1.4. USING ENERGY EFFICIENCY EDUCATIONAL CASES IN THE PROFESSIONAL TRAINING OF SKILLED WORKERS

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The use of energy efficiency educational cases contributes to the development of practical skills and competencies necessary to work in the context of the implementation of energy-saving technologies. The study of the problem allows to identify effective approaches to the integration of energy-efficient solutions into professional education and to develop recommendations for their application, taking into account industry requirements and national educational standards. It is determined that the implementation of the case method contributes to the development of practical skills, critical thinking and the ability to make informed decisions in the field of energy saving. The basic principles of developing educational cases are characterized.

Keywords: *skilled workers, professional training, energy efficiency, methodological support, case-based learning.*

1.4. ВИКОРИСТАННЯ ОСВІТНІХ КЕЙСІВ ЕНЕРГОЕФЕКТИВНОГО СПРЯМУВАННЯ У ПРОФЕСІЙНІЙ ПІДГОТОВЦІ КВАЛІФІКОВАНИХ РОБІТНИКІВ

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Використання освітніх кейсів енергоефективного спрямування сприяє формуванню практичних навичок і компетентностей, необхідних для роботи в умовах впровадження енергозберігаючих технологій. Дослідження порушеної проблеми дозволяє виявити ефективні підходи до інтеграції енергоефективних рішень у професійну освіту та розробити рекомендації щодо їхнього застосування з урахуванням галузевих вимог і національних освітніх стандартів. Визначено, що впровадження кейс-методу сприяє розвитку практичних навичок, критичного мислення та здатності приймати обґрунтовані рішення у сфері енергозбереження. Охарактеризовано основні принципи розроблення освітніх кейсів.

Ключові слова: *кваліфіковані робітники, професійна підготовка, енергоефективність, методичне забезпечення, практико-орієнтоване навчання.*

The relevance of this article lies in its focus on integrating energy-efficient technologies into professional training, which has become crucial in addressing Ukraine's challenges in sustainable development and environmental safety, especially in the context of the ongoing war with Russia. As the country faces the immense task of rebuilding and modernizing infrastructure damaged by the war, there is a growing demand for qualified workers who can implement energy-saving technologies, particularly in the construction sector. The war has highlighted the urgent need for a more energy-efficient economy, making the incorporation of energy-efficiency case studies into vocational education essential for preparing the next generation of workers to meet these demands.

Moreover, one of the strategic objectives of reforming Ukraine's vocational education, as outlined in the concept for implementing state policy in vocational education "Today's Vocational Education" for the period until 2027 (The Cabinet of Ministers of Ukraine, 2019), is the development of educational standards and the design of vocational education content based on a competency-based approach. It correlates with Ukraine's integration into the European education space, which, in turn, actively promotes green technologies.

As can be seen, it is crucial to examine the role of energy-efficiency case studies in professional training of future qualified workers, emphasizing their importance in developing critical thinking, decision-making, and practical expertise within Ukraine's energy sector. By analyzing the integration of modern energy-efficient technologies and real-world scenarios, one can highlight how such educational tools can better equip students to face the challenges of reconstruction in the aftermath of the war and contribute to the country's long-term energy resilience. Emphasis is placed on the significance of case-based learning in fostering an environmentally responsible professional mindset, empowering future workers to play a pivotal role in Ukraine's energy transition and recovery. It is therefore essential to offer effective recommendations to adapt educational approaches to the evolving needs of Ukraine's labour market, ensuring that professionals are well-prepared to drive the country's energy-efficient future in the face of ongoing challenges.

Accordingly, the article aims to explore the integration of energy-efficiency case studies into professional training of future qualified workers, focusing on their potential to enhance practical skills and competencies in energy conservation and sustainability.

The article employs several research methods. The methods of analysis and synthesis are used to outline the conceptual framework of the research. An exploratory method is applied to formulate general conclusions, while a prognostic method is used to justify the application of innovative ideas drawn from the international experience in professional training of future qualified workers in Ukraine.

A review of recent research and publications reveals significant trends and findings in both international and Ukrainian contexts regarding the integration of energy-efficiency case studies into vocational education.

Internationally, numerous studies have underscored the importance of integrating energy-efficiency technologies into vocational training programmes. The European Union, for instance, has recognized the pivotal role of vocational education and training (VET) in achieving energy conservation and fostering a sustainable economy (Barbero et al., 2023; Brychkov et al., 2023; European Commission, 2024; European Training Foundation, 2023; UNESCO-UNEVOC International Centre for TVET, 2017). A key aspect of this strategy is the use of case-based learning to equip future workers with both theoretical and practical knowledge related to energy-efficient technologies (Andrews, 2021; Mosannenzadeh et al., 2017; Stanley, 2021). Studies in countries such as Germany, Denmark, Sweden, and the UK, which are at the forefront of energy transition initiatives, demonstrate that incorporating energy-efficiency case studies into educational programmes enhances workers' competencies in real-world applications (Dyrhauge, 2022; GIZ, 2021; Ibenholt, 2009; Johansson, 2022; MeetMED, 2020; Kemmerzell, 2022; La Fleur, 2019; Prego et al., 2012). Case studies offer students the opportunity to engage with practical scenarios involving energy-saving technologies, such as renewable energy systems, building insulation, and energy-efficient manufacturing practices (Ahamad et al., 2024; Daoudi, 2024; Li, 2024; Morley, 2024; Oyedeji et al., 2023; Pears, 2020; Toogood, 2023). This approach not only improves technical skills but also cultivates an environmentally responsible mindset among future professionals.

In Ukraine, integrating energy-efficiency case studies into vocational education has gained increasing attention, especially as the country faces significant reconstruction efforts following the war with Russia (Leu-Severynenko, 2022; GOPA International Energy Consultants GmbH, 2024). The need for skilled workers capable of implementing energy-efficient solutions in various industries, especially construction and energy sectors,

has never been more pressing (Lisogor, 2024; The NAES of Ukraine, 2020). Research conducted within Ukraine has highlighted the necessity of training workers who can effectively apply modern energy-saving technologies in rebuilding the nation's infrastructure (Diedusheva, 2025; Ukraine Plan 2024-2027, 2023).

Ukrainian researchers also emphasize the need to adapt global best practices in energy-efficiency education to the unique challenges facing the country. While international models have proven successful in countries with advanced energy infrastructures, they must be tailored to meet Ukraine's specific needs, including its energy dependencies and the challenges posed by rebuilding its energy infrastructure.

The training of qualified workers in vocational education institutions is currently based on vocational education standards, which follow a competency-based approach. This approach focuses on developing and strengthening learners' key and professional competencies. Key competencies equip individuals with the ability to understand various situations, achieve success in personal and professional life, gain social independence, and engage in effective professional and interpersonal interactions. Professional competencies define one's capacity to apply specialized knowledge, skills, and abilities within their scope of responsibilities while demonstrating appropriate ethical and professional qualities necessary for performing assigned tasks, continuous learning, and professional and personal growth.

Key competencies are acquired throughout the educational programme and align with general competencies. The essential key competencies in vocational education standards involve environmental and energy efficiency competencies, which include knowledge of a) the fundamentals of energy efficiency, b) legal and regulatory frameworks in energy conservation and environmental protection, c) methods for energy-efficient use of materials, resources, and energy-saving equipment in both professional activities and everyday life, d) energy conservation practices in the workplace, e) waste sorting and disposal regulations, f) principles of sustainable use, restoration, and conservation of natural resources, and g) strategies for environmental protection in both professional and personal contexts.

Additionally, these competencies involve the ability to use energy resources and materials efficiently in professional and daily activities,

operate energy-efficient equipment, and adhere to environmental standards in professional and everyday settings.

Consequently, the use of energy-efficiency case studies within professional training of future qualified workers in Ukraine is particularly relevant as the country develops its energy sector and transitions to sustainable practices. Integrating case studies on energy efficiency into vocational education enhances learning and prepares students for the evolving labour market focused on energy conservation and sustainability (Andrews, 2021).

A key benefit of this approach is the development of practical skills. Case studies offer hands-on learning, engaging students with real-world scenarios directly relevant to Ukraine's context (Ahamad et al., 2024). For instance, students may explore case studies on energy-efficient buildings, renewable energy solutions, and improvements in industrial energy consumption, helping them develop critical skills in analyzing energy use, proposing solutions, and evaluating energy-saving technologies (Mosannenzadeh et al., 2017; Stanley, 2021). These skills are essential in sectors such as construction, manufacturing, and agriculture, which are vital to Ukraine's economy.

Energy-efficiency case studies also foster critical thinking and decision-making. Students are encouraged to evaluate energy challenges in terms of cost, environmental impact, and technological feasibility, equipping them to make informed decisions about outdated infrastructure and modernization needs. By assessing the outcomes of energy-efficiency measures, students can identify successful strategies and adapt them to local conditions (The Veregy Team, 2024).

Moreover, case-based learning enhances knowledge retention by promoting active engagement. Unlike traditional lectures, case studies require students to apply theoretical knowledge to practical problems, making learning more engaging and preparing students for professional settings. Topics such as improving energy use in district heating systems or adopting solar energy in rural areas provide a contextual understanding of energy efficiency (Barbero et al., 2023; Daoudi, 2024).

Energy-efficiency case studies also encourage an interdisciplinary approach, essential in the Ukrainian context, where energy conservation requires expertise from engineering, economics, environmental science, and policy (Repko et al., 2020). By examining how these fields intersect, students develop a broad skill set for solving complex energy challenges. For

example, they might explore the impact of policy changes on energy use or how energy-efficient technologies can be integrated into traditional sectors like agriculture and manufacturing (Brychkov et al., 2023; European Commission, 2024; European Training Foundation, 2023).

Additionally, case studies foster an ecologically oriented professional mindset, which is crucial given Ukraine's environmental challenges, such as high energy consumption and pollution (Ukraine Plan 2024-2027, 2023). Energy-efficiency cases highlight the economic and environmental benefits of conservation, demonstrating how energy-saving measures can reduce costs, improve air quality, and decrease reliance on imported energy, issues critical to Ukraine's energy security and sustainability (The NAES of Ukraine, 2020).

Tailored case studies ensure that training aligns with Ukraine's specific industrial needs. For example, case studies in construction might focus on retrofitting Soviet-era buildings, while those in agriculture could examine energy-saving techniques for farming equipment (GIZ, 2021; La Fleur, 2019). This sector-specific approach ensures students acquire relevant skills for Ukraine's key industries, while local case studies reflect the latest trends, technologies, and policies.

Finally, the practical experience gained through case-based learning enhances students' employability. As Ukraine modernizes its energy infrastructure, the demand for skilled workers in the green energy, construction, and agriculture sectors is rising. Case studies equip students with the problem-solving skills needed for these roles, boosting their employment prospects in a competitive labour market (Pears, 2020).

The principles behind effective educational cases in energy efficiency draw from global best practices. These include integrating modern energy-efficient technologies, using an interdisciplinary approach, and engaging with real production situations (Toogood, 2023). For example, universities in countries such as Germany and the US incorporate renewable energy systems and smart grids into their curricula, preparing students to apply energy-saving solutions in construction and manufacturing (GIZ, 2021; Kemmerzell, 2022; The Veregy Team, 2024). Interdisciplinary programmes in the UK, Denmark and Sweden combine engineering, economics, and environmental science, enabling students to evaluate energy challenges from multiple perspectives (Dyrhauge, 2022; Ibenholt, 2009; Johansson, 2022; OECD, 2024). In Ukraine, case studies could focus on issues such as energy efficiency in agriculture or industrial modernization, offering students

valuable practical experience. By integrating these principles, educational programmes can effectively prepare students to address energy efficiency challenges in their professional careers (Diedusheva, 2025).

Therefore, integrating energy-efficiency case studies into professional training of future qualified workers in Ukraine is essential for aligning with the country's energy sector development and sustainability goals. The following recommendations aim to ensure that these educational cases effectively address industry-specific needs, modern labour market requirements, and technological advancements.

Tailoring educational cases to specific industries. Energy efficiency challenges vary across sectors, and educational cases should reflect the unique needs of key industries: 1) construction (focusing on energy-efficient renovations of Soviet-era buildings); 2) agriculture (exploring energy-saving techniques for farming equipment and irrigation systems); 3) manufacturing (addressing optimization of energy use in industrial processes); and 4) renewable energy (highlighting the implementation of solar, wind, and biomass energy solutions). This approach ensures that students acquire relevant skills and knowledge for Ukraine's economy.

Adopting an interdisciplinary approach. Energy efficiency spans multiple fields, including engineering, economics, environmental science, and policy. Educational cases should encourage students to 1) approach problems from multiple perspectives (technological, economic, and environmental), and 2) foster critical thinking and collaboration across disciplines, enabling students to solve complex, real-world energy challenges.

Incorporating real-world production scenarios. Engaging students with real production situations will enhance practical problem-solving skills. By addressing live industry challenges such as a) conducting energy audits, b) modernizing infrastructure, and c) integrating renewable energy. Students will gain hands-on experience that better prepares them for professional work.

Integrating modern energy-efficient technologies. Case studies should include examples of cutting-edge technologies, such as a) renewable energy systems (solar, wind, and biomass), and b) energy storage solutions. Exposing students to these technologies prepares them to apply energy-saving solutions in various sectors and keeps them aligned with global trends.

Promote ecologically oriented professional thinking. Given Ukraine's environmental challenges, it is crucial to instil an understanding of the long-term benefits of energy conservation. Students should recognize how energy efficiency measures can reduce costs, improve air quality, and decrease reliance on imported energy, as well as support Ukraine's energy security and sustainability efforts.

Regularly updating case studies. Case studies should be updated regularly to reflect technological advancements, policy changes, and market trends. This ensures that students are equipped with the most current knowledge and skills to address dynamic energy efficiency challenges.

By implementing these recommendations, Ukraine can enhance vocational training programmes that not only develop practical skills but also equip future qualified workers with the expertise needed to contribute to the country's energy efficiency goals. These approaches will increase employability, foster sustainable development, and support energy modernization in Ukraine.

Future research prospects include developing more detailed instructional materials for teachers on the implementation of case studies. Additionally, there is potential for exploring the adaptation of international experiences in creating case studies that focus on developing skills for working with energy-efficient technologies.

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