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Perception of the Transition to a Zero-Emission Economy in the Opinion of Polish and Foreign Students: A Comparative Analysis

Barbara Kaczmarczyk [1,*] and Karolina Lis [2,*]

[1] Faculty of Security and Safety Research, General Tadeusz Kosciuszko Military University of Land Forces, ul. Czajkowskiego 109, 51-147 Wrocław, Poland
[2] Faculty of Logistics and Transport, International University of Logistics and Transport in Wrocław, ul. Sołtysowicka 19b, 51-198 Wroclaw, Poland
* Correspondence: barbara.kaczmarczykwso@gmail.com (B.K.); lis.karolina.e@gmail.com (K.L.)

Abstract: Renewable energy sources serve as an alternative to conventional energy sources, with the main advantages being their inexhaustible nature and the absence of or significant reduction in greenhouse gas emissions. On the other hand, the development of energy production utilising renewable sources remains controversial, primarily because of the high initial costs of RES investment projects and the carbon footprint during the production phase of RES facilities. However, these appear to be gradually offset by the many benefits that outweigh the initial RES facility maintenance costs. Unsurprisingly, European Union (EU) countries are at the forefront of the transition to a low-emission economy. This is evidenced by such things as the 22% decrease in greenhouse gas emissions in the Member States, achieved despite a 58% increase in gross domestic product (GDP) between 1990 and 2017. Nonetheless, the use of renewable energy sources, such as solar, wind, water, etc., is much more expensive than burning fossil fuels. It must be stressed that the European Union's success in this regard is influenced by the actions taken by all Member States to implement the European Green Deal and their individual targets. Furthermore, the transition to a zero-emission economy is also the result of the informed participation and involvement of all European Community residents. Therefore, there exists a need for education on renewable energy sources to facilitate the transition to a zero-emission economy in European Union countries. This education should primarily target young people, whose critical choices will shape this area in the future. It is the knowledge and awareness of young people that will largely determine whether it will be possible to limit greenhouse gas emissions by 2050. This article aimed to determine how Polish and foreign students view the transition to a zero-emission economy. The article places a special emphasis on renewable energy sources as a key factor in shaping national security in terms of sustainable ecology and friendly social development. The aim of the study was achieved through a research process using theoretical and empirical research methods. To that end, the subject literature and current legislation on renewable energy sources were analysed. Moreover, a survey was conducted among Polish and foreign students living in Poland. The analysis of the research results made it possible to formulate recommendations on how to shape national security in terms of sustainable ecology and friendly social development.

Keywords: renewable energy sources; national security; ecology; social development; non-emission economy; European Union

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1. Introduction

Combating climate change remains one of the most important challenges of the 21st century. To avoid a climate catastrophe, all countries should strive for climate neutrality. Climate neutrality means a balance between emissions and greenhouse gas capture and storage, that is, "net zero emissions". Notably, the transition should be achieved by 2050 at the latest, so that greenhouse gas emissions do not reach a point where the global temperature increase exceeds 1.5 °C [1]. This is particularly important as current research

indicates that the increase in global average temperature after 2060 could reach 2 °C—and continue to rise—if no concrete action is taken to transition to climate neutrality. Such severe climate change may bring about risks that are difficult to predict for society and, above all, for the environment [2].

Particular emphasis on implementing change and shifting towards a zero-emission economy is placed by the European Union; this is reflected by its strategies that refer to opportunities to use renewable energy sources and electricity, among other things, for the full decarbonisation of Europe's energy supply, as well as the development of smart grid infrastructure and improved energy efficiency. It must be stressed that the European Union's success in this regard is influenced by the actions taken by all Member States to implement the European Green Deal and their individual targets. Furthermore, the transition to a zero-emission economy is also the result of the informed participation and involvement of all European Community residents [3].

The role played by citizens in the implementation of the European Green Deal is crucial, especially from the point of view of young people who are just learning how to approach a low-emission society. Consequently, there is a need for education on a zero-emission economy and the use of renewable energy sources, which will enable all European Union Member States to transition to "net zero emissions". This education should be aimed primarily at young people, who will have to make the right decisions in the future [4]. The achievement of climate neutrality by 2050 largely depends on their knowledge, and most of all their awareness of sustainable development. This implies the need to learn how much young people know about climate neutrality. Notably, the emergence of a zero-emission economy will be influenced not only by the knowledge of Polish students, which is in line with that of their EU peers, but also by the knowledge of young people from outside the EU, who arrive in Poland to study and plan to remain in the country afterwards. The article aimed to provide a comparative analysis of Polish and foreign students' perceptions of the transition to a zero-emission economy.

The article consists of five substantive sections: introduction, theoretical outline, research methodology, results and conclusions. The introduction outlines the topics related to the zero-emission economy and identifies the need for the present study. The theoretical outline section reviews the literature on the need for a zero-emission economy in the European Union and the need to educate young people in this area. The research methodology section contains the assumptions of the research conducted and the main results, indicating trends in the empirical material obtained. The final section presents the main findings of the research in the areas of knowledge, awareness and opinion of Polish and foreign students on the zero-emission economy and the need for sustainability. Existing knowledge gaps and differences between Polish and foreign students were identified. Educational needs in this area were also discussed.

2. Theoretical Outline

The climate has been changing since the dawn of time. A report by the Intergovernmental Panel on Climate Change (IPCC) indicates that the atmosphere and the oceans have warmed by an average of 1.5 °C compared to the pre-industrial era. These changes are reflected by the declining mass of snow and ice, rising ocean levels and increasing greenhouse gas concentrations in the atmosphere. Further confirmation of climate change is the fact that between 1983 and 2012, the Northern Hemisphere experienced its warmest 30-year period in the last 1400 years. Due to global temperature increase, the Greenland and Antarctic ice caps are losing volume, increasing the rate of ocean and sea level rise. At the same time, atmospheric levels of carbon dioxide (CO_2), nitrous oxide (NO) and methane (CH4) are rising to values that our planet has not seen in 800,000 years. Scientists note that the high levels of carbon dioxide are the result of fossil fuel burning (coal, lignite and oil), as well as changes in land use. Since the industrial revolution, humans have been the primary culprits behind carbon dioxide emissions and, as such, are directly responsible for the increase in greenhouse gas emissions. Because all elements are interconnected and affect

each other, this process contributes to global warming, decreasing glacier mass and sea level rise. The authors would like to note that various future scenarios can be formulated based on projections in this area. First of all, global warming can vary from one region of the world to another. In some, it results in more frequent and longer heatwaves; in others, it increases the likelihood of flooding. Additionally, changes in the amount and characteristics of precipitation, such as droughts or heavy rains, or changes in the frequency of adverse weather events like hurricanes and storms are to be expected. Climate change does not only affect environmental issues but also causes social, economic and political impacts; this includes such issues as so-called climate refugees, the economic burden caused by climate change mitigation and conflicts over access to natural resources [5]. One of the worst-case scenarios for global warming involves massive climate-related migration and international political conflicts—including armed conflicts. Not only citizens of such countries as Iran, Iraq, Saudi Arabia, Kuwait, Bahrain, Oman and Qatar, but especially those living in impoverished African countries, may be forced to migrate due to the inability to feed themselves [6].

Based on the above, the goal of reducing the existing effects of climate change and achieving climate neutrality becomes both a necessity and a priority. However, one should bear in mind that this target is a long-term one, and so strategies to achieve it also need to include far-reaching plans to transform economies and reduce greenhouse gas emissions to zero. Until the changes are implemented and the first effects of the transition emerge, climate warming, ocean level rise and melting glaciers will continue [7]. Furthermore, a reduction in the negative changes occurring in the biosphere can only be effected through appropriate human action, provided that they are carried out to the extent feasible [8]. More optimistic scenarios require a long time horizon and multidimensional and coherent action by many countries [9]. The European Union is pushing for a low-emission economy in the wake of the global climate recession. Achieving climate neutrality is one of the European Union's priorities and may be referred to as "green capitalism" [10]. Efforts to implement it focus on decoupling the growing GDP of the Member States from the increasing and environmentally destructive consumption of energy. The EU's energy priority is the deployment of environmentally neutral renewable energy technologies. Discussions are also underway to introduce an EU-wide ban on environmentally harmful energy use [11]. However, researchers emphasise that reducing or completely displacing energy generation utilising conventional fuels requires the creation of practically fully green societies, aware of the importance of both individual and group decisions in energy production and consumption processes [12]. This requires people to be able to think ahead, but also to think independently about their immediate environment. Importantly, research conducted in EU countries shows that citizens tend to behave in extremes, e.g., they support certain innovation trends but still exhibit a Not in My Backyard mentality. This attitude is confirmed by such things as the citizens having a negative view of industrial carbon storage if it is carried out close to where they live [13].

The transition of countries towards climate neutrality requires the promotion of various activities in support of multidimensional initiatives in economic, social and political areas [14]. Attempts to reduce greenhouse gas emissions should manifest themselves in practical solutions arising from everyday life [15]. Any choice that brings climate neutrality closer will have future consequences, and avoiding a climate catastrophe depends on the implementation of various measures in every aspect of life, i.e., in such sectors as energy, construction, forestry, agriculture and transport [1].

One ought to point out that the use of renewable energy sources like sun, wind or water has both advantages and disadvantages. Advantages undoubtedly include their unlimited nature and zero or near-zero emissions. In contrast, the most significant drawback is that the use of renewable energy sources is significantly more expensive than burning fossil fuels. Unfortunately, this argument often prevails both during political debates and whenever anyone on Earth is considering whether they should work towards a zero-emission economy. In this regard, it is important to point out the need for such things

in the education and awareness-raising of future leaders regarding the implementation of zero-emission policies, which ought to take place at various decision-making levels across the Member States and EU institutions [16]. It is also necessary to create ideals and competencies conducive to shaping citizenship and acting for the public good [17]. It is worth emphasising that any responsible EU citizen can take such actions through their everyday consumer decisions [18]. Environmental education is therefore fundamental here, providing guidance on reducing greenhouse gas emissions, conserving natural resources and adopting a carbon-neutral economy. Its essence is to foster pro-environmental attitudes and thus innovative approaches to energy use [19].

To conclude the above considerations, it must be stressed that in striving for climate neutrality, both political decisions on the implementation of solutions favouring a low-emission economy and various initiatives concerning future actions to be taken by the people of the European Union play an important role. It may therefore seem justified to hypothesise that the knowledge and awareness of young people are crucial to achieving the EU's primary climate neutrality objectives since it is this social group that will have the greatest impact on the transition to a zero-emission economy. The target set by the European Union is for Europe to become the world's first continent to eliminate its carbon footprint in industry, transport, agriculture and services, as well as in the lifestyles of its inhabitants in general [20]. The interim period of this transition is expected to last from 2020 to 2050. The transition to renewable energy sources, reduction in the dependence on external suppliers and diversification of supply itself are to be intensified during this period. The expected benefits also include implementing solutions to ensure future mobility, improving air and water quality, developing sustainable agriculture and strengthening climate initiatives. All of these measures are intended to bring about climate neutrality for EC countries by 2050, meaning that they will only emit as much greenhouse gas as they can absorb [16]. This imperative became the stimulus for the research, the results of which are presented in the article.

3. Research Methodology

The research described in this article concerned two interrelated areas. The first one concerned the understanding of the current changes in climate policy by a representative research sample of Polish and foreign students. It can therefore be concluded that this scope refers to transitional thinking embedded in scientific innovation [18]. The second area of research concerned the preferred forms of energy generation, distribution and use in European Union society. This preference survey provided an opportunity to fill the knowledge gap on the stimulus action model for the future implementation of a zero-emission economy accompanied by environmental protection and climate change mitigation [21]. The literature is replete with related issues identifying the relationship and dependency between climate change, environmental protection, economic development and the projection of changes in these areas resulting from European Union policy [22]. This analysis is based on man-made climate change, carbon emissions, the pollution of water resources and the possibility of developing sustainable agriculture [23].

The aim of the research conducted and presented in this article was to identify the environmental and energy awareness of foreign students studying and living in Poland and to compare it with the opinions of Polish students studying national security. The research has made it possible to identify the knowledge base characteristic of an informed EU resident who is ready to pursue social, economic and political needs [24].

To comprehensively clarify the adopted research problems, a quantitative–qualitative research strategy was applied, which made the research itself diagnostic and explanatory in nature [25]. The research process involved an analysis of the subject literature and the applicable legislation, which made it possible to classify, generalise, describe and systematise the facts gathered during the research.

The research was carried out among students at the International University of Logistics and Transport in Wrocław (IULT), which offers logistics-related fields of study. The

respondents were students studying in English as part of both undergraduate (first-cycle) and graduate (second-cycle) programmes. Among the students studying at IULT in English are citizens of such countries as Nigeria, Morocco, Egypt, Turkey, Congo, Vietnam, Ukraine, Belarus, Azerbaijan, Kazakhstan and many other non-EU countries.

The survey covered 780 students in different age ranges: 15–18 (5.6%), 19–25 (77.8%), 26–30 (5.6%) and 31–50 (5.6%). International students are a specific research group, since their age while at the university varies depending on which country they come from. One example is students from Ukraine, who start their undergraduate studies at the age of 17. In contrast, students from African countries typically complete their first-cycle programmes in their home countries and only come to Poland to continue their education and gain experience.

An important element during the empirical research was to determine the minimum research sample to obtain reliable results. This number was determined by the following formula:

$$n_b = \frac{N}{1 + \frac{4d^2(N-1)}{Z^2}}$$

where:

n_b = necessary sample size;
N—the size of the population of interest to the researcher;
Z—standard deviation for a given significance level p (Z = 1.96 for p = 0.05%);
d—standard estimation error (4% = 0.04).

A research sample of 89,400 people [26] was adopted, because that is how many foreign students studied in Poland in the academic year 2021/2022. The minimum sample size was nb = 597 people, and 780 people were tested. The study population meets the requirements of the minimum statistical sample.

The choice of the university where the research was conducted was determined by several factors. First of all, the IULT University positively considered the request for the possibility of conducting surveys among foreign students. Other universities, which are also distinguished by a high percentage of foreign students, did not respond to the authors' inquiry or did not agree to conduct the study. It should be emphasized that the main emphasis in the conducted research was on the general knowledge of students about renewable energy sources and the zero-emission economy, and not on the knowledge acquired during studies. Therefore, the field of study attended by foreigners was not a criterion determining the choice of respondents. An additional limitation during the conducted research was the fact that the group with which the answers of foreign students were compared was of Polish students of majors related to national security. It should be emphasized that foreign students do not choose military fields of study due to the requirement of having Polish citizenship. Therefore, there was a limitation in the form of comparing the same fields of study for Polish and foreign students. The main objective of the empirical research was therefore to compare the knowledge of Polish students with the general knowledge of foreign students studying and living in Poland.

The survey questionnaire contained a dozen questions, eight of which allowed the respondent to express their own thoughts, opinions and preferences. The sampling was random.

The study contrasted the knowledge of foreign students living and studying in Poland with that of Polish students studying national security, who were surveyed in May 2021 using the same set of questions. The research results were presented in "Perception of the Transition to a Zero-Emission Economy in the Opinion of Polish Students", an article by B. Kaczmarczyk and I. Urych, published in 2022 [27]. The survey conducted for the above article covered a total of 1106 students in different age groups: 15–18 (1.67%), 19–25 (86.7%) and 26–30 (10.66%). The gender breakdown of respondents was as follows: 19.7% female and 80.3% male. Respondents studied at the following universities: AGH University of Science and Technology in Kraków, General Tadeusz Kosciuszko Military University of

Land Forces in Wrocław, Military University of Technology in Warsaw, Rzeszów University of Technology, Silesian University of Technology, University of Warsaw. The students' curricula, as well as the dedicated programmes they attended, addressed renewable energy sources, including prosumer energy and the green capital economy. Members of the Youth Climate Council (YCC), a consultative and advisory body under the Ministry of Culture and Environment, also participated in the study [27].

This article will serve to complement the article by B. Kaczmarczyk and I. Urych. The results obtained in the course of the research on the knowledge and awareness of environmental and energy issues among foreign students will be compared and analysed with the results obtained in the article by B. Kaczmarczyk and I. Urych titled "Perception of the Transition to a Zero-Emission Economy in the Opinion of Polish Students".

4. Results

The survey consisted of a dozen questions. Nine of these were open-ended questions; eleven were ranking or optional questions. The responses of the two groups surveyed, Polish students and foreign students studying and living in Poland, are presented and compared below (Tables 1–10).

Table 1. Question no. 1, research results.

Response Options								
	Question		Photovoltaic	Geothermal energy	Wind energy	Wave energy	Water energy	Biomass energy
No. 1	Which forms of energy production do you think are the most environmentally, social and human friendly in Poland?	Polish students	26.64%	21.86%	17.65%	16.87%	11.32%	5.66%
		Foreign students	16.66%	11.13%	50%	11.11%	8.33%	2.77%

Table 2. Question no. 2, research results.

Response Options									
	Question		Waste segregation	Participation in "farm to table" food consumption	Saving water	Using recycled materials	Living in an energy-efficient building	Using biodegradable materials	Saving electricity
No. 2	How would you like to protect the environment?	Polish students	35.4%	22.44%	13.7%	9.06%	7.8%	5.9%	5.7%
		Foreign students	13.88%	19.44%	27.77%	5.55%	27.77%	2.77%	2.82%

Table 3. Question no. 3, research results.

Response Options						
	Question		Very good	Good	Sufficient	Insufficient
No. 3	How do you assess your knowledge of renewable energy sources?	Polish students	8.7%	26%	46.9%	18.4%
		Foreign students	2.8%	33.3%	55.6%	8.3%

Table 4. Question no. 4, research results.

Response Options							
No. 4	Question		Using dual-use water technology, e.g., by reusing water forhygiene purposes	Living in an energy-efficient building	Using energy-efficient heating	Using energy-efficient lighting	Using an energy-efficient building for people to work in.
	How would you like to reduce your carbon footprint when using energy?	Polish students	34.04%	31.28%	15.16%	14.21%	5.4%
		Foreign students	50%	16.66%	2.8%	13.88%	16.66%

Table 5. Question no. 5, research results.

Response Options									
No. 5	Question		Would share their electricity in a free wired and wireless manner	In a paid wired manner	In a paid wireless manner	In a free wireless manner	In a free and paid wired manner	In a paid wired and free wireless manner	In a free wired manner
	How would you like to share the electricity you generate?	Polish students	42.37%	26.9%	9.48%	6.97%	6.23%	4.02%	4.03%
		Foreign students	19.44%	27.77%	11.11%	16.66%	13.88%	8.33%	2.81%

Table 6. Question no. 6, research results.

Response Options					
No. 6	Question		Using distributed free forms of energy	Using grid centric free forms of energy	Using paid wired and free wireless forms of energy
	Which energy-saving model would you and your family prefer?	Polish students	45.4%	38.2%	16.5%
		Foreign students	16.7%	50%	33.3%

Table 7. Question no. 7, research results.

Response Options				
No. 7	Question		As active energy prosumers	As passive energy consumers
	How do you see your future in a zero-carbon society?	Polish students	60.8%	39.2%
		Foreign students	55.6%	44.4%

Table 8. Question no. 8, research results.

Response Options				
No. 8	Question		Financial incentives, e.g., discounts on energy-efficient manufactured goods	Discounts on organic food
	How do we encourage society to eliminate its carbon footprint?	Polish students	91.5%	8.5%
		Foreign students	66.66%	33.34%

Table 9. Question no. 9, research results.

Response Options					
No. 9	Question		Financial savings	Eco-empathy	Eco-fashion
	What would convince you to introduce low-carbon technologies into your immediate environment?	Polish students	68.26%	21.96%	9.78%
		Foreign students	38.9%	33.33%	27.77%

Table 10. Question no. 10, research results.

Response Options					
No. 10	Question		Financial incentives to use public transport	Financial incentives for using communal nutrition	Subsidies and no restrictions on installing own renewable energy sources
	Which forms of incentives would you prefer most?	Polish students	65.6%	31.9%	12.5%
		Foreign students	75%	19%	6%

Analysing the presented results, it can be concluded that there were significant differences in the answers to the question "Which forms of energy production do you think are the most environmentally, socially and human friendly in Poland?" (Table 1) given by Polish and foreign students. In this context, Polish students primarily pointed to photovoltaics, followed by geothermal energy and wind energy. Foreign students typically pointed to wind energy, with as many as 50% of them choosing this option, followed by photovoltaics and geothermal energy as the subsequent RES technologies of choice.

Differences between Polish and foreign students also appeared with respect to views on how to protect the environment (Table 2). The environmental protection measure most often chosen by the former was waste segregation, followed by "farm-to-table" food consumption and water conservation. In contrast, the latter rated both saving water and living in an energy-efficient building as being of the greatest importance. The third measure ranked as the most crucial by foreign students was "farm-to-table" food consumption and the fourth one was waste segregation.

Both Polish and foreign students rated their knowledge of renewable energy sources at a comparable level (Table 3). The conclusions drawn by both groups are similar. However, there was a noticeable difference in the "insufficient" category, which amounted to nearly 10%.

Polish students believed that carbon footprint reduction should take place in the following order (Table 4): using dual-use water technology, e.g., by reusing water for hygiene purposes; living in an energy-efficient building; using energy-efficient heating; using energy-efficient lighting; using an energy-efficient building for people to work in. The views of foreign students coincided with the above order based on the responses of Polish students only when it came to the first step—using dual-use water technology. Foreign students pointed to living in energy-efficient buildings and working in such buildings as the next most vital steps, with further ones being the use of energy-efficient lighting and heating.

Both Polish and foreign students perceived the possibility of energy sharing as follows: they would share their electricity in a free wired and wireless system, as well as a paid wired system. However, the order in which respondents indicated their answers differed (Table 5).

Responses regarding the energy-saving model preferred by the respondents and their families differed significantly (Table 6). Polish students ranked the use of distributed free forms of energy first, followed by the use of grid-centric free forms of energy. Based on their choices, a model utilising paid wired or wireless energy distribution ranked third. In contrast, foreign students ranked grid-centric free energy first, followed by paid wired or wireless grids, with distributed free forms of energy ranking last.

When asked how they see their future in a zero-emission society, Polish and international students were unanimous. Most students saw themselves as future active energy prosumers (Table 7).

Further, most students perceived the issue of encouraging a zero-carbon lifestyle in society in a similar way (Table 8), i.e., encouraging it through financial incentives in the form of discounts for energy-efficient industrial products is more important than discounts for organic food. Nonetheless, it must be noted that while energy-efficient industrial products were ranked first by foreign students, the ratio of indications of organic food discounts was nearly 30% lower, and in the case of students almost 80% lower.

The most convincing argument for the introduction of low-emission technologies for both groups surveyed was financial savings. Eco-empathy ranked second, followed by eco-fashion (Table 9), according to the respondents' consensus. A convergence of opinions of both groups surveyed was also noticeable in the answers to the question "Which forms of incentives would you prefer most?" (Table 10). The majority of students would prefer financial incentives for the use of public transport, followed by financial incentives for communal nutrition. The measure ranked last by students was subsidies and no restrictions on installing renewable energy sources.

The survey also included several open-ended questions. The following section juxtaposes the opinions of foreign students with those of Polish university students studying national security.

Both foreign and Polish students were asked the following open-ended questions:

(1) What information activities on renewable energy sources have you encountered during your education?
(2) What educational activities on renewable energy sources have you encountered during your education?

Answering the question "What information and education activities on renewable energy sources have you encountered during your education?", the students indicated that there were already several initiatives to disseminate knowledge about renewable energy sources and that they had already participated in them. A total of 62.5% of Polish students and 41.4% of foreign students noted that they learned about renewable energy sources during classes at university. Earth Day was attended by 50.3% of Polish students but only 13.8% of international students. Environmental workshops were attended by 26.9% of Polish students and 22.4% of international students. Meetings with environmentalists were attended by a similar number of students in both groups, i.e., by 23.3% of Polish students and 20.7% of foreign students.

As regards educational activities, both respondent groups indicated that social media and the Internet are important sources of information with a wealth of data on renewable energy sources. They also pointed to the easy availability of these data. The Polish students noted that there were many measures to promote renewable energy sources, including competitions, tree-planting campaigns, brochures and books. International students, however, did not mention any of these measures, most likely due to language barriers.

(3) What forms of information activities could increase public awareness of renewable energy sources?
(4) What forms of educational activities could increase public awareness of renewable energy sources?

Both survey groups concluded that public awareness of renewable energy sources is not comprehensive and that there is room for improvement. In response to the question "What forms of information and education activities do you think could increase public awareness of renewable energy sources?", the respondents stated that social media would help raise awareness in this respect. Moreover, both groups surveyed pointed to the potential of mass media and television. The respondents pointed to such activities as information efforts as part of educational campaigns, noting that these activities should offer an interdisciplinary view, showing different aspects of the issues in question. Such campaigns should involve energy and environmental experts who, apart from holding expert panels, could organise demos focusing on the benefits of renewable energy sources compared to traditional energy use. The respondents believed that showcasing these issues visually would increase understanding and raise awareness of the need to adopt RES. To complement such activities, it is also necessary to design flyers and brochures explaining renewable energy sources, including the advantages and disadvantages of their use.

(5) What do you think renewable energy is used for at home?
(6) What do you think renewable energy is used for at work?

According to Polish students, renewable energy sources are applicable both at home and at work. In their view, photovoltaics, heat pumps and biomass energy are the most common RES systems. Indeed, photovoltaics was indicated by both groups since it generates energy from sunlight, offering lower costs for the operation of residential buildings by replacing a traditional heat sources such as a coal- or gas-fired boilers or an electric water heater. Photovoltaic systems also reduce the household's dependence on energy suppliers. The students surveyed also pointed to the use of heat pumps, which extract renewable energy stored in the ground, water or air, as heating devices. Modern pumps can be used for both heating and cooling buildings. Apart from the above, the low operating costs of heat pumps are yet another advantage. Students consider biomass burning to be environmentally neutral since it releases only as much carbon dioxide into the atmosphere as the plants have absorbed during their growth; thus, they argue that it is an environmentally friendly alternative to such systems as coal-fired boilers. When it comes to energy generated by wind turbines, the students believe it is used to power lighting or water pumps on the premises. Contrasting the above with the responses of foreign students, it should be noted that the latter, too, identified photovoltaics as the most common use of renewable energy sources; however, their responses mostly referred to the financial benefits of using this technology. Here, there is a noticeable difference in knowledge of renewable energy sources between the Polish and foreign students surveyed. This is probably because foreign students are not interested in the possibility of obtaining energy from renewable sources due to the different social and living conditions in their home country.

The answers to the question about the use of renewable energy sources at work were largely similar. In addition, students indicated that the use of RES by companies and enterprises can improve their image both at home and abroad, as well as bringing financial savings in energy consumption, and resulting in increased product competitiveness. The students surveyed believe that the most common applications of RES include heating for

rooms or sports halls, as well as water heating for buildings. Wind energy, on the other hand, can be used in industrial facilities, e.g., for lighting rooms or irrigating fields.

(7) What renewable energy sources are used in Poland?

Both groups surveyed showed excellent knowledge of existing renewable energy sources in Poland.

(8) Do you think the public can be encouraged to adopt a low-emission lifestyle in ways other than those suggested in the above questions?

In response to the question of whether society can be encouraged to adopt a low-emission lifestyle in ways other than those already mentioned, respondents took a fairly similar stance, although that offered by Polish students was slightly more expansive.

A total of 93.4% of the Polish students believed that financial incentives, i.e., discounts on the purchase of bio foods and energy-efficient industrial products, would be sufficient to encourage society to move towards a low-emission lifestyle. Other respondents indicated that the following actions that could further improve this process: raising national awareness, organising contests at store bio food stands, offering subsidy programmes for RES systems, educating the public about the consequences of polluting the planet, introducing stricter legislation against polluters, introducing tax breaks and additional discounts and offering cheaper electric cars and free charging, as well as changing modes of transport, e.g., from cars to bicycles.

In comparison, it should be noted that 76.5% of international students also indicated that incentives in the form of discounts on the purchase of bio foods and energy-efficient industrial products, as mentioned before, are fully sufficient to engage the public in the transition to a low-emission lifestyle. However, when asked to come up with ideas other than those already listed, other students provided only very general suggestions for incentives, proposing to "offer something in return". Few students pointed to such proposals as introducing coupons and discounts on other foods and everyday products, tax breaks for those who produce energy from renewable sources or abolishing taxes on electric vehicles and introducing privileges for their users.

5. Conclusions

Ongoing climate change has made it necessary to implement solutions aimed at achieving a low-emission economy across all European Union countries. In this regard, the European Commission is defining strategies like the European Green Deal to help achieve this goal. Nonetheless, it is worth emphasizing that it is not only the policies of EC countries that affect this issue. Indeed, the implementation of a zero-emission economy is also the result of a conscious effort by all EU residents to protect the environment. The achievement of zero greenhouse gas emissions by 2050 largely depends on their knowledge and awareness of sustainable ecology and its friendly social development.

The research presented in this article was undertaken to determine how Polish and foreign students view the transition to a zero-emission economy. The survey of foreign students studying and living in Poland aimed to determine their environmental and energy awareness and knowledge of renewable energy sources and to find out their opinions on RES use. However, another goal of the research conducted was to compare the student opinions collected as part of this study with those expressed by Polish students studying national security and published in the article "Perception of the Transition to a Zero-Emission Economy in the Opinion of Polish Students" by B. Kaczmarczyk and I. Urych [27].

This made it possible to compare the knowledge, awareness and opinions of the two groups surveyed on the zero-emission economy and the need for sustainable development, the groups in question being foreign students who came to Poland to study, and Polish university students studying national security.

The research results presented in this article are a continuation of the research conducted to identify the environmental and energy awareness of Polish and foreign students.

Based on the surveys conducted, it can be concluded that both Polish and foreign students rate their level of knowledge as "sufficient". However, a nearly 10% difference occurred in the "insufficient" category, with Polish students choosing this option more often than foreign ones. Both groups of students surveyed were also familiar with different types of environmentally friendly renewable energy sources. They also had similar opinions on how to take care of the environment, but with noticeable differences in how they ranked the specific measures in this area.

In many cases, the indications given by foreign students differed significantly from those of Polish students. There was no overlap in either the carbon footprint reduction models or the perceptions of energy-sharing possibilities.

In contrast, both student groups opted for similar ways of encouraging a zero-emission lifestyle in society, i.e., they deemed financial incentives in the form of discounts on energy-efficient products more important than discounts on green food. Further, the most convincing argument for the introduction of low-emission technologies for both groups surveyed was financial savings. Both student groups ranked eco-empathy second and eco-fashion third.

There were slight differences in terms of how education and information activities were viewed by the respondents. Both groups of respondents indicated that they encountered education and information activities on environmental protection and the carbon-neutral economy during their university classes. They also pointed to the easy availability of these data. Additionally, the Polish students emphasized that there were many measures to promote renewable energy sources, including competitions, tree-planting campaigns, brochures and books. Foreign students made no such statements, which indicates that despite living in Poland, cultural and language barriers prevented them from fully assimilating and participating in such social events. Both groups of respondents also indicated that social media and the internet, which make available a wide range of renewable energy content, were important sources of information.

Notably, the answers to the open-ended questions given by the Polish students were much more elaborate and creative. The answers of Polish students pointed to a greater interest in the issue of RES use compared to those of foreign students.

Analysis of the survey results allows us to conclude that the knowledge of both Polish and foreign students on the need for a low-emission society is insufficient. The respondents recognised the need to protect the environment and take action to avoid climate catastrophe, but had only a meagre knowledge of the necessity of introducing a low-emission economy across all EU Member States. The respondents pointed to a lack of a comprehensive approach to reducing greenhouse gas emissions. In their view, they also lacked role models for such practices, as well as values related to sustainable ecology and environmentally responsible social development. This preference survey helped fill the knowledge gap on the stimulus action model for the future implementation of a zero-emission economy accompanied by environmental protection and climate change mitigation.

To summarise the research, it must be noted that there exists a gap in the knowledge of Polish and foreign students, as well as in educational needs in this area. The paradigm of eliminating, or at least reducing, the carbon footprint of industry, agriculture, transport, services and the lifestyles of EC inhabitants should begin with effective environmental education as an integral part of the implementation of the European Union's net zero emissions policy.

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