This presents new challenges for the education system, which must reorient itself toward developing competencies relevant to Ukraine's modernized energy sector.

The practical implementation of state initiatives requires a transformation of the entire educational vertical, including institutions of vocational (technical-vocational) education. The effectiveness of this process depends, among other factors, on establishing productive collaboration between the educational and business environments. Such interaction lays the foundation for systemic transformations in Ukraine's energy sector, aligning it with contemporary global trends and sustainable development requirements. Only through the combined efforts of the educational community, research institutions, and energy enterprises can a workforce be developed capable of implementing energy-efficient technologies and enhancing the competitiveness of the domestic energy sector based on principles of environmental responsibility.

A vivid example of the educational system responding to labor market demands in the energy sector is the training of skilled workers in state vocational (technical-vocational) education institutions for the profession of "Technician for the Installation and Maintenance of Renewable Energy Systems." This relatively new profession is gaining particular relevance amid the rapid development of alternative energy sources. The functional responsibilities of such specialists encompass a broad range of knowledge and skills: from the installation and maintenance of renewable energy systems, assessment of the quality of installed equipment, and monitoring of energy device operations to the ability to establish their own businesses, thereby ensuring self-employment and self-reliance. The professional activities of a technician in this field involve setting up structures to secure system components in designated locations, laying cables and pipelines, and assembling individual installation units. Key competencies of the specialist include the ability to work with technical documentation and equipment operation manuals, utilize assembly drawings and diagrams, and select the necessary tools and devices. An essential aspect of the job also involves identifying failures and malfunctions in renewable energy systems, monitoring the external condition of equipment, and conducting preventive maintenance to ensure the reliable operation of energy systems (Svit profesiy, 2025).

Defining the functional responsibilities of technicians for the installation and maintenance of renewable energy systems highlights the

wide range of professional competencies required for effective performance. For a systematic understanding of qualification requirements, it is advisable to refer to the regulatory framework governing vocational training in the context of modern labor market demands. The foundational tool for regulating professional qualifications within Ukraine's educational landscape is professional standards, which, pursuant to Article 39 of the Law of Ukraine "On Education" (Verkhovna Rada Ukrayiny, 2017), are defined as officially approved requirements for workers' competencies. These documents serve as the fundamental basis for shaping professional qualifications and the subsequent development of educational programs. Methodologically significant is the fact that the development of professional standards involves various stakeholders in the educational and professional environment, including employers, their organizations and associations, government bodies, research institutions, industry councils, public associations, and other interested parties. This ensures a multi-stakeholder approach and comprehensive representation of requirements. Emphasis is placed on the fact that professional standards are developed for the most promising and in-demand types of labor activities, professions, and qualifications on the labor market. The process of developing a professional standard involves thorough research and analysis of effective labor practices, with the mandatory involvement of experts – experienced professionals in the relevant field – ensuring the document's alignment with current industry needs.

Within the educational system, professional standards are utilized for three key processes: first, the development of educational programs, standards, and teaching materials for all forms and types of education, including on-the-job training for workers and the preparation of pedagogical staff; second, the establishment of standards for evaluating learning outcomes and awarding professional qualifications, ensuring objectivity and uniformity in certification processes; third, the creation of unified criteria for assessing the competencies of individuals seeking professional qualifications, regardless of the pathways through which they were obtained. This aligns with the principles of lifelong learning and the recognition of outcomes from non-formal and informal education.

A thorough study of the regulatory framework for the professional training of energy sector specialists requires an analytical consideration of the professional standard that governs the qualification requirements for future industry professionals. To identify the potential for developing

entrepreneurial competence among prospective specialists in alternative energy sources, a systemic analysis will be conducted of the structural and substantive characteristics of the professional standard "Master of Installation and Maintenance of Renewable Energy Systems," approved by Order No. 106-22 of the Ministry of Economy of Ukraine on January 13, 2022. This standard serves as a normative and methodological document reflecting a consolidated approach to defining qualification requirements, structured according to labor functions, professional competencies, and the necessary knowledge and skills. Analysis of the document enables the identification of competence units that correlate with the entrepreneurial component of professional activity.

Methodologically significant is the section "Professional Qualifications," which establishes a hierarchical structure of qualification levels – from Category III to Category I – with a corresponding expansion of labor functions. For instance, a Category III master must possess the labor functions of "Performing preparatory and auxiliary works," "Installing supporting structures and system fasteners," "Installing system equipment," and "Maintaining and repairing systems" (with professional competencies such as "Ability to perform instrument repair work," "Ability to monitor the operation of relevant devices and equipment," and "Ability to oversee system functionality"). A Category II master encompasses the functions of the first level, with the added competence of "Setting up, adjusting, testing, inspecting, and commissioning systems." A Category I master includes all the aforementioned functions, supplemented by "Organizational support for installation and maintenance works." It is this final labor function that integrates a set of competencies directly linked to entrepreneurial activity.

A detailed analysis of the substantive content of the labor function "Organizational support for works" reveals a structured system of professional competencies, knowledge, and skills that shape the entrepreneurial dimension of a specialist. The competence "Ability to develop simple projects and schemes for the installation of renewable energy systems" presupposes proficiency in methods of economic efficiency, as well as fundamentals of economics and production organization. These knowledge components foster the development of economic thinking as a foundational element of entrepreneurial competence. The skills of "Developing modifications and determining general operating parameters of renewable energy systems" and "Developing and/or selecting schemes and procedures for installing modules and blocks of renewable energy systems"

integrate technical and economic aspects of professional activity, which are essential characteristics of entrepreneurial thinking.

The competencies "Ability to prepare technical documentation related to the maintenance of renewable energy systems" and "Ability to manage the preparation of planned and reporting documentation of the relevant focus" form the procedural and operational component of entrepreneurial competence. Of particular importance is the skill of "Preparing specifications, diagrams, tables, and charts necessary for the maintenance of renewable energy systems," which underpins the analytical dimension of entrepreneurial activity. The knowledge of "Methods for calculating the economic efficiency of implementing new equipment, advanced technology, and inventions of the relevant focus" acquires a system-forming significance for the development of entrepreneurial competence. This knowledge enables the ability to evaluate innovative technological solutions from the perspective of their economic feasibility – an imperative of entrepreneurial thinking—alongside "Fundamentals of economics, production organization, labor, and management." This latter competence unit is integrative in nature, as it combines knowledge components from four interrelated domains that form the cognitive foundation of entrepreneurial activity: understanding the economic mechanisms of the energy services market, the ability to optimally structure production processes, competence in the rational organization of labor, and managerial skills necessary for establishing one's own business.

The analysis of the "General Competencies" section of the professional standard reveals the presence of components that are integral characteristics of entrepreneurial activity: the ability to make decisions within the scope of professional competence and bear personal responsibility for the outcomes; adaptability and stress resilience; and the capacity for professional mobility and adaptation. These competencies form the personal component of entrepreneurial competence, ensuring readiness to act under conditions of uncertainty and risk. Particularly significant are the competencies "Ability to apply digital technologies and tools, and evaluate information" and "Ability to rationally use energy resources and materials in professional activities," which reflect contemporary trends in the digitalization of business processes and resource efficiency as foundational elements of competitiveness in the energy sector.

The analysis of the section "Regulatory and Legal Framework Governing the Relevant Professional Activity" demonstrates the complexity of legal regulation within the industry and the necessity of integrating

knowledge from various normative legal acts that govern activities in the field of renewable energy. Specifically, the Laws of Ukraine "On Alternative Energy Sources" (Verkhovna Rada Ukrayiny, 2003), "On Environmental Protection" (Verkhovna Rada Ukrayiny, 1991b), and "On Consumer Rights Protection" (Verkhovna Rada Ukrayiny, 1991a) constitute the legal component of entrepreneurial competence.

The professional standard for the occupation "Technician for the Installation and Maintenance of Renewable Energy Systems" identifies competency units that facilitate the development of entrepreneurial competence across the domains of knowledge, skills, and personal qualities. At the same time, the standard reflects the integrated nature of professional activity, where entrepreneurial competence is not a standalone component but is organically embedded within the system of professional competencies of an energy sector specialist. The identified structure of entrepreneurial competence within the professional standard provides a methodological foundation for the development of innovative pedagogical technologies aimed at fostering this competence in future renewable energy specialists within the system of vocational (technical-vocational) education. These technologies are tailored to the specifics of the industry and the current needs of Ukraine's energy market, while also serving as a basis for the development of a national educational standard.

The National Educational Standard for the occupation "Technician for the Installation and Maintenance of Renewable Energy Systems," approved by Order No. 535 of the Ministry of Education and Science of Ukraine on April 18, 2024, serves as the regulatory foundation for training qualified workers, underscoring its strategic importance in building the human resource capacity of the renewable energy sector. Developed based on the professional standard, it constitutes an integrated normative-methodological document that regulates the content of education, its structure, and learning outcomes. The conceptual foundation of the standard is a competency-based approach, as outlined in the introductory section of the document, which emphasizes the formation and development of key, general, and professional competencies. The structural design of the standard reflects a hierarchical logic for developing professional qualifications, progressing from foundational to advanced levels. It establishes three qualification levels for technicians in the installation and maintenance of renewable energy systems: Category III as the entry level, Category II as the baseline level, and Category

I as the highest level, aligning with the principle of continuity in vocational education.

An analysis of the list of key competencies reveals the systemic integration of entrepreneurial competence into the educational process, particularly through its designation as a core component, described via a structured system of knowledge and skills. A substantive analysis of this competence highlights its cognitive components: economic-theoretical knowledge of market economics and its operational principles; organizational-legal knowledge regarding forms of entrepreneurship in Ukraine and relevant regulatory documents; procedural knowledge related to starting a business, types of wages, and labor incentives; and strategic-managerial knowledge concerning the transformation of ideas into actionable outcomes, the economic and social prerequisites of entrepreneurship, project planning and management, and the development of business plans.

Entrepreneurial competence is defined as a recommended outcome to be developed at the final stage of an educational program, emphasizing its integrative nature and the necessity of being grounded in other competencies. Its significance is particularly evident in its development within the structure of learning outcomes for Category I masters, specifically through the learning outcome "Provide organizational support for the installation and maintenance of renewable energy systems." This is achieved via the professional competence "Ability to prepare technical documentation related to the maintenance of renewable energy systems," encompassing knowledge of methods for calculating economic efficiency, as well as fundamentals of economics and production organization. The activity component of entrepreneurial competence is structured through regulatory and legal skills in utilizing relevant acts, analytical skills for critical analysis of creative processes in project planning, financial and managerial skills for independent financial decision-making and negotiation, communicative and motivational skills to inspire appreciation of ideas, and project-related skills in developing business plans.

A structural-functional analysis of the standard reveals the systemic integration of entrepreneurial competence components into various learning outcomes and professional competencies, particularly in documentation and analytical competencies. A methodological feature of the standard is the systemic integration of entrepreneurial competence with other key competencies, notably digital competence, which creates a synergistic effect

in the context of readiness for entrepreneurial activity in a modern digitalized environment. The state educational standard for the profession establishes a comprehensive regulatory and methodological framework for developing the entrepreneurial competence of future energy sector specialists. It ensures the systemic integration of entrepreneurial knowledge, skills, and abilities into the educational process structure, aligning with current industry trends and labor market demands. Its implementation in the educational process of vocational (technical-vocational) education institutions provides a methodological foundation for training a new type of specialist capable not only of effectively performing technical tasks but also of demonstrating entrepreneurial initiative and developing and implementing innovative projects in the field of renewable energy.

A significant component in fulfilling the objectives outlined by the state educational standard is the availability of appropriately oriented curricula. In this context, it is expedient to analyze the curriculum of the academic discipline "Fundamentals of Innovative Entrepreneurship," developed by researchers from the Institute of Vocational Education of the National Academy of Pedagogical Sciences of Ukraine (Alekseieva et al., 2019). The structure and content of the program allow for the identification of its key features and potential for adaptation to the training of energy sector specialists. The program has a clear modular structure, comprising seven thematic blocks and a culminating project. The total volume of 20 instructional hours is distributed based on the significance of various aspects of entrepreneurial training. The largest allocation (4 hours) is devoted to the module "Economic and Legal Conditions of Innovative Entrepreneurship," underscoring the importance of a regulatory and legal framework for successful business operations. At the same time, considerable attention is given to "Theoretical Foundations of Innovative Entrepreneurship" and "Personal Self-Management" (3 hours each), forming the basis for theoretical knowledge and personal qualities.

The program's content is logically structured, progressing from an understanding of the fundamentals of innovative entrepreneurship to practical skills in planning, communication, and ethical aspects of business conduct. Notably, the program integrates not only economic and legal issues but also personal development components, such as "Personal Self-Management," which includes time management, personal development, and career planning. This approach aligns with the contemporary understanding of entrepreneurial competence as a comprehensive combination of

knowledge, skills, and personal attributes. The teaching methods recommended by the program – such as targeted discussions, brainstorming, Gordon’s method, and heuristic methods – are aimed at fostering creative thinking and innovative exploration, which are critical for developing an entrepreneurial mindset. The practical orientation of the program is realized through the educational project "Creating a Business Plan," which serves as a final assessment task, ensuring the application of acquired knowledge in a specific development project.

The "Fundamentals of Innovative Entrepreneurship" program can serve as a methodological foundation for developing the entrepreneurial competence of future specialists. However, it requires targeted adaptation and modernization to account for the specifics of applying alternative energy sources and current trends in the development of the energy component of the national economy. To align the program with the needs of training specialists in renewable energy, it is advisable to supplement it with thematic modules reflecting the sector's particularities. These may include innovative business models in the energy sector; digital technologies related to renewable energy sources and their application in entrepreneurial activities; environmentally oriented entrepreneurship in the energy sector; the development of innovative projects in renewable energy; and the establishment of businesses focused on the installation and maintenance of renewable energy systems, among others.

Research into the modern educational environment demonstrates that the implementation of entrepreneurial training tasks for specialists in the renewable energy sector involves significant methodological updates to educational programs in vocational (technical-vocational) education institutions. An analysis of their practices reveals the transformation of courses such as "Fundamentals of Sectoral Economics and Entrepreneurship," "Fundamentals of Innovative Entrepreneurship," and "Fundamentals of Entrepreneurial Activity" into a comprehensive educational component. This component integrates fundamental economic concepts with the sectoral specifics of alternative energy. Such integration is characterized by the interpenetration of entrepreneurial and professional competencies, creating a reinforced, mutually complementary effect in training qualified workers. The methodological rethinking of educational programs occurs through systematic interaction between educational institutions and stakeholders, ensuring that the educational process aligns with current industry requirements. This approach fosters the development

of institutional collaboration models by involving representatives of energy companies in educational-methodological councils, contributing to the content development of programs, and providing expert evaluation of learning outcomes. This enables the integration of progressive industry experience into the educational process, reflecting broader trends in the development of green energy in Ukraine.

A structural-content analysis of adapted educational programs reveals that traditional entrepreneurial components undergo substantive transformation. Specifically, the theoretical foundation of entrepreneurship is enriched with an analysis of the renewable energy market's peculiarities ("Entrepreneurial Potential of Renewable Energy"); the development of an entrepreneur's personal qualities is examined through the lens of the sector's specific demands ("Professional Profile of an Entrepreneur in the Renewable Energy Sector"); and the legal aspects of entrepreneurial activity are contextualized within the regulatory framework governing alternative energy. A noticeable transformation is also evident in other program components: traditional business planning methodology gains subject-specific focus through an emphasis on renewable energy projects, while formal procedures for starting a business are highlighted with attention to the organizational and legal specifics of green energy enterprises; production management shifts its focus to technological innovations and operational processes characteristic of the alternative energy sector; general economic principles of pricing policy are adapted to account for specific tariff-setting mechanisms, while financial and economic tools are considered through the prism of investment features of energy projects; and the ethical-value component of entrepreneurial activity is enriched with issues of environmental responsibility and sustainable development, which are defining for the renewable energy sector.

It is important to emphasize that the development of such adapted programs considers not only current but also prospective industry needs, enhancing the relevance of training specialists with well-developed entrepreneurial competencies. The involvement of employers in designing educational programs ensures that both the current state of the energy sector and its projected transformation directions are taken into account.

The methodological framework for fostering entrepreneurial competence in future renewable energy specialists is achieved through the organic integration of innovative digital ecosystems and the implementation of international cooperation projects. This creates conditions for aligning

national educational practices with global standards of entrepreneurial education. Contemporary educational practice faces the need to develop comprehensive digital environments capable of providing high-quality professional training for "digital natives" – a generation shaped by a technologically saturated environment. For instance, the "Professional Education Online" platform, introduced by the Ministry of Education and Science of Ukraine in 2022, serves as a comprehensive didactic environment, including for the development of entrepreneurial competence. This educational ecosystem is characterized by the integration of interactive tests with adaptive algorithms, the availability of virtual simulators, and production process simulations, ensuring a high level of immersion for learners in professional realities. The multimedia content format enables the modeling of professional scenarios in a virtual environment, the individualization of educational trajectories, and an increase in learners' cognitive engagement. The platform's functional capabilities lay the groundwork for developing strategic thinking and communication skills through virtual presentations and collaborative projects.

In the context of international collaboration, the online course "BIZ-UP: Entrepreneurial Skills for Youth," developed by the International Labour Organization, stands out. The course features a clear structure comprising six concise modules, each lasting approximately 45 minutes, which progressively cover key aspects of entrepreneurial activity – from business idea development to financial planning and personnel management. A distinctive feature of the course is its practical orientation: through real-world examples, participants can observe the progress of three young entrepreneurs and assist them in addressing business challenges. While the course can be completed independently, its effectiveness is enhanced with the involvement of a mentor who can evaluate completed tasks and provide recommendations for further entrepreneurial development (Mizhnarodna orhanizatsiya pratsi, 2023).

European Union programs and GIZ initiatives in Ukraine are exemplified by a project implemented by the Volyn Resource Center titled "Strengthening the Capacity of Vocational Education Institutions to Enhance Youth Adaptability to Labor Market Needs During Wartime Through the Development of Entrepreneurial Skills" (Volynskiyi resursnyi tsentr, 2023). This project was carried out within the "EU4Skills: Better Skills for Modern Ukraine" program. The outcome was the online course "Own Business: Methods for Teaching Students Entrepreneurship," distinguished by the

accessibility of didactic materials, interactivity, modular structure, and an integrated approach to building entrepreneurial competencies. Additionally, under the initiative "Business Skills for Economic Growth: Training Courses for Students, Vocational Education Teachers, and Aspiring Entrepreneurs," implemented as part of the "Professional Education in Ukraine/Skills4Recovery" program by the German Society for International Cooperation (GIZ) with financial support from the German Ministry for Economic Cooperation, two key educational directions were realized: youth entrepreneurship development and adult entrepreneurship training (Vyshcha osvita v Ukrayini, 2024).

The "Recovery through Social Entrepreneurship" program (2023–2025), implemented by the European Union in collaboration with the Ministry of Foreign Affairs of Lithuania, merits particular attention. This initiative aims to cultivate a cohort of social entrepreneurs among the youth of Ukraine, Georgia, and Moldova. Its methodological framework incorporates components of the Startup Pre-Accelerator, including grant support (2,000 EUR) for prototyping and presenting business models to investors (Proiekt EU4Youth, 2025).

The aforementioned international projects and digital educational platforms in the field of vocational education demonstrate a positive impact on the development of foundational entrepreneurial competencies among future skilled workers. These educational resources effectively facilitate the mastery of general aspects of entrepreneurial activity through the integration of interactive methodological tools, virtual simulators, and practice-oriented approaches. However, for the comprehensive training of specialists in renewable energy, it is essential to significantly expand their methodological toolkit, taking into account sector-specific requirements. The development of entrepreneurial competence in the domain of alternative energy sources should involve the integration of educational and methodological modules into these initiatives. Such modules should focus on fostering skills in technical analysis of project energy efficiency, energy balance calculations, and grid integration of renewable sources. It is also advisable to incorporate components addressing tariff policy, licensing specifics in the "green" energy sector, mechanisms of energy auctions, and the intricacies of contract formulation. A promising direction for the methodological support of such projects lies in integrating components for modeling sector-specific business structures for startups in bioenergy, solar, and wind energy sectors, with the involvement of industry experts and potential investors. This targeted

approach will ensure the development of specialized competencies necessary for effective entrepreneurial activity within the unique context of the renewable energy market.

The results of the study on the development of entrepreneurial competence among future specialists in Ukraine's energy sector economy indicate that transformational processes in the energy industry – particularly in the renewable energy segment – demand a fundamentally new approach to professional training. The rapid increase in the share of alternative energy in the country's energy balance, as outlined in strategic documents, underscores the need for specialists capable of operating effectively amid the demonopolization of the energy market and the development of decentralized energy systems.

The content of regulatory documents concerning the professional training of specialists, as reflected in the professional standard and the state educational standard for the occupation "Technician for the Installation and Maintenance of Renewable Energy Systems," ensures the structural integration of entrepreneurial competencies across various qualification levels. These range from organizational task execution, the development of simple projects and installation schemes, to knowledge of methods for calculating economic efficiency, as well as fundamentals of economics, production organization, labor, and management. Nevertheless, the demands of the energy market are outpacing the current state of the educational system, as evidenced by the findings of expert studies.

The vast majority of entrepreneurial training programs demonstrate potential for developing basic entrepreneurial competencies but require significant industry-specific adaptation. To effectively train specialists in renewable energy, these programs should be supplemented with thematic modules reflecting the specifics of economic activities related to alternative energy sources: innovative business models in the energy sector, digital technologies and their application in entrepreneurial activities, environmentally oriented enterprises, the development of innovative projects in the field of renewable energy, and the peculiarities of launching a business focused on the installation and maintenance of relevant systems. At the same time, transformative processes are already underway in the educational practices of vocational (technical-vocational) institutions – educational components of entrepreneurship are undergoing substantive modification through the contextualization of theoretical material to the specifics of alternative energy. Thematic modules on its entrepreneurial potential are

being developed, the features of organizational and legal forms of green energy enterprises are being explored, and business planning methodologies are focusing on renewable energy projects. A positive trend is the involvement of energy company representatives in shaping the content of educational programs and evaluating learning outcomes, which helps bridge the institutional gap between education and business.

Significant potential for enhancing entrepreneurial competence lies in innovative educational initiatives and digital platforms introduced through mechanisms of international cooperation. Interactive tests, virtual simulators, and production process emulators create conditions for modeling professional scenarios and increasing learners' cognitive engagement. Educational services resulting from international collaboration provide structured learning of key aspects of entrepreneurial activity using real-world examples, characterized by accessible didactic materials and an integrated approach to fostering entrepreneurial competence, while also enabling the practical implementation of business ideas. However, these educational resources require substantial industry-specific contextualization to effectively train specialists in alternative energy systems.

To address the identified challenges, we consider it necessary to implement systemic changes in the methodological support for training specialists in the energy sector. In our view, the priorities today include the development of specialized educational materials on the technical and economic feasibility of energy projects, tariff policies, and licensing in the field of green energy, as well as mechanisms for energy auctions and the specifics of contract negotiation; the introduction of dual education with direct involvement of energy enterprises; the development of industry-specific business incubators and startup support programs in the fields of bioenergy, solar, and wind energy; and the establishment of institutional partnerships between educational institutions, research organizations, and energy companies.

A promising direction for further research is the development of a comprehensive model for fostering entrepreneurial competence that accounts for the specifics of various renewable energy segments, as well as the study of integration mechanisms combining traditional vocational (technical-vocational) education with innovative approaches to developing entrepreneurial skills. The issue of exploring pedagogical conditions for enhancing entrepreneurial competence within the dual training system remains relevant, as does the analysis of global experiences in integrating

digital technologies into entrepreneurial education, with particular attention to the specifics of restoring Ukraine's war-damaged energy infrastructure.

References

Alekseeva, S., & Yershova, L. (2020). Content and forms of modern training of future specialists for entrepreneurship activity. *Professional Pedagogics*, 2(21), 44–52. <https://doi.org/10.32835/2707-3092.2020.21.44-52>

Alekseieva, S. (2020). Osoblyvosti suchasnoyi pidhotovky molodi do pidpryyemnyts'koyi diyal'nosti [Features of modern youth training for entrepreneurial activity]. In V. O. Radkevych (Ed.), *Naukovo-metodychne zabezpechennya profesiynoyi osvity i navchannya: Zbirnyk materialiv XIV zvitnoyi Vseukrayinskoyi naukovo-praktychnoji konferentsiyi* [Scientific and methodological support of vocational education and training: Proceedings of the 14th Annual All-Ukrainian Scientific and Practical Conference]. (Kyiv, May 7, 2020) (pp. 88–91). IPTO NAPN Ukrayiny. https://lib.iitta.gov.ua/id/eprint/721972/1/Zbirnyk_materialiv_konferentsii_07_05_2020.pdf

Alekseieva, S., Bazyl, L., Baydulin, V., Vanina, N., Yershova, L., Zakatnov, D., Orlov, V., & Radkevych, O. (2019). Osnovy innovatsiynoho pidpryyemnytstva: Prohrama navchal'noyi dystsypliny dlya zakladiv profesiynoyi (profesiyno-tekhnichnoyi) osvity. [Fundamentals of innovative entrepreneurship: Curriculum for vocational (vocational-technical) education institutions]. *Profesiïna osvita* [Vocational Education], 2(83), 33–35. <https://lib.iitta.gov.ua/id/eprint/717529>

Baydulin, V. (2022). Konsultuvannya uchniv'skoyi molodi z biznes-kar'yery v suchasnomu informatsiinomu prostori [Career counseling for student youth in business within the modern information space]. *Profesiïna osvita* [Vocational Education], 4, 26–28. https://lib.iitta.gov.ua/id/eprint/735613/1/Baydulin_2022.pdf

Bazyl, L. (2021). Training of future specialists for entrepreneurial activity: Realities and prospects. *Professional Pedagogics*, 2(23), 149–158. <https://doi.org/10.32835/2707-3092.2021.23.149-158>

Bazyl, L., & Orlov, V. (2022). Problems of consulting on youth entrepreneurship development. *Professional Pedagogics*, 1(24), 18–26. <https://doi.org/10.32835/2707-3092.2022.24.18-26>

Bazyl, L., & Orlov, V. (2023). Kontseptual'no-paradyhmal'ni vymiry pidhotovky zdobuvachiv profesiynoyi osvity do molodizhnoho pidpryyemnytstva [Conceptual and paradigmatic dimensions of preparing vocational education applicants for youth entrepreneurship]. *Visnyk Hlukhivs'koho natsional'noho pedahohichnoho universytetu imeni Oleksandra Dovzhenka. Pedahohichni nauky [Bulletin of Hlukhiv National Pedagogical University named after Oleksandr Dovzhenko. Pedagogical Sciences]*, 53, 31–39. http://nbuv.gov.ua/UJRN/vgnpu_2023_3_5

Forbes Ukraine. (2024, October 9). *20 naybil'shykh hravtsiv alternatyvnoyi enerhetyky [Top 20 major players in alternative energy]*. <https://forbes.ua/ratings/20-naybilshikh-gravtsiv-alternativnoi-energetiki-09102024-24056>

Hrytsenok, I. (2024). State support for youth entrepreneurship under martial law. *Innovative Professional Education*, 6(19), 399–408. <https://doi.org/10.32835/2786-619X.2024.6.19.399-408>

Kabinetu Ministriv Ukrayiny. (2024, August 13). *Pro zatverdzhennya Natsional'noho planu diy z vidnovlyuvanoyi enerhetyky na period do 2030 roku ta planu zakhodiv z yoho vykonannya [On the approval of the National Action Plan for Renewable Energy for the period until 2030 and the action plan for its implementation]*. Rozporyadzhennya Kabinetu Ministriv Ukrayiny. <https://zakon.rada.gov.ua/laws/show/761-2024-%D1%80#Text>

Kudria, S. O. (Ed.). (2024). *Vidnovlyuvani dzherela enerhiyi: vydannya druhe, dopovnene [Renewable energy sources: Second, revised edition]*. Instytut vidnovlyuvanoi enerhetyky NANU. <https://www.ive.org.ua/wp-content/uploads/monograph2024.pdf>

Ministerstvo ekonomiky Ukrayiny. (2022). *Pro zatverdzhennya profesiynoho standartu «Mayster z montazhu ta obsluhovuvannya system vidnovlyuval'noyi enerhetyky» [On the approval of the professional standard "Technician for installation and maintenance of renewable energy systems."]*. Nakaz Ministerstva ekonomiky Ukrayiny. https://register.nqa.gov.ua/uploads/0/391-nakaz_106.pdf

Mizhnarodna orhanizatsiya pratsi. (2023). *BIZ-UP. Navychky pidpryyemnytstva dlya molodi [BIZ-UP. Entrepreneurship skills for youth]*. Profesiĭna osvita onlayn. [Vocational Education Online]. <https://profosvita.online/courses/course-v1:Profosvita+CS-CM002-ILO+2023/about>

Proiekt EU4Youth. (2025). *Vidnovlennya cherez sotsial'ne pidpryyemnytstvo: praktychna vidpovid' na zapyt suchasnoyi ukrayins'koyi*

molodi [Recovery through social entrepreneurship: a practical response to the needs of modern Ukrainian youth]. Ja-Ukraine. <https://ja-ukraine.org/proiekt-eu4youth-vidnovlennia-cherez-sotsialne-pidpriemnytstvo-praktychna-vidpovid-na-zapyt-suchasnoi-ukrainskoi-molodi/>

Semyhina, T., & Markevych, N. (2022). «Zeleni» kompetentnosti ta «zeleni» navychky: ohlyad mizhnarodnoho dosvidu. ["Green" competencies and "green" skills: a review of international experience]. *Grail of science*, 16, 400–406. <https://bit.ly/3mV60Lm>.

Svit profesiy. (2025). *Tsyfrova platforma profesiyanoi osvity*. [Digital platform for vocational education]. <https://svitprof.org.ua/>

UkraineInvest. (2024). *Alternative energy*. <https://ukraineinvest.gov.ua/industries/energy/alternative-energy/>

Ukrainian Clean Generation. (2023). *Shcho varto znaty s'ohodni pro rynek pratsi u sferi ponovlyuvanoi enerhetyky: problemy pratsevlashtuvannya ta naymu v haluzi zelenoyi enerhetyky* [What you should know today about the labor market in renewable energy: Employment and hiring challenges in the green energy sector]. <https://ucg.in.ua/article/shho-varto-znati-sogodni-pro-rinok-praczi-u-sferi-ponovlyuvano%D1%97-energetiki-problemi-pratsevlashtuvannya-ta-najmu-v-galuzi-zeleno%D1%97-energetiki/>

UN Global Compact Network in Ukraine. (2022, December 6). *Osvita ta biznes v enerhetytsi: tochky vzaemodiyi* [Education and business in energy: points of interaction]. <https://globalcompact.org.ua/news/osvita-ta-biznes-v-energetytsi-tochky-vz/>

Vanina, N. (2024). Sotsial'no-ekonomichna efektyvnist' innovatsiyogo konsultuvannya z molodizhnoho pidpriemnytstva [Social and economic effectiveness of innovative counseling for youth entrepreneurship]. *Pedahohichni nauky: teoriya, istoriya, innovatsiyni tekhnologii* [Pedagogical Sciences: Theory, History, Innovative Technologies], 4, 370–384. <https://doi.org/10.24139/2312-5993/2024.04/370-384>

Verkhovna Rada Ukrayiny. (1991a, May 12). *Zakon Ukrayiny "Pro zakhyst prav spozhyvachiv"* [The Law of Ukraine "On Consumer Protection"]. <https://zakon.rada.gov.ua/laws/show/1023-12#Text>

Verkhovna Rada Ukrayiny. (1991b, June 25). *Zakon Ukrayiny "Pro okhoronu navkolyshnoho pryrodnoho seredovyshcha"* [The Law of Ukraine

"On Environmental Protection"].

<https://zakon.rada.gov.ua/laws/show/1264-12#Text>

Verkhovna Rada Ukrainy. (2003, February 20). *Zakon Ukrainy "Pro alternatyvni dzherela enerhiyi" [The Law of Ukraine "On Alternative Energy Sources"]*. <https://zakon.rada.gov.ua/laws/show/555-15#Text>

Verkhovna Rada Ukrainy. (2017, September 5). *Zakon Ukrainy "Pro osvitu" [The Law of Ukraine "On Education"]*. <https://zakon.rada.gov.ua/laws/show/2145-19#Text>

Volynskiy resursnyi tsentr. (2023). Rozvytok navchannya pidpryyemnytstva u zakladakh profesiynoyi osvity [Development of entrepreneurship education in vocational education institutions.]. *Entre-VET Camp*. <https://vrc.rv.ua/service/entre-vet-camp/>

Vseukrayinska enerhetychna Asambleya. (2020, January 23). *Kontseptsiya «zel'eno» enerhetychnoho perekhodu Ukrainy do 2050 roku [Concept of Ukraine's "green" energy transition by 2050]*. <https://uaea.com.ua/news/our-news/concept-2050.html>

Vyshcha osvita v Ukraini. (2024, February 27). *Profesional'na osvita: biznes-navychky dlya vidbudovy Ukrainy [Vocational education: business skills for rebuilding Ukraine]*. *Osvita.ua*. <https://osvita.ua/vnz/reform/91522/>

Yershova, L. (2024). Principles of counseling vocational education students on youth entrepreneurship. *Professional Pedagogics*, 1(28), 69–79. <https://doi.org/10.32835/2707-3092.2024.28.69-79>

Zakatnov, D. (2024). Methods of psychological counseling of future qualified workers in the issues of readiness for entrepreneurial activities. *Innovative Professional Education*, 1(14), 166–170. <https://conference.ivet.edu.ua/index.php/1/article/view/308>