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IMPLEMENTING ENERGY EFFICIENCY POLICIES IN GERMAN VOCATIONAL EDUCATION: PROSPECTS FOR UKRAINE

ABSTRACT

This article examines the implementation of energy efficiency policies in German vocational education and training (VET) and explores prospects for their adaptation in Ukraine. Drawing on sustainable development theory, competence-based education, and policy transfer models, it analyses how German VET institutions systematically integrate energy efficiency through curriculum design, dual education structures, strong industry collaboration, and alignment with national and European sustainability policies, including the EU Green Deal objectives. Literature review, document analysis, and comparative analysis reveal that Germany's approach equips learners with technical knowledge, practical skills, problem-solving abilities, digital literacy, environmental responsibility, and ecological awareness, fostering sustainable professional practices and preparing the workforce for a green, low-carbon economy. The article identifies key opportunities for Ukraine, including the development of competence-based curricula, modernisation of educational infrastructure, teacher upskilling, establishment of long-term public-private partnerships, and enhanced collaboration among policymakers, educators, industry stakeholders, and civil society actors. Effective adaptation requires careful consideration of Ukraine's socio-economic, cultural, and institutional conditions, as well as alignment with national energy strategies and sustainable development priorities, to ensure successful and context-sensitive implementation. The findings provide actionable recommendations for policymakers, educational leaders, and VET institutions and outline directions for further research, including evaluating the impact of energy efficiency initiatives on learner competence, professional readiness, curriculum effectiveness, teacher training, institutional capacity, and the scalability and sustainability of reforms across different regions of the country. Further research needed to examine the practical implementation of these recommendations in Ukrainian VET institutions is outlined.

***Keywords*:** *vocational education and training, energy efficiency, sustainable development, green competencies, Germany, Ukraine, education policy, professional development.*

ВПРОВАДЖЕННЯ ЕНЕРГОЕФЕКТИВНОЇ ПОЛІТИКИ У ЗАКЛАДАХ ПРОФЕСІЙНОЇ ОСВІТИ НІМЕЧЧИНИ: ПЕРСПЕКТИВИ ДЛЯ УКРАЇНИ

АНОТАЦІЯ

У статті порушено проблему впровадження енергоефективної політики у закладах професійної освіти (VET) Німеччини. Проаналізовано перспективи успішної адаптації зазначеної ініціативи у системі професійної освіти в Україні. У контексті

теорії сталого розвитку, компетентнісної освіти та моделі трансферу політики, досліджено, яким чином заклади професійної освіти Німеччини інтегрують принципи енергоефективності, зокрема через розроблення освітніх програм, дуальну систему освіти, тісну співпрацю з промисловим сектором й узгодження навчання з національною і європейською політикою сталого розвитку, включно з цілями Європейського зеленого курсу. Зазначено, що підхід німецьких колег забезпечує здобувачів освіти технічними знаннями, практичними навичками, умінням розв'язувати проблеми, цифровою грамотністю, екологічною відповідальністю та екологічною свідомістю, готуючи робочу силу до «зеленої» економіки. У статті також визначено ключові можливості для України, серед яких розроблення компетентнісно орієнтованих освітніх програм, модернізація освітньої інфраструктури, підвищення кваліфікації педагогів, створення довгострокових державно-приватних партнерств і посилена співпраця між політиками, освітянами, представниками промисловості та громадянського суспільства. Ефективна адаптація потребує ретельного врахування соціально-економічних, культурних та інституційних умов України, а також узгодження з національними енергетичними стратегіями та пріоритетами сталого розвитку. Отримані результати містять практичні рекомендації для освітніх лідерів, а також окреслюють напрями подальших досліджень, зокрема оцінювання впливу ініціатив з енергоефективності на компетентності здобувачів освіти, їхню професійну готовність, ефективність освітніх програм, підготовку викладачів, інституційну спроможність, а також на масштабованість і сталість реформ у різних регіонах країни. Окреслено перспективи подальших досліджень особливостей практичного впровадження цих рекомендацій в українських закладах професійної освіти.

Ключові слова: *професійна освіта, енергоефективність, сталий розвиток, зелені компетентності, Німеччина, Україна, освітня політика, професійний розвиток.*

INTRODUCTION

In recent years, global environmental challenges such as climate change, resource depletion, and pollution have underscored the urgent need for sustainable development across all sectors. The European Union's Green Deal, launched as a comprehensive strategy to achieve climate neutrality by 2050, has further intensified efforts to integrate sustainability principles into economic, social, and educational policies (European Commission, 2019). Among these, education, particularly vocational education and training (VET), holds a pivotal position.

According to S. Nielsen, VET is uniquely tasked with preparing a skilled workforce capable of driving the transition towards a green economy. It is, however, only possible by equipping future technicians, engineers, and service professionals with the necessary competencies in energy efficiency, renewable technologies, and sustainable practices (Nielsen et al, 2023).

Germany, with its well-established dual education system that combines classroom instruction with practical workplace training, stands out as a leading example of successfully embedding energy efficiency and environmental considerations into vocational education. Its advanced environmental policies, strong collaboration between government, industry, and educational institutions, and continuous curriculum reforms have made the German VET system a model of how education can contribute effectively to sustainability goals. German VET institutions not only provide technical knowledge but also foster green skills, enabling learners to contribute to energy conservation and environmentally responsible innovation in their future professions (Albertz & Pilz, 2025).

Meanwhile, Ukraine is undergoing comprehensive reforms in its vocational education sector, aiming to modernise its systems and harmonise its standards with those of the European Union (European Commission, 2024). As Ukraine seeks to align its policies and educational practices with EU directives and green transition objectives, the experience of Germany offers valuable lessons and a practical roadmap for implementing energy efficiency within vocational education institutions.

By studying Germany's approach, Ukraine can identify effective strategies for curriculum development, infrastructure modernisation, and stakeholder engagement that support sustainable development and help prepare its workforce for the demands of a low-carbon economy.

THE AIM OF THE STUDY

Accordingly, this article aims to analyse the implementation of energy efficiency policies in German VET, identify key factors contributing to their success, and explore how these practices can be adapted to enhance Ukraine's VET system, strengthen green skills development, and support the country's sustainable development objectives.

THEORETICAL FRAMEWORK AND RESEARCH METHODS

The implementation of energy efficiency policies in VET can be analysed through the lenses of sustainable development theory, competence-based education, and policy transfer models. As noted by Abo-Khalil (2024), sustainable development theory emphasises integrating environmental, economic, and social dimensions into education, positioning vocational institutions as key drivers of the green transition. In this context, VET plays a dual role: preparing skilled professionals for the labour market and embedding sustainable values and practices into learners' professional identity (Siliņa-Jasjukeviča et al., 2025).

In Germany, VET has successfully incorporated energy efficiency through dual education structures, strong industry partnerships, and alignment with the European Union's Green Deal objectives (Koundouri et al., 2021). This approach exemplifies the systemic nature of sustainable development, where education, policy, and industry are closely interconnected.

Competence-based education theory provides a useful framework for understanding how energy efficiency skills can be developed in vocational contexts. According to Tahirsylaj and Sundberg (2025), competence-based education emphasises acquiring integrated knowledge, skills, and attitudes necessary for effective professional practice. Applied to energy efficiency, this involves equipping learners not only with technical expertise but also with digital literacy, ecological awareness, and problem-solving abilities that support sustainable decision-making in the workplace (Lo, 2024). Embedding energy efficiency standards into curricula, assessment, and teacher training ensures learners acquire both theoretical knowledge and applied skills aligned with current and future industry needs (Chinedu et al., 2023).

From a broader perspective, policy transfer and adaptation theory highlights how successful models in one national context can inform reforms in another. As Stone suggests, policy transfer involves not only adopting practices but also adapting them to fit specific socio-economic and institutional conditions (Stone et al, 2019). For Ukraine, the German experience offers a valuable framework for integrating energy efficiency into VET through curriculum reform, public-private partnerships, and collaboration among education providers, industry, and government. Effective adaptation, however, must address

Ukraine's specific challenges, including modernising training infrastructure, upskilling teachers, and aligning reforms with national energy and education strategies.

Thus, the theoretical framework places energy efficiency in VET at the intersection of sustainability, competence development, and international policy transfer. It provides a conceptual basis for analysing how Germany's achievements in embedding energy efficiency into vocational education can inform Ukraine's efforts to modernise its VET system and contribute to the country's sustainable development goals.

Research methods include literature review, document analysis, and comparative analysis to examine current practices in implementing energy efficiency policies within German VET institutions and explore their applicability and adaptation in the Ukrainian context.

RESULTS

The analysis of German VET institutions reveals a highly structured and multi-level approach to implementing energy efficiency policies. Literature review, document analysis, and comparative study indicate that Germany's success stems from three interrelated dimensions: *curriculum integration, industry collaboration,* and *systemic policy alignment*.

German VET curricula systematically embed energy efficiency principles across technical and vocational subjects, enabling learners to acquire a combination of theoretical knowledge, practical skills, and professional attitudes aligned with sustainable development objectives (Albertz & Pilz, 2025). Competence-based approaches ensure that students not only understand energy-efficient technologies but also develop problem-solving abilities, digital literacy, and ecological awareness, which support sustainable decision-making in real workplace contexts. Teacher training programmes similarly emphasise energy efficiency, ensuring instructors are equipped to deliver both knowledge and applied skills effectively (Brychkov et al., 2023).

Clarke et al. (2020) claim that strong collaboration between VET institutions and industry partners further facilitates hands-on learning and the practical application of energy efficiency standards. Dual education models allow students to rotate between classroom learning and industry placements, providing exposure to sustainable energy technologies, energy management practices, and workplace innovation. These partnerships also enable curricula to remain responsive to evolving industry requirements and European Union Green Deal objectives (Clarke et al., 2020).

Germany's approach is additionally reinforced by close alignment with national and EU sustainability policies (Peiseler & Serrenho, 2022). Institutional strategies integrate education, industrial, and governmental policies, creating a systemic environment where energy efficiency functions as both a learning outcome and a structural objective. Analysis of policy transfer indicates that these practices are embedded within a coordinated socio-economic framework, which supports long-term sustainability goals and provides lessons for adaptation in other national contexts (Alibašić & Atkinson, 2023).

Comparative analysis highlights the potential for Ukraine to adopt German strategies within its VET system. Opportunities include integrating energy efficiency into curricula, strengthening public-private partnerships, modernising training infrastructure, and implementing teacher upskilling programmes. Effective adaptation requires careful consideration of Ukraine's socio-economic and institutional conditions, including existing infrastructure limitations and resource constraints, while maintaining alignment with national energy and education strategies.

Based on these findings, practical recommendations for Ukrainian policymakers and VET institutions include the following: 1) *developing national guidelines for energy*

efficiency education, 2) *designing competence-based curricula with clear learning outcomes related to sustainable practices*, and 3) *fostering long-term collaboration with industry partners to provide students with hands-on experience*.

Additionally, targeted professional development programmes for instructors can ensure effective delivery of both technical skills and sustainable awareness, while pilot projects and incremental implementation can help tailor reforms to the Ukrainian context. Implementing these strategies would strengthen Ukraine's VET system, equip the workforce with essential green skills, and support the country's broader sustainable development objectives.

Overall, the German case demonstrates that successful implementation of energy efficiency in VET relies on the combination of competence-based curriculum design, practical industry engagement, and systemic policy coordination.

CONCLUSIONS AND PROSPECTS OF FURTHER RESEARCH

Therefore, this article demonstrates that Germany's VET system provides a successful model for integrating energy efficiency policies into the educational sector. Several recommendations can be proposed to support the integration of energy efficiency policies into Ukraine's VET system.

First, it is essential to develop national guidelines for energy efficiency education, establishing clear standards and objectives that align with Ukraine's national energy policies and European sustainability frameworks. These guidelines would provide a consistent foundation for curriculum development and institutional planning. Second, competence-based curricula should be designed to systematically embed energy efficiency principles across technical and vocational subjects. Curricula should define clear learning outcomes encompassing technical knowledge, practical skills, problem-solving abilities, digital literacy, and ecological awareness, while remaining flexible to adapt to evolving industry requirements and technological innovations.

Strengthening collaboration between VET institutions and industry partners is another key priority. Expanding dual education models, combining classroom learning with practical industry placements, will allow students to gain hands-on experience with sustainable energy technologies and energy management practices. Long-term partnerships with enterprises should also contribute to curriculum design, ensuring alignment with real-world energy efficiency standards. Modernising training infrastructure is equally important, with upgraded facilities, modern equipment, and simulation tools enabling learners to apply energy efficiency principles in practical contexts.

Targeted professional development programmes for instructors are essential to enhance technical expertise, sustainable awareness, and pedagogical skills. Continuous teacher training should include modules on energy efficiency, digital tools, and ecological practices. To ensure effective adaptation, pilot projects and incremental implementation can be introduced in selected VET institutions, allowing reforms to be tested, refined, and gradually scaled across different regions while considering local socio-economic conditions. Finally, systemic policy coordination is crucial, integrating educational reforms with national energy strategies and broader sustainability policies. Coordination among governmental bodies, educational authorities, and industry associations will support coherent and effective implementation.

Thus, adopting these strategies will strengthen Ukraine's VET system, accelerate the integration of sustainability principles, enhance the green skills of the workforce, and contribute to the country's broader sustainable development objectives.

Further research is needed to examine the practical implementation of these strategies in Ukrainian VET institutions. Longitudinal studies could evaluate the impact of curriculum reforms and industry partnerships on learners' competence and professional readiness. Comparative studies across different regions and sectors within Ukraine would provide insights into context-specific challenges and best practices. Additionally, research on teacher training effectiveness, resource allocation, and policy coordination can inform evidence-based strategies for scaling up energy efficiency initiatives in vocational education. Finally, continued investigation will help ensure that Ukraine's VET system can effectively contribute to a sustainable, low-carbon economy.

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