UDC 69.003:502.174](477)
ISSN: 2707-3092 (Online)
DOI: https://doi.org/10.32835/2707-3092.2025.30.61-69

Institute of Vocational Education of NAES of Ukraine

Professional Pedagogics/1(30)'2025, pp. 61-69

ENERGY-EFFICIENT RECONSTRUCTION OF UKRAINE: ECOLOGICALLY-ORIENTED TRAINING OF CONSTRUCTION INDUSTRY SPECIALISTS

Tetiana Pashchenko

Candidate of Pedagogical Sciences, Senior Research Fellow, Department of Subject matter and Technologies of Vocational Education, Institute of Vocational Education of the National Academy of Pedagogical Sciences of Ukraine, http://orcid.org/0000-0002-7629-7870, e-mail: tantarena@ukr.net

Abstract:

Relevance: Determined by the need for Ukraine's reconstruction based on principles of energy efficiency and sustainable development, which aligns with both internal economic challenges and international environmental standards.

Aim: To analyze the challenges and prospects of training construction industry specialists in the context of energy-efficient construction, to identify key competencies of future builders, and to outline directions for improving educational programs in accordance with modern environmental requirements.

Methods: Theoretical methods of analysis, systematization, and generalization of scientific sources and regulatory documents, comparative analysis of global experience in training builders in the context of energy efficiency, and forecasting methods for developing recommendations on improving educational policy in the construction sector.

Results: Modern trends in the development of the construction industry in sustainable construction and specialist training have been investigated. Key competencies necessary for future builders to work in energy-efficient construction have been identified, including technical, cognitive, behavioral-activity, and social competencies. Special attention has been paid to the principles of eco-oriented education, teaching methods, and global experience in training specialists in sustainable construction. Successful educational practices that integrate ecological principles into curricula have been analyzed, and directions for improving the professional training of future builders in accordance with international standards have been proposed.

Conclusions: Eco-oriented training of construction industry specialists in energy efficiency is an important condition for ensuring the country's sustainable development and its integration into the European economic space; the introduction of modern teaching methods, the use of renewable energy sources, and the adaptation of international standards will contribute to the creation of highly qualified specialists capable of working in the face of new environmental challenges.

Keywords: *energy efficiency, energy-efficient competence, construction, eco-oriented training, future builders.*

Introduction. The full-scale war ongoing in Ukraine has caused significant destruction to residential, social, and industrial infrastructure. According to estimates by the Kyiv School of Economics (KSE) and Forbes Ukraine magazine, damages in the construction industry amount to hundreds of billions of dollars and continue to grow (Kyiv School of Economics, 2025; Antoniuk, 2025). However, the country's reconstruction must not merely be the restoration of destroyed objects, but a modernization of the entire infrastructure in accordance with the principles of energy efficiency and environmental sustainability. This aligns with both national interests and global trends, particularly the European Green Deal (European Commission, 2019), which defines the direction of development for the

construction sector in EU countries, focusing on reducing energy consumption and decarbonizing construction.

The training of construction industry specialists plays a significant role in this process. These specialists must not only possess traditional skills in designing and erecting structures but also understand the principles of energy-efficient construction, circular economy, the use of environmentally friendly materials, and modern digital technologies. Therefore, the issue of reforming educational programs and personnel training in accordance with new challenges is extremely urgent.

The war has changed Ukraine's construction sector not only in terms of physical destruction but also in its approaches to reconstruction. One of the key problems is the personnel deficit caused by the mobilization of a significant portion of the working-age population and the forced migration of qualified specialists. At the same time, the construction industry faces serious challenges related to the destruction of energy infrastructure, requiring the implementation of autonomous and resource-saving technologies. The rising cost of construction materials and the need to harmonize Ukrainian standards with European norms further complicate the situation, but also open up opportunities for industry modernization.

The transition to energy-efficient construction is not just a forced response to energy challenges, but a strategic decision that will enable reduced energy consumption and decreased reliance on fossil fuels. Implementing modern insulation technologies, using renewable energy sources such as solar panels or heat pumps, and intelligent planning of ventilation and heat recovery systems – all this will contribute to creating a comfortable and safe living environment, as well as optimizing operating costs.

At the same time, the issue of adapting construction education to new realities remains important. Specialists must be prepared not only to use modern construction materials but also to integrate digital technologies such as BIM modeling (Building Information Modeling), big data analytics in construction, automation of design, and energy consumption management. It is the digitalization of the construction industry, along with the use of environmentally safe technologies, that will allow Ukraine not only to recover but also to become a leading country in sustainable construction.

Furthermore, high-quality training of construction personnel is a necessary condition for Ukraine's integration into the European economic space. Compliance with international standards, such as the Energy Performance of Buildings Directive (EPBD), and the ability to attract investments from international financial institutions (World Bank, EBRD, EIB) will largely depend on how well specialists master modern construction methods and sustainable development principles.

Under such conditions, the necessity of forming and developing energy-efficient competence in future builders becomes especially important. It not only contributes to improving professional training but also ensures compliance with the requirements of the modern labor market and global environmental challenges. That is why the key guiding principle for modernizing the vocational education system should be the development of "the specialist's personality as the highest value of the state and the main driver of renewing production relations" (Yershova, 2018, p. 162).

Thus, the formation of energy-efficient competence in future skilled workers of the construction industry is not only relevant but also a necessary step in training highly qualified specialists. This process is crucial for implementing a strategy of sustainable (balanced) societal development, which provides for the rational use of natural resources, reduction of energy consumption, integration of energy-efficient technologies into construction, and the formation of environmental responsibility among construction industry specialists.

The introduction of innovative educational programs focused on energy efficiency and environmental safety will ensure the creation of an economically sustainable and comfortable infrastructure that meets the requirements of the 21st century.

Research Sources. The theoretical analysis of the problem was conducted based on scientific works concerning energy efficiency in the construction industry and the formation of relevant competencies in future specialists (V. Bezyazychnyi, O. Hlushchenko, O. Kovalenko, N.

Kulalaieva, N. Maistrenko, A. Mandryka, V. Radkevych, et al.). Ukrainian scholars have investigated various aspects of forming energy-efficient competence in future specialists. Specifically, V. Radkevych emphasizes that the rational use of energy resources at state, regional, and personal levels requires the formation of energy-efficient awareness among all citizens, including both management structures and production personnel of enterprises. An important aspect is involving students and pupils in studying energy efficiency issues, as they will become direct participants in the processes of developing high-tech products and providing quality services to the population in the future (Radkevych, 2013).

N. Kulalaieva, while researching the methodology for forming energy-efficient competence in future builders through project-based learning, notes that "energy efficiency, comfortable stay in buildings, and reduction of negative environmental impact are the main aspects of 'sustainable,' 'green' construction" (Kulalaieva, 2018).

O. Zakharova and D. Kozyriev, in defining approaches to infrastructure reconstruction in the post-war period, emphasize "the use of ecological construction technologies and ensuring the reliability of buildings for all types of purposes, building a safe and reliable energy infrastructure of the city based on the creation of 'smart' grids and the use of alternative energy sources" (Zakharova, Kozyriev, 2022, p. 7).

Foreign authors associate energy saving with emissions reduction, which forms the basis for satisfying people's desire for a better life. It is improved energy efficiency that is "a practical way to reduce emissions and save energy, implying improved energy efficiency planning in smart cities" (Wang et al., 2021; Cui & Cao, 2024).

A significant number of studies address energy efficiency in the context of determining the energy potential of renewable energy sources, the application of solar, hydro, hydrogen, geothermal energy, bioenergy, wind energy, building energy efficiency, and rational energy use, among others. Despite numerous publications on energy efficiency, researchers still state insufficient coverage of "energy efficiency, as well as the economic, environmental, and social benefits of energy saving among vocational students" (Hlushchenko, 2017, p. 42).

The results of the scientific search confirm the necessity and expediency of researching eco-oriented training of construction industry specialists for Ukraine's energy-efficient reconstruction.

The aim of this study is to analyze the challenges and prospects of training construction industry specialists, considering the requirements of energy efficiency and environmental orientation. The research tasks include defining key components of training, examining existing methodologies, and developing recommendations for their improvement. Primary attention is given to analyzing the experience gained in domestic and foreign educational institutions, as well as studying examples of successful implementation of energy-efficient technologies in construction practice.

Research Methods. A complex of scientific methods was used in the study of environmentally oriented training of construction industry specialists for the energy-efficient reconstruction of Ukraine. Theoretical methods include analysis, systematization, and generalization of scientific literature, regulatory documents, and international experience in the formation of energy-efficient competence in future builders. Comparative analysis allowed for the identification of modern trends in the training of builders in countries successfully implementing environmental standards in construction. Practical methods, particularly forecasting, were used to develop recommendations for improving the vocational education system in the context of sustainable development of Ukraine's construction industry.

Results and Discussion. The modern world faces global environmental challenges that demand radical changes in all spheres of human activity. The construction industry, one of the most resource-intensive and environmentally impactful sectors, requires special attention, as its development is closely linked not only to environmental challenges but also to the country's overall economic state. Foreign researchers emphasize that a state's economic prosperity often coincides with the active development of its construction sector (Osuizugbo et al., 2023). As a fundamental driver of economic growth, the construction sector not only provides society with necessary infrastructure but also

stimulates production in interconnected industries, creating additional jobs and enhancing the country's investment attractiveness (Su et al., 2022). The transition to sustainable development and minimization of negative environmental impact is impossible without training specialists capable of designing, building, and operating buildings according to ecological principles. Therefore, eco-oriented training of construction industry specialists becomes a key task of modern education and a strategic element in ensuring Ukraine's energy-efficient reconstruction.

Eco-oriented training of construction industry specialists in the context of energy efficiency is a process of forming energy-efficient competence, knowledge, skills, and beliefs aimed at mitigating the negative impact of construction activities on the environment "throughout the entire life cycle of a building: from design and construction to operation and disposal" (Borovyk, Yelagin, Polyakova, 2021).

The modern construction industry demands that specialists not only possess traditional professional skills but also the ability to implement energy-efficient technologies, which is a key factor in sustainable development and rational resource use. The competencies necessary for future builders to work with modern energy-saving approaches can be divided into technical, cognitive, behavioral-activity, and social.

Technical competencies include: proficiency in energy-efficient construction technologies (e.g., "passive house" concept, "green" standards (LEED, BREEAM, DGNB), innovative thermal insulation materials and recovery technologies); ability to work with software for designing and modeling energy-efficient buildings (AutoCAD, Revit, EnergyPlus, DesignBuilder) to optimize energy costs; understanding of physical processes in construction (heat transfer, ventilation, influence of climatic conditions on building operational characteristics); practical skills in implementing energy-saving technologies (use of renewable energy sources, integration of "smart" building management systems, etc.).

Cognitive competencies ensure: analytical thinking (ability to evaluate technical solutions from the perspective of energy efficiency and their economic feasibility); critical thinking (evaluation and comparison of alternative construction solutions to minimize energy consumption); innovative thinking (generation of new ideas for energy saving, adaptation of global practices to local conditions); understanding of norms and standards (knowledge of legislative requirements for energy efficiency and ecological construction, etc.).

Behavioral-activity competencies include: teamwork (ability to interact with architects, engineers, clients, and environmentalists during project development and implementation); organizational skills (planning construction stages with consideration of energy saving and cost optimization); decision-making ability (choosing the best materials and technologies for energy-efficient construction in specific conditions).

Social competencies: environmental responsibility (awareness of the need for rational use of natural resources and reduction of carbon footprint); communication skills (ability to effectively explain the benefits of energy-efficient solutions to clients, contractors, and employees); self-learning skills (continuous updating of knowledge in technological innovations, participation in trainings and professional courses).

The implementation of energy-efficient construction requires a comprehensive approach to competence acquisition for future specialists. The combination of technical knowledge, analytical skills, organizational effectiveness, and environmental awareness will enable builders to develop and implement effective, economically viable, and environmentally safe solutions. Therefore, educational institutions must adapt their educational programs to modern requirements of energy saving and sustainable development in the construction industry.

Eco-oriented education for the energy-efficient construction industry is based on several fundamental principles:

- *Holistic systemic approach* – viewing a building as a complex ecosystem interacting with the environment to ensure consideration of all stages of the building's life cycle, from design and construction to operation and use;
- *Sustainable development* (ensuring the needs of the modern generation without harming possible future generations) – rational use of resources, minimization of waste and pollution, and ensuring

the durability and adaptability of buildings (example: use of local building materials, which reduces transport costs and emissions, supports the local economy, and reduces negative environmental impact);

- *Integration of knowledge* (combining knowledge from various disciplines such as architecture, building materials, ecology, economics, and social sciences), which enables the development of comprehensive solutions that consider all aspects of sustainable construction;
- *Practical orientation* – equipping students with practical skills and knowledge necessary for the implementation of energy-efficient and environmentally safe projects. Students should have the opportunity to model scenarios and evaluate the impact of various parameters (e.g., thermal insulation, orientation, different types of windows) on a building's energy consumption.

In the professional training of future skilled workers in the construction industry, it is appropriate to apply the following directions of eco-oriented training for specialists in energy efficiency: Fundamentals of energy saving and energy efficiency: studying principles of heat transfer, heating, ventilation, and air conditioning systems, familiarization with various types of thermal insulation materials and their properties, knowledge of methods for assessing the energy efficiency of buildings, etc. Renewable energy sources: familiarization with technologies for using solar, wind, geothermal energy, etc., to meet building energy needs. Ecological building materials: studying the characteristics of environmentally friendly building materials such as wood, natural stone materials, straw, production waste, and methods of their use in construction. Designing energy-efficient buildings: concepts of "passive house," "zero-energy house," "active house" construction (Radkevych, 2015, pp. 55-62), optimization of building orientation, use of natural lighting and ventilation, and selection of energy-efficient equipment and systems. Building energy consumption management: studying methods for monitoring and controlling building energy consumption, as well as developing strategies for energy saving and optimizing energy efficiency.

Effective eco-oriented training of construction industry specialists requires the application of diverse teaching methods that activate students' cognitive activity and contribute to the formation of practical skills: interactive lectures and seminars (ensuring active student participation in discussions of current issues of energy efficiency and ecological construction); problem-based learning (considering real ecological problems related to construction activities and finding ways to solve them); project activities (development and implementation of projects for energy-efficient modernization of buildings, green building, use of renewable energy sources, processing of construction waste) (Kulalaieva, 2018); case method (solving real-life situations – examples of applying energy-efficient technologies) (Hlushchenko, 2017); practical classes and laboratory works (conducting experiments and measurements to assess the ecological characteristics of building materials, energy efficiency of buildings, etc.); business games and simulations (modeling real situations related to the design, construction, and operation of energy-efficient buildings); excursions to ecologically oriented construction sites (familiarization with advanced experience in ecological construction); involvement of experts (conducting lectures and seminars with the participation of specialists in ecological construction, representatives of construction companies and organizations involved in building certification).

Globally, more and more educational institutions are integrating ecological principles into their educational programs, preparing future specialists for work in the context of sustainable development and energy-efficient construction. Below are examples of successful eco-oriented training practices in foreign educational institutions.

German universities and colleges offer a wide range of energy-efficient construction programs that include theoretical training, practical classes, and internships at construction companies. Special attention is paid to the use of renewable energy sources and environmentally friendly building materials, for example, the Technical University of Munich (TUM, 2025) has a "Resource Efficient and Sustainable Building" program.

Swiss educational institutions actively offer interactive teaching methods such as case studies and project-based learning. Students have the

opportunity to develop their own energy-efficient building projects and present them at competitions and conferences. For example, the ENBau initiative, founded by Swiss universities, offers advanced training programs in sustainable construction, energy efficiency, and renewable energy sources. These programs include modules on designing passive solar buildings and managing the energy efficiency of real estate, which contributes to the development of practical skills in students.

Conclusions. It is evident that, being a complex, multifaceted, and multilevel construct, energy-efficient competence cannot be formed solely through the acquisition of predominantly theoretical knowledge. Its development requires the comprehensive implementation of educational and upbringing, classroom and extracurricular pedagogical tools within a holistic educational process. Eco-oriented training of construction industry specialists in energy efficiency is a key factor for ensuring the sustainable development of society. It requires a comprehensive approach that includes the integration of knowledge from various disciplines, practical orientation, and the use of modern teaching methods and tools. The implementation of eco-oriented approaches into the curricula of construction specialties makes it possible to prepare a generation of specialists who will design, build, and operate energy-efficient and environmentally safe buildings, contributing to the sustainable development of Ukraine.

List of references

Антонюк, Т., (2025, лютий, 14). Прямі збитки України через війну сягнули $170 млрд. Оцінка KSE Institute. Forbes Ukraine. https://forbes.ua/news/pryami-zbitki-ukraini-cherez-viynu-syagnuli-170-mlrd-otsinka-kse-institute-14022025-27193

Боровик, Ю. Т., Єлагін, Ю. В., Полякова, О. М. (2021). Стійке будівництво: сутність, принципи, тенденції розвитку. Вісник економіки транспорту і промисловості, 72-73, 47-56.

Глущенко, О. В. (2017). Формування енергоефективної компетентності майбутніх кваліфікованих робітників машинобудівного профілю (Дисертація кандидата педагогічних наук). Національна академія педагогічних наук України, Інститут професійно-технічної освіти. Керівник: Радкевич, В. О.

Єршова, Л., (2018). Трансформація системи цінностей учнівської і студентської молоді в контексті реформування вітчизняної професійної освіти. Науковий вісник Інституту професійно-технічної освіти НАПН України. Професійна педагогіка, 16, с. 162-168. DOI: http://doi.org/10.32835/2223-5752.2018.16.162-168.

Захарова, О. В., Козирєв, Д. М. (2022). Концепція розумного міста як альтернативний підхід до відновлення міської інфраструктури України в повоєнний період. Збірник наукових праць ЧДТУ. 67. 5-14.

Коваленко, О. М. (2023). Формування енергоефективної компетентності майбутніх інженерів: порівняльний аналіз. Вісник Національного технічного університету України «КПІ», 3(123), 45-52. https://www.ntu-kpi.ua/uk/journal

Кулалаєва, Н. В. (2018). Формування енергоефективної компетентності майбутніх кваліфікованих робітників будівельного профілю через проектне навчання. Вісник Глухівського національного педагогічного університету імені Олександра Довженка : Педагогічні науки. 2(2). 118-124. http://nbuv.gov.ua/UJRN/vgnpu_2018_2(2)__18 .

Радкевич, В. О. (2015). Формування енергоефективної культури діяльності виробничого персоналу (на прикладі галузей, суміжних з будівельною): посібник: Київ.

Радкевич, В. О. (2013). Енергоефективність у підготовці майбутніх фахівців будівельного профілю. Нові комп'ютерні технології, 8 (1), 58-60. https://doi.org/10.55056/nocote.v8i1.167.

Cui, H.-y., & Cao, Y.-q. 2024. Do smart cities improve energy efficiency? A test of spatial effects and mechanisms. Sustainable Cities and Society, 100. https://doi.org/10.1016/j.scs.2023.105124.

European Commission. (2019). The European Green Deal (COM (2019) 640 final). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019 DC0640

Kyiv School of Economics. (2025). War-Induced Damages and Reconstruction in Ukraine. https://publications.kse.ua/publications/warinduced-damages-reconstruction-ukraine-463

Osuizugbo, I. C., Aina, O. O., & Onokwai, A. O. (2023). Roles of clients in buildability improvement in Nigeria: An exploratory factor analysis. Built Environment Project and Asset Management, 13, 862–879. https://doi.org/10.1108/BEPAM-01-2023-0007.

Su, Y., Zou, Z., Ma, X., & Ji, J. (2022). Understanding the relationships between the development of the construction sector, carbon emissions, and economic growth in China: Supply-chain level analysis based on the structural production layer difference approach. Sustainable Production and Consumption, 29, 730–743. https://doi.org/10.1016/j.spc.2021.11.018

Technical University of Munich (2025). Resource Efficient and Sustainable Building. https://www.tum.de/en/studies/degree-programs/detail/resource-efficient-and-sustainable-building-master-of-science-msc

Wang, C., Gu, J., Martínez, O. S., & Crespo, R. G. 2021. Economic and environmental impacts of energy efficiency over smart cities and regulatory measures using a smart technological solution. Sustainable Energy Technologies and Assessments, 100. https://doi.org/10.1016/j.seta.2021.101422.

Translated & Transliterated

Antoniuk, T., (2025, liutyi, 14). Priami zbytky Ukrainy cherez viinu siahnuly $170 mlrd. Otsinka KSE Institute [Ukraine's direct losses due to the war reached $170 billion. Estimated by the KSE Institute.]. *Forbes Ukraine*. https://forbes.ua/news/pryami-zbitki-ukraini-cherez-viynu-syagnuli-170-mlrd-otsinka-kse-institute-14022025-27193, [in Ukrainian].

Borovyk, Yu. T., Yelahin, Yu. V., Poliakova, O. M. (2021). Stiike budivnytstvo: sutnist, pryntsypy, tendentsii rozvytku [Sustainable construction: essence, principles, development trends]. *Visnyk ekonomiky transportu i promyslovosti [Bulletin of the Economy of Transport and Industry]*, 72-73, 47-56, [in Ukrainian].

Hlushchenko, O. V. (2017). *Formuvannia enerhoefektyvnoi kompetentnosti maibutnikh kvalifikovanykh robitnykiv mashynobudivnoho profiliu [Formation of energy-efficient competence of future qualified workers in the mechanical engineering field]* (Dysertatsiia kandydata pedahohichnykh nauk). Natsionalna akademiia pedahohichnykh nauk Ukrainy, Instytut profesiino-tekhnichnoi osvity. Kerivnyk: Radkevych, V. O., [in Ukrainian].

Yershova, L., (2018). Transformatsiia systemy tsinnostei uchnivskoi i studentskoi molodi v konteksti reformuvannia vitchyznianoi profesiinoi osvity [Transformation of the students' values system in the context of domestic vocational education and training reforming]. *Naukovyi visnyk Instytutu profesiino-tekhnichnoi osvity NAPN Ukrainy. Profesiina pedahohika [Scientific Herald of the Institute of Vocational Education and Training of NAES of Ukraine. Vocational pedagogy],* 16, s. 162-168. DOI: http://doi.org/10.32835/2223-5752.2018.16.162-168, [in Ukrainian].

Zakharova, O. V., Kozyriev, D. M. (2022). Kontseptsiia rozumnoho mista yak alternatyvnyi pidkhid do vidnovlennia miskoi infrastruktury Ukrainy v povoiennyi period [The concept of a smart city as an alternative approach to the restoration of urban infrastructure in Ukraine in the post-war period]. *Zbirnyk naukovykh prats ChDTU [Collection of scientific works of ChSTU].* 67. 5-14, [in Ukrainian].

Kovalenko, O. M. (2023). Formuvannia enerhoefektyvnoi kompetentnosti maibutnikh inzheneriv: porivnialnyi analiz [Formation of energy-efficient competence of future engineers: comparative analysis.]. *Visnyk Natsionalnoho tekhnichnoho universytetu Ukrainy «KPI» [Bulletin of the National Technical University of Ukraine «KPI»]*, 3(123), 45-52. https://www.ntu-kpi.ua/uk/journal, [in Ukrainian].

Kulalaieva, N. V. (2018). Formuvannia enerhoefektyvnoi kompetentnosti maibutnikh kvalifikovanykh robitnykiv budivelnoho profiliu cherez proektne navchannia [Formation of energy-efficient competence of future qualified construction workers through project-based learning]. *Visnyk Hlukhivskoho natsionalnoho pedahohichnoho universytetu imeni Oleksandra Dovzhenka: Pedahohichni nauky [Bulletin of the Oleksandr Dovzhenko Glukhiv National Pedagogical University: Pedagogical Sciences]*. 2(2). 118-124. http://nbuv.gov.ua/UJRN/vgnpu_2018_2(2)__18, [in Ukrainian].

Radkevych, V. O. (2015). *Formuvannia enerhoefektyvnoi kultury diialnosti vyrobnychoho personalu (na prykladi haluzei, sumizhnykh z budivelnoiu) [Formation of an energy-efficient culture of production personnel (using the example of industries related to construction)]*: posibnyk: Kyiv, [in Ukrainian].

Radkevych, V. O. (2013). Enerhoefektyvnist u pidhotovtsi maibutnikh fakhivtsiv budivelnoho profiliu [Energy efficiency in the training of future construction specialists]. *Novi kompiuterni tekhnolohii [New computer technologies]*, 8 (1), 58-60. https://doi.org/10.55056/nocote.v8i1.167, [in Ukrainian].

Cui, H.-y., & Cao, Y.-q. 2024. Do smart cities improve energy efficiency? A test of spatial effects and mechanisms. *Sustainable Cities and Society*, 100. https://doi.org/10.1016/j.scs.2023.105124, [in English].

European Commission. (2019). *The European Green Deal* (COM (2019) 640 final). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019 DC0640, [in English].

Kyiv School of Economics. (2025). *War-Induced Damages and Reconstruction in Ukraine*. https://publications.kse.ua/publications/warinduced-damages-reconstruction-ukraine-463, [in English].

Osuizugbo, I. C., Aina, O. O., & Onokwai, A. O. (2023). Roles of clients in buildability improvement in Nigeria: An exploratory factor analysis. *Built Environment Project and Asset Management*, 13, 862–879. https://doi.org/10.1108/BEPAM-01-2023-0007, [in English].

Su, Y., Zou, Z., Ma, X., & Ji, J. (2022). Understanding the relationships between the development of the construction sector, carbon emissions, and economic growth in China: Supply-chain level analysis based on the structural production layer difference approach. *Sustainable Production and Consumption*, 29, 730–743. https://doi.org/10.1016/j.spc.2021.11.018, [in English].

Technical University of Munich (2025). *Resource Efficient and Sustainable Building*. https://www.tum.de/en/studies/degree-programs/detail/resource-efficient-and-sustainable-building-master-of-science-msc, [in English].

Wang, C., Gu, J., Martínez, O. S., & Crespo, R. G. 2021. Economic and environmental impacts of energy efficiency over smart cities and regulatory measures using a smart technological solution. *Sustainable Energy Technologies and Assessments*, 100. https://doi.org/10.1016/j.seta.2021.101422, [in English].

DOI: https://doi.org/10.32835/2707-3092.2025.30.61-69

ЕНЕРГОЕФЕКТИВНА ВІДБУДОВА УКРАЇНИ: ЕКООРІЄНТОВАНА ПІДГОТОВКА ФАХІВЦІВ БУДІВЕЛЬНОЇ ГАЛУЗІ

Тетяна Пащенко

кандидат педагогічних наук, старший науковий співробітник відділу змісту і технологій професійної освіти Інституту професійної освіти НАПН України, http://orcid.org/0000-0002-7629-7870, e-mail: tantarena@ukr.net

Реферат:

Актуальність: зумовлена потребою у відбудові України на принципах енергоефективності та сталого розвитку, що відповідає як внутрішнім економічним викликам, так і міжнародним екологічним стандартам.

Мета: проаналізувати виклики та перспективи підготовки фахівців будівельної галузі в умовах енергоефективного будівництва, визначити ключові компетентності майбутніх будівельників та окреслити напрями вдосконалення освітніх програм у відповідності до сучасних екологічних вимог.

Методи: теоретичні методи аналізу, систематизації та узагальнення наукових джерел і нормативно-правових документів, порівняльний аналіз світового досвіду підготовки будівельників у контексті енергоефективності, а також методи прогнозування для розроблення рекомендацій щодо вдосконалення освітньої політики у сфері будівництва.

Результати: досліджено сучасні тенденції розвитку будівельної галузі у сфері сталого будівництва та підготовки фахівців. Визначено основні компетентності, необхідні майбутнім будівельникам для роботи в умовах енергоефективного будівництва, зокрема технічні, когнітивні, поведінково-діяльнісні та соціальні. Окрема увага приділена принципам екоорієнтованої освіти, методам навчання та світовому досвіду підготовки фахівців у сфері сталого будівництва. Проаналізовано успішні освітні практики, що інтегрують екологічні

принципи в навчальні програми, та запропоновано напрями вдосконалення професійної підготовки майбутніх будівельників відповідно до міжнародних стандартів.

Висновки: екоорієнтована підготовка фахівців будівельної галузі з питань енергетичної ефективності є важливою умовою забезпечення сталого розвитку країни та її інтеграції в європейський економічний простір; упровадження сучасних методів навчання, використання відновлюваних джерел енергії та адаптація міжнародних стандартів сприятиме створенню висококваліфікованих спеціалістів, здатних працювати в умовах нових екологічних викликів.

Ключові слова: *енергетична ефективність, енергоефективна компетентність, будівництво, екоорієнтована підготовка, майбутні будівельники.*

Received: 30 February 2024
Accept: 08 July 2025