RENEWABLE ENERGY INDUSTRY & WAR RESILIENCY AND POST-WAR RECOVERY OF UKRAINE: CHALLENGE OF HUMAN RESOURCE DEVELOPMENT

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Abstract. *The paper analyzes the training of personnel with higher education in specialty 145 "Renewable energy sources and hydraulic power engineering" for staffing the renewable energy industry on the basis of formal lifelong learning. It is shown that this training, despite some progress, does not yet meet the challenges facing Ukraine recently. These challenges include increasing defense capabilities and security on a high-tech basis in the conditions of a protracted war, high-tech post-war reconstruction of the country, and effective European integration as a competitive state. Among the progressive developments in recent years in this specialty are a doubling (to six) of the number of universities providing relevant training, a multiple expansion of bachelor's training, sustained public support for training, and the willingness of the population to pay for applicants' education at their own expense. The unresolved current problems include the outdated standards of higher education, the stagnation of master's and the absence of doctoral training, which makes it impossible to have a holistic system of formal lifelong learning in higher education, and the general incompleteness of training, which, in conditions of resource shortage, does not allow providing adequate competitive quality. This negatively affects the implementation of the National Energy and Climate Plan for the period up to 2030 and the Strategy for the Development of Higher Education in Ukraine for 2022–2032 due to problems with the lack of relevant highly qualified personnel. It is recommended that state administration bodies pay special attention to ensuring a full-fledged system of formal training of specialists with higher education for renewable energy sources and hydraulic power engineering, in the process of updating the aforementioned National Plan in 2025 in accordance with the government mandate and when developing the draft Operational Plan for the implementation of the aforementioned Strategy in 2025–2028.*

Keywords: *European integration, formal lifelong learning, higher education, long war conditions, post-war recovery, renewable energy sources, Ukraine.*

INTRODUCTION

The full-scale and exhausting war of russian federation against Ukraine, now in its fourth year, has also proven to be a factor in technological progress. First, the technological basis of war itself has changed over this time. In modern warfare, the focus has shifted to the efficiency and effectiveness of weapons, the use of drones, artificial intelligence, etc. for this purpose. Secondly, the prospects for the country's post-war recovery include the priority of advanced technologies and their provision by highly qualified personnel (Vidnovlennia Ukrainy, n. d.).

Therefore, the objective increase in the importance of Electrical and Energy Engineering is accompanied by a natural enhance in the role of renewable energy and the training of personnel for its needs.

In addition, Ukraine's progress towards membership in the European Union also requires the modernization of the energy sector of the economy, especially the development of renewable energy sources, particularly in the context of environmental and climate security. In this regard, on June 25, 2024, the Government approved a comprehensive National Energy and Climate Plan for the period until 2030, which was submitted to the European Secretariat of the Energy Community. The Ministry of Economy of Ukraine, together with other interested central executive bodies, is also tasked to develop proposals for updating this National Plan and submit it to the Cabinet of Ministers of Ukraine by December 31, 2025 (Verkhovna Rada Ukrainy, 2024a).

As for the personnel support for solving the problem, the National Plan, among the negative factors and realities in which Ukraine finds itself, notes the multifaceted shortage of qualified personnel: its quantitative and qualitative losses, the shortage of appropriate training, the lack of competitiveness of specialists, etc. (Verkhovna Rada Ukrainy, 2024a).

Within the framework of the Bologna Process for the development of the European Higher Education Area (EHEA), the Tirana Communiqué of the Tirana EHEA Ministerial Conference on May 29–30, 2024, in the section "An innovative EHEA", emphasizes: "The EHEA also needs to respond to ongoing change, due to societal, economic, geopolitical, environmental and technological developments. As the world is in rapid change, this has important consequences for higher education. The green … transitions require unprecedented innovation with new technologies, processes and practices to drive positive change, as well as more

advanced and widespread levels of knowledge and skills, nurturing awareness, engagement and responsibility of learners". The corresponding obligations are imposed on Ukraine. (National Erasmus+ Office in Ukraine, 2024).

In the paper, presented at the 6th International Conference on Modern Electrical and Energy System (MEES'24), the authors analyzed the gains and losses in the training of bachelors, masters and doctors of philosophy in the field of study 14 "Electrical Engineering" as of mid-2024. This training was carried out in five specialties related to Electrical and Energy Engineering, including specialty 145 "Renewable energy sources and hydraulic power engineering". It was conducted by a total of 82 institutions (excluding the institutions of the Ministry of Defense of Ukraine due to limited availability of relevant data) (Zagirnyak et al, 2024).

Over the past year, there have been certain positive and negative changes in the training of highly qualified personnel, in particular in specialty 145 "Renewable energy sources and hydraulic power engineering" (YeDEBO, n. d.; Derzhavna sluzhba statystyky Ukrainy, 2021a, 2021b, 2024a, 2024b). In addition, for the purpose of European integration, changes have been made to the domestic List of fields of knowledge and specialties in which specialists with higher education are trained, which comes into effect in 2025. Therefore, this year the window of opportunity for a longitudinal comparative systematic statistical analysis of the state of affairs in the specified field of knowledge and the specialties assigned to it is closing for the purpose of effective operational and strategic response and adjustment of activities (Verkhovna Rada Ukrainy, 2024b).

PROBLEM STATEMENT

Given the current and future challenges for the country, an analysis of the state and justification of recommendations for the training of higher education personnel, providing a formal educational component for lifelong learning in specialty 145 "Renewable energy sources and hydraulic power engineering" in conditions of a protracted war, the tasks of post-war reconstruction and European integration of Ukraine and its higher education are an urgent and topical problem.

CURRENT OPPORTUNITIES FOR FORMAL LIFELONG LEARNING IN SPECIALTY 145 "RENEWABLE ENERGY SOURCES AND HYDRAULIC POWER ENGINEERING": CHALLENGES AND ANSWERS

In general, training of specialists with higher education in specialty 145 "Renewable energy sources and hydraulic power engineering" is carried out by six higher education institutions (HEIs) (see Table 1), as in the previous year, which is twice as many as in 2021.

Table 1.

The list of universities, which provide specialty 145 "Renewable energy sources and hydraulic power engineering", and number of students of this specialty as of June 15, 2025

No	HEIs *(Parts of Ukraine)*	Levels of higher education		
		Bachelor	*Master*	*PhD*
1	Kyiv National Un. of Construction and Architecture (*North Center*)	9	-	-
2	Vinnytsia National Technical Un. (*West Center*)	15	-	-
3	Zaporizhzhia National Un. (*South*)	29	8	-
4	Stepan Gzhytskyi National Un. of Veterinary Medicine and Biotechnologies Lviv (*West*)	71	-	-
5	The National Un. of Water and Environmental Engineering *(West)*	45	15	-
6	National Technical Un. "Kharkiv Polytechnic Institute" *(East)*	24	3	-
	Total	*193*	*26*	-

Note: Dark blue highlights PhD level, which is not provided at all.
Source: Created by the authors based on (YeDEBO, n. d.).

As can be seen from Table 1, these universities represent all regions of Ukraine. At the same time, all of them only train bachelors, while just three of them offer a limited number of master's degrees and none of them offers doctorates. That is, there is a level (by complexity of educational programs) disproportion in the training of specialists that is inadequate to current challenges. We should also note that half of these universities conducted enrollment in 2024 without yet having the appropriate accreditation.

As can be seen from Figures 1–4, this situation with focus and afterburner in undergraduate training will likely continue (YeDEBO, n. d.; Derzhavna sluzhba statystyky Ukrainy, 2021a, 2021b, 2024a, 2024b).

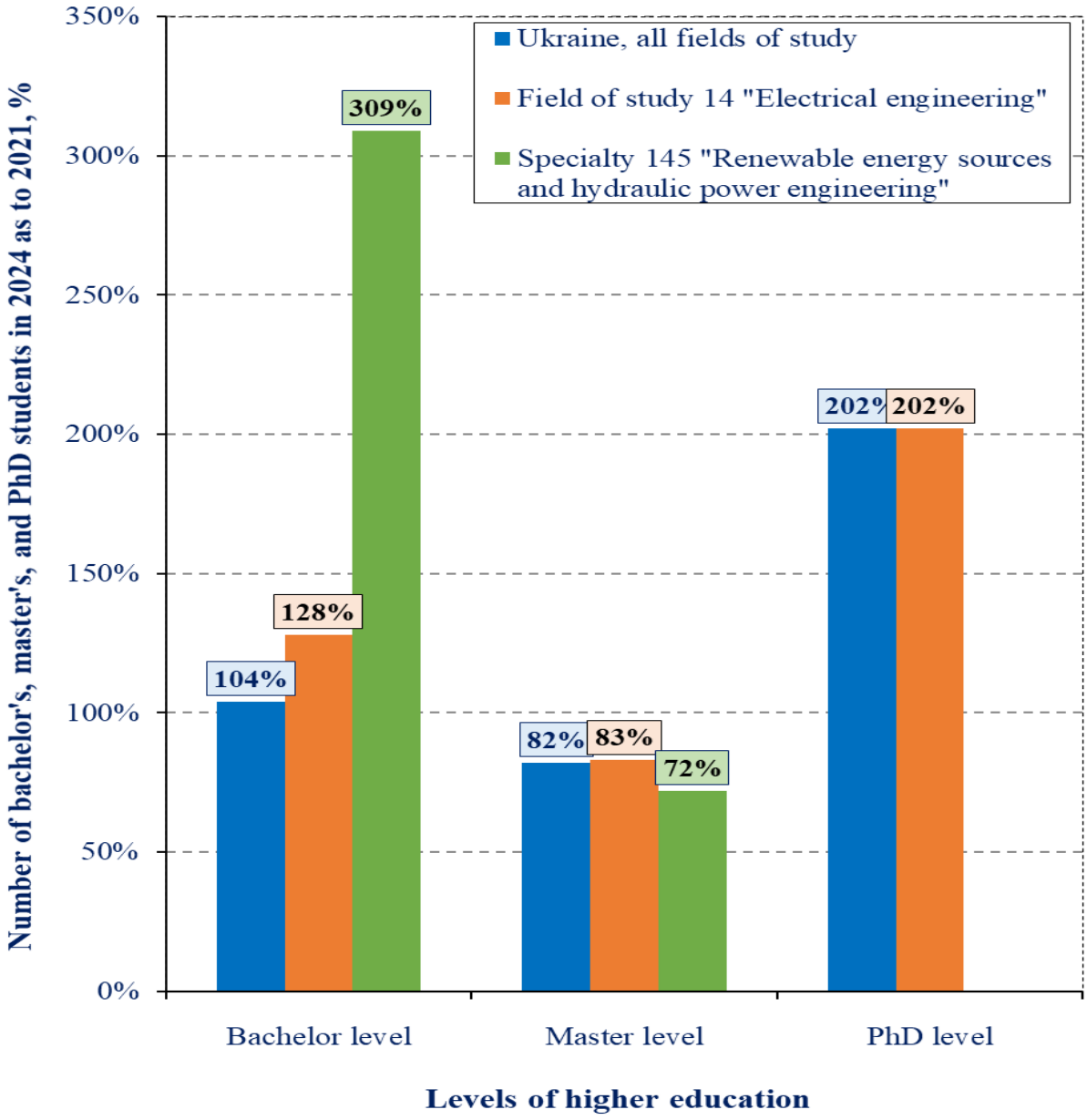

Figure 1. Relative change in the number of students by level of higher education (bachelor, master, and PhD training) in Ukraine as a whole, in the field of study 14 "Electrical engineering", and by specialty 145 "Renewable energy sources and hydraulic power engineering" in 2024 compared to 2021

Source: Created by the authors based on: YeDEBO, n. d.; Derzhavna sluzhba statystyky Ukrainy, 2021a, 2021b, 2024a, 2024b.

The dynamics in Figure 1 confirm the statics in Table 1.

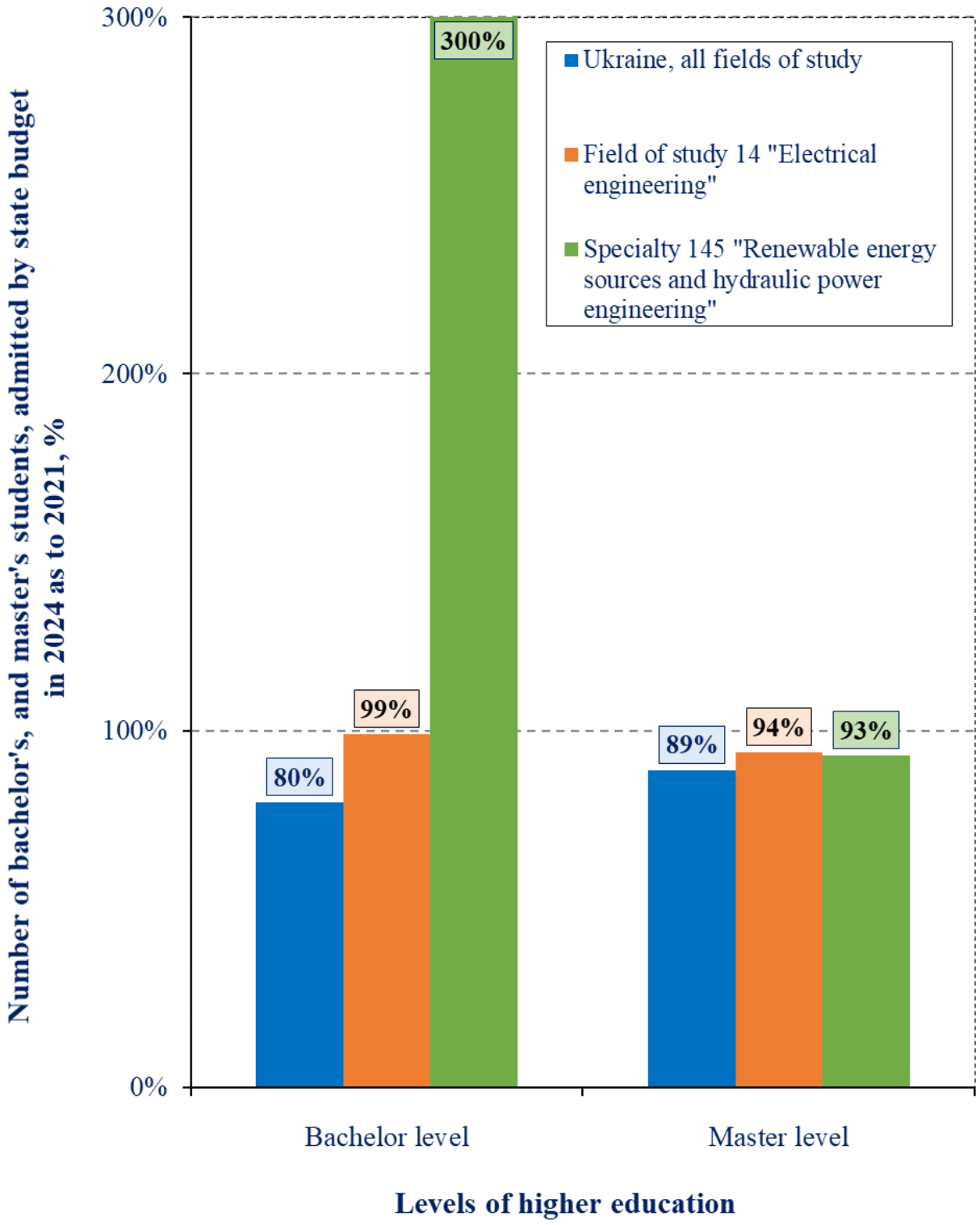

Figure 2. Relative change in the number of students by level of higher education (bachelor, and master training) in Ukraine as a whole and in the field of study 14 "Electrical engineering", and by specialty 145 "Renewable energy sources and hydraulic power engineering", admitted by state budget in 2024 compared to 2021

Source: Created by the authors based on: Derzhavna sluzhba statystyky Ukrainy, 2021b, 2024b.

It can be understood from Figure 2 that the state efforts to correct the situation are insufficient. To some extent, the increased public interest in this specialty and the increase in the share of applicants at the expense of the population have a positive impact, which is illustrated in Figure 3.

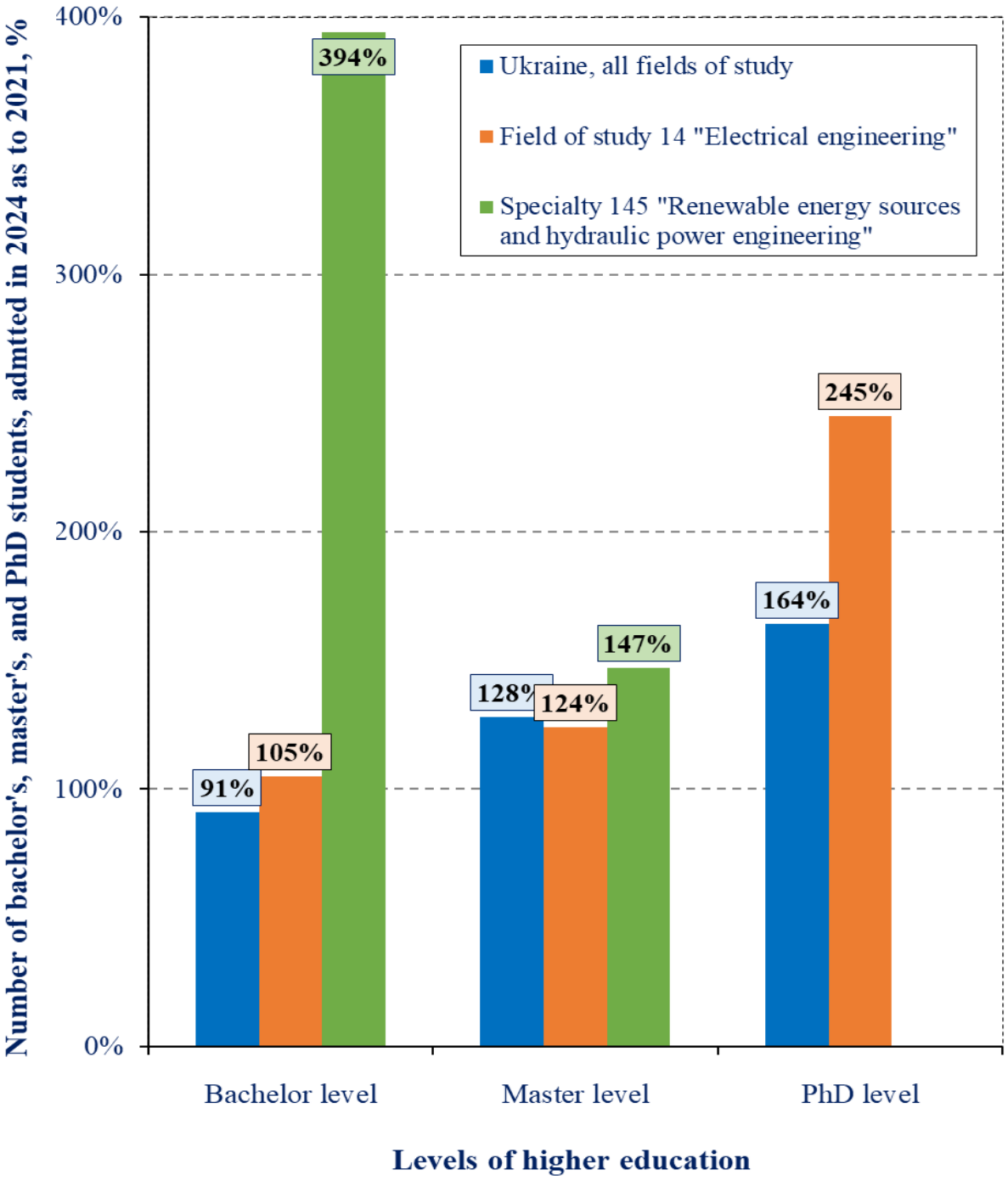

Figure 3. Relative change in the number of students by level of higher education (bachelor, master and PhD training) in Ukraine as a whole and in the field of study 14 "Electrical engineering", and by specialty 145 "Renewable energy sources and hydraulic power engineering", admitted (including extra state budget funds) in 2024 compared to 2021

Source: Created by the authors based on: Derzhavna sluzhba statystyky Ukrainy, 2021a, 2021b, 2024a, 2024b.

Figure 4 illustrates that compared to other (141, 142, 143, 144) specialties of the field of study 14 “Electrical engineering” specialty 145 “Renewable energy sources and hydraulic power engineering” is developing ahead only at the bachelor’s level of higher education.

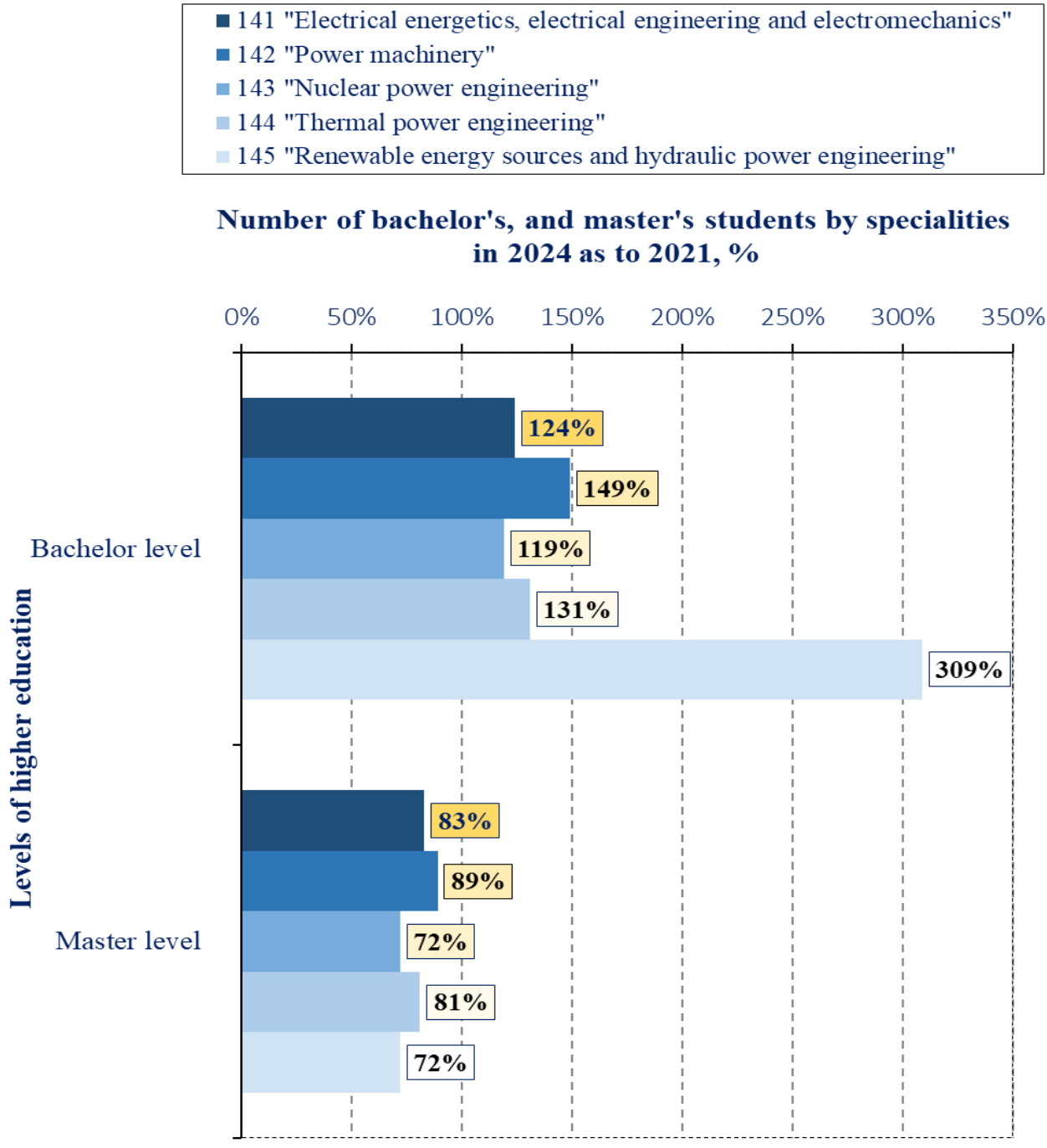

Figure 4. Relative change in the number of students at the bachelor’s and master’s levels of higher education by specialties of the field of study 14 “Electrical engineering” in 2024 compared to 2021

Source: Created by the authors based on: Derzhavna sluzhba statystyky Ukrainy, 2021b, 2024b.

It is also important that specialty 145 in the part “Renewable energy sources” was clarified in 2022 (Verkhovna Rada Ukrainy, 2022a), however, the higher education standards for it have not been revised since then (Ministerstvo osvity i nauky Ukrainy, n. d.), which nega-

tively affects the quality of training, as well as its average understaffing (see Table 1) in conditions of funding shortage.

In the "Group 11" of the leading 11 HEIs, highlighted in the aforementioned previous authors' paper (Zagirnyak et al, 2024)., out of 82 institutions that train specialists in the field of study 14 "Electrical engineering", only three provide training in the specialty 145 "Renewable energy sources and hydraulic power engineering": Vinnytsia National Technical University (15 bachelor students), Zaporizhzhia National University (37 bachelor, and master students), and National Technical University "Kharkiv Polytechnic Institute" (27 bachelor, and master students). Their contribution to training is a modest share (36%) in this specialty (see Table I).

Identification of "Group 11" universities is important. After all, these institutions have sufficient potential to provide quality education in the absence of some standards (Ministerstvo osvity i nauky Ukrainy, n. d.) and are able to maintain the interest of foreign citizens in training in Ukraine, which has significantly fallen due to the war (Zagirnyak et al, 2024; Derzhavna sluzhba statystyky Ukrainy, 2021a, 2021b, 2024a, 2024b).

It follows from the above that the training of specialists in specialty 145 "Renewable energy sources and hydraulic power engineering" should be recognized as controversial. On the one hand, there has been progress in recent years (an increase in the number of universities offering it, a multiple expansion of bachelor's training, and public support for this specialty). On the other hand, there are serious gaps (outdated standards, stagnation of master's and complete absence of doctoral training, and therefore the lack of holistic formal lifelong learning in higher education and the competitiveness of training, burdened by its understaffing in conditions of resource shortage), which does not meet the modern challenges facing Ukraine. This requires strengthening the systematic nature of state policy in determining the prospects, priorities, and motivation for training specialists with higher education.

APPLICATION OF THE RESEARCH FINDINGS

The findings are important for the 2025 update in line with the government's mandate of the National Energy and Climate Plan for the period up to 2030 (Verkhovna Rada Ukrainy, 2024a).

The performed analysis is also relevant for finalizing the draft Operational Plan for the Implementation of the Strategy for the Development of Higher Education in Ukraine for 2022–2032 in accordance with the function of scientific support and methodological provision for the implementation of this Strategy assigned to the Institute of Higher Education of the National Academy of Educational Sciences of Ukraine (NAES) (Verkhovna Rada Ukrainy, 2022*c*).

CONCLUSIONS

An analysis of the training of personnel with higher education in specialty 145 "Renewable energy sources and hydraulic power engineering" for staffing the renewable energy industry on the basis of formal lifelong learning shows that, despite some progress, it still does not meet the challenges facing Ukraine (increasing defense capabilities and security in the conditions of a protracted war, post-war reconstruction of the country on a high-tech basis, European integration as a strong state). The progressive developments of recent years include the doubling of the number of universities providing this training, the manifold expansion of bachelor's training, sustained public support for training, and the willingness of the population to pay for their education at their own expense. Among the unresolved problems are the outdated standards of higher education, the stagnation of master's and the lack of doctoral training, which makes it impossible to have a holistic system of formal lifelong learning in higher education, and taking into account the incompleteness of training, it also does not allow providing a competitive quality adequate to modern civilizational progress. This nega-

tively affects the implementation of the National Energy and Climate Plan for the period up to 2030 and the Strategy for the Development of Higher Education in Ukraine for 2022–2032. It is recommended that public administration authorities pay special attention to ensuring a full-fledged system of formal training of specialists with higher education for renewable energy sources and hydraulic power engineering, in the process of updating in 2025 the National Energy and Climate Plan for the period up to 2030, in accordance with the government mandate and when developing the draft Operational Plan for the implementation in 2025–2028 of the Strategy for the Development of Higher Education in Ukraine for 2022–2032. This will contribute to the implementation of the tasks of the Decree of the President of Ukraine (Verkhovna Rada Ukrainy, 2022b).

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