

Article

Toward Low-Carbon European Union Society: Young Poles' Perception of Climate Neutrality

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Abstract: (1) Introduction: The European Union is a global leader in the transition to a low-carbon economy. The community's population has already reduced greenhouse gas emissions by 22%, while the gross domestic product (GDP) in its member states increased by 58% between 1990 and 2017. The Union has shown that economic growth is possible in the link between politics, nature, and the citizens' eco-empathy. It has implications for both the European and global economy, infrastructure, food production, public health, and biodiversity, the formula for political stability. The hallmark of the European Union is the blending of politics, culture, and nature in its quest for climate neutrality. The community's horizon is a zero-emission economy by 2050. (2) Theoretical framework: The cognitive assumptions of the article are the following theses: 1. The Union strives to accelerate the transition process to a regenerative growth model using technologies for obtaining and distributing energy for individual and collective needs; 2. The Union and the European citizens want to hand over more to planet Earth than they take away from it, thus making progress toward keeping resource consumption within planetary limits. 3. The Union aims to reduce its consumption footprint and double the rate of applying closed-loop materials in the next decade. Finally, it fits in with the organization's policy projections. (3) Methodology and research results: Qualitative and quantitative research methods were used in the research process. The literature has been analyzed on the subject and the applicable legal acts, making it possible to classify, generalize, describe, and systematize the facts collected during the research. A survey was conducted on 1106 students, and in-depth interviews were conducted with three energy experts: Krzysztof Tomaszewski (the University of Warsaw, researcher and lecturer on energy security issues), Dariusz Pachniewski (inventor in energy sector, businessman in hydrogen energy sector), and Tomoho Umeda (President of Polish Chamber of Commerce). The research aimed to identify the environmental and energy awareness, knowledge of renewable energy sources, and opinions of young Poles on their use in two areas: home and work. (4) Discussion: The reinforced narrative of creating a low-carbon society, a green economy, was adapted and evaluated for innovative individual and collective approaches in the research conducted in this paper. In the quantitative and qualitative samples, the assumptions made were double-checked. The former verified the students' views, while the latter, the experts' views. The procedure established the directions of knowledge evolution and approach to technologies and innovations among students of technical faculties related to the energy sector. There were existing individual and collective mental constructs on energy transition and climate neutrality identified. (5) Conclusions: The surveys conducted among university students of energy-related majors and specialties and experts revealed important information. First, it concerned the way knowledge is communicated and how it is interpreted; second, informing and implementing the European Union's climate policy; third, the creation of a low-carbon society; fourth, the perception of climate neutrality among young Poles, and finally, preferences in energy generation and use in homes and businesses.

Keywords: environmental awareness; energy awareness; renewable energy sources; EU Green Deal



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1. Introduction

The communication from the European Commission A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive, and climate neutral economy refers to the Intergovernmental Panel on Climate Change (IPCC) issued in October 2018. “The impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways. Based on scientific evidence, this demonstrates that human-induced global warming has already reached 1 °C above preindustrial levels and is increasing at approximately 0.2 °C per decade. Without stepping up international climate action, global average temperature increase could reach 2 °C soon after 2060 and continue rising afterwards. That will mean unpredictable threats for humanity as well as for the natural environment. All kinds of catastrophic films may become true despite their context. Poverty, hunger, climate migrations, deforestation and dissertations may be typical daily news of tomorrow. Such unconstrained climate change has the potential to turn the Earth into a ‘hothouse’, making large-scale irreversible climate impacts more likely” [1].

The European Union’s management of social, economic, and political processes is based on efficiency, decentralization, individual, and collective participation, creating joint legitimacy for the actions taken [2]. Efficiency dominates in constructing legitimacy and effectiveness in the forms given to environmental protection. The implementation of climate neutrality in the European Union is linked to individual and collective responsibility for shaping the social, economic, and political environment [3]. It is also the result of the conscious participation of its citizens in protecting the natural environment and in implementing the European Union’s New Green Deal [4]. On the edge of our decade, NATO’s Allied Command Transformation stated that efforts to reduce the greenhouse effect based on reducing greenhouse gas emissions to “0” would take at least two decades. Delivering a tangible impact will not happen until 2035. Due to the warming of the oceans, smelting of glaciers, reduction in ice around the Arctic, the rising of the levels of the seas and oceans would continue as it is today. This means that humanity and the natural environment will face significant changes worldwide and in the European Union [5]. The situation creates the need to disseminate knowledge related to the conceptual preparation for implementing solutions in climate neutrality and the low-carbon society of the European Union. It also creates a requirement to identify the kind of knowledge, its verification, especially among young people, and their preferences.

In the adopted interpretation of knowledge, reference is made to experience, indicating the need for a more considerable emphasis on a bottom-up approach with technological and socio-economic pathways to climate neutrality. In this approach, GHG emission reduction targets are indicated by concrete solutions to be applied in the practice of everyday life [6]. Stakeholder participation in environmental protection is referred to herein for pragmatic reasons, based on formed preferences and choices [7], above all, in creating ideals and competencies serving the formation of responsible civic attitudes and understanding the public good. Especially in the time frames shown in (Figure 1), “Greenhouse gas emissions in the EU-27 decreased by 24% between 1990 and 2019, exceeding the target of a 20% reduction from 1990 levels by 2020. By 2030, the projections based on current and planned measures of the EU-27 show an emission reduction of 36%, which is a rather conservative outlook in the absence of new measures. Further effort will undoubtedly be necessary with a view to achieving climate neutrality by 2050 and the proposed increased milestone target of a 55% reduction by 2030 (compared with 1990 and including removals)” [8]. Moreover, it concerns the creation of future leaders in implementing climate policies at various levels of decision-making in the Member States and European Union institutions [9].

The element of the social space transformation was co-determining how low-carbon climate policies are legitimized within society. In the above context, pro-environmental education in using energy, as part of the education of a climate citizen, guided by eco-empathy, is fundamental. First, in the economic space, social activity, specific consumer preferences limiting greenhouse gas emissions, and protection of natural resources in

everyday life [10]. The role of the responsible citizen in ensuring the implementation of the European Union's New Green Deal is crucial, especially in the aspect of young people still forming their approach to a climate-neutral, low carbon society in the European Union. "Soft skills", as opposed to "hard skills", are crucial for future policy professionals dealing with low-carbon societies [11]. The purpose of the article is to achieve knowledge about the approach of the young Poles, students of the energy specializations in different universities, to the energy usage and policy-shaping preferences in the context of individual and group attitudes.

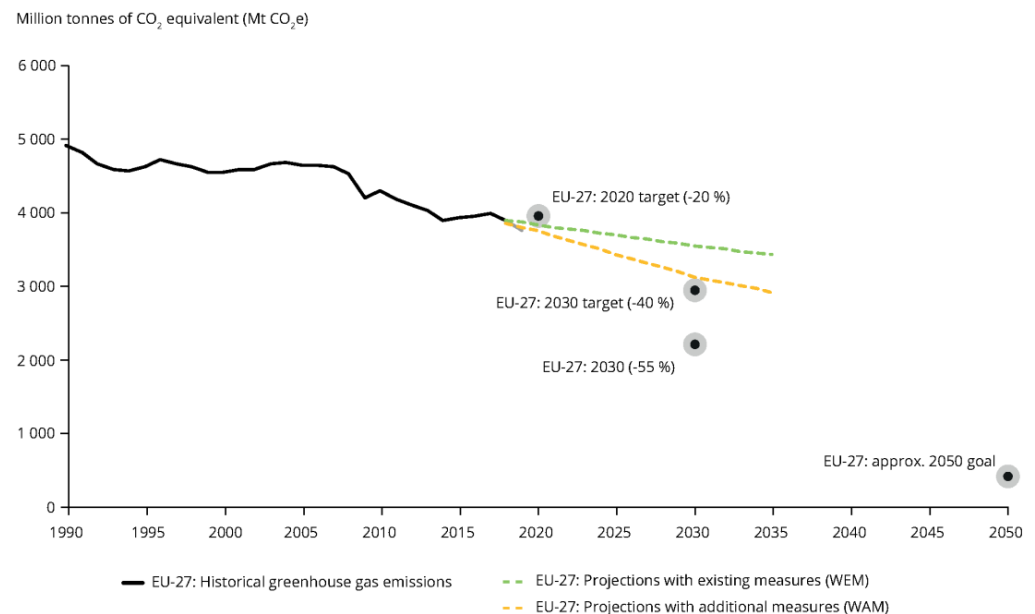


Figure 1. Greenhouse gas emission targets, trends, and Member States' MMR projections in the EU, 1990–2050. Source: <https://www.eea.europa.eu/data-and-maps/indicators/greenhouse-gas-emission-trends-7/assessment> (accessed on 5 August 2021).

2. Theoretical Framework

The paradigm of climate change is imperative to social changes, entrepreneurship, and innovation. Integration of the European Union societies' eco-empathy with the development of new industries (economy 4.0, 5.0), labor market, technical innovations, education takes place in the educational process. Its fundamental element is forming pro-environmental attitudes, together with an innovative approach to entrepreneurship and energy use. As a consequence, it is possible to move away from the burning of fossil fuels [12]. In the above context, the young generation's attitude is vital in achieving the EU's main objectives. Young people's knowledge and awareness of the phenomena is exceptionally crucial and, in the authors' opinion (assuming the time of changes within the next 30 years), it is this social group that will have the most considerable impact on the emergence of a non-emission economy.

The research undertaken in this paper focused on two parallel themes. The first is the changes in the discourse on climate policy and its understanding by a representative research sample of Polish students and experts. It captured the parameters of transitional thinking, a synthesis of evolving and associative approaches in science, technology, and innovation research [13]. The other theme concerns the preferred forms of obtaining, distributing, and using the energy within the European Union society. The parameters of knowledge of an aware citizen ready to follow their social, economic, and political needs were indicated [14]. Even though no direct reference was made to the European Union institutions or the organization itself [15], the respondents' preferences were related to their intuitive choice of behavioral paths. In the context of the European Green Deal embedded in the framework of green capitalism, it was assumed that the current high standard of

living of Europeans would be improved by meeting vital, ecological, individual, group, and social needs [16].

The research formula was defined by the relationship between energy consumption, carbon reduction, and the desired form of environmental protection linked to economic development [17]. The study of preferences allowed filling the gap in the knowledge about the model of actions stimulating the implementation of economic competitiveness, innovations combined with environmental protection, and counteracting climate change [18]. The interpretation of knowledge in the literature compiles many interdependent issues determining the relationship between climate change, environmental protection, economic development, and the projection of changes in these areas resulting from the European Union's actions [19]. The starting point is climate change determined by human activity, ecosystem services, carbon dioxide emissions, biodiversity, desertification and contamination of water resources, and the ability to develop sustainable agriculture [20].

Qualitative and quantitative research methods were used in the research process. The subject literature and the applicable legal acts were analyzed, making it possible to classify, generalize, describe, and systematize the facts collected during the research. A survey was conducted on 1106 students, and in-depth interviews were conducted with three energy experts: Krzysztof Tomaszewski (the University of Warsaw, researcher and lecturer on energy security issues), Dariusz Pachniewski (inventor in energy sector, businessman in hydrogen energy sector), and Tomoho Umeda (president of Polish Chamber of Commerce). The research aimed to identify young Poles' environmental and energy awareness, knowledge of renewable energy sources, and opinions on their use in two areas: home and work.

In recent decades, the literature has focused on humans' lives on Earth, their natural, social, collective, and environment [21]. These apparent relationships are now perceived and defined by society differently than in the past years or even millennia. In the new geological era, the Anthropocene, the human impact on the environment is significant and is expressed in its transformations, enabling or constituting barriers to the existence of both plants and animals, but also to humans themselves [22]. The relevant human activities reduce the negative changes occurring in the biosphere [23]. Furthermore, they imply the protection of the environment, its maintenance and restoration, and primarily relate to the use of energy [24].

While referring to the conducted research and literature, the article defines the approach of young Poles, university students, to the activities at the level of the European Union member state from the aspect of economic development within the European Green Deal with the use of energy sources [25]. The formula of knowledge in the literature indicates its ideological, social, and economic justification [26]. The Deal aims to make the European continent the first place on the planet where the carbon footprint from industry, services, agriculture, transport, and lifestyle of the community's citizens will be reduced or eliminated [27]. The assumed period of transformation is 30 years, from 2020 to 2050. It is intended to ensure the compatibility of EU policies with the Paris Agreement, accelerate the transition to renewable energy sources and increase energy efficiency, reduce dependence on external sources, diversify supplies and invest in solutions to ensure future mobility, improve air and water quality, promote sustainable agriculture, implement the European pillar of social rights at the level of the EU and the Member States, and strengthen climate action [28]. This determinant defined the research direction adopted in the article.

In the literature describing the European Union's policies, several parallel processes define "green capitalism" [29]. The first one concerns the decoupling of the increasing GDP of the EU member states from increasing environmentally destructive energy consumption. The second refers to the Union-wide implementation of environmentally neutral technologies for renewable energy extraction and use. In the third, the complete elimination of environmentally damaging energy consumption is considered [30]. The critical elements in the research undertaken for this article were:

- closed-loop economy (i.e., “green” jobs provided by “green” consumption and “green” disposal of its residues in the “green” cycle of energy extraction and use);
- increased competitiveness of European industry; and
- formation of “ecological” societies of the European Union countries, aware of individual and group roles played in the processes of energy consumption and production [31].

Every study has an implicit, if not explicitly articulated, research project. This paper takes advantage of an inductive method to identify the actions of ‘actors’ in everyday life. It was expressed by the coherence between the researcher’s constructs and the typification of those found in the experts’ common-sense and deductive experience [32]. The knowledge of the students and experts was confronted in a holistic approach. Professionally, scientifically, and didactically experienced persons were opposite those who acquire knowledge. This provided an opportunity for a comparative comparison of the respondents’ knowledge. The participants’ closed and open answers to new phenomena created a research field subject to interpretation. A randomized controlled trial was used [33]. It was somewhat limited due to the diverse number of respondents, but their participation created an opportunity to present a spectrum of views. Attention to the usefulness of the outcomes was linked to interpretative research on the students’ attitudes and its usability in qualitative research related to the fields of study and specializations [34]. The research was practice-based, and the aim was to formulate relevant and valuable results and recommendations for change and improvement, above all, in the current processes of focus group education [35]. The adequacy of the research was verified based on the participants’ answers confronted with the primary sources of information, namely the experts [36]. The study combined data and conclusions with the initial research questions in a survey that was conducted to assess attitudes on a specific group of individuals toward issues such as renewable energy sources, power generation, and their usage at the personal level [37].

3. Methodology and Research Results

The young Poles’ knowledge and awareness regarding the application of renewable energy sources in two different areas were identified for both home and work. The test criteria regarded the attendance of the specific courses and lectures following the issues raised in the survey. The scope of studies was reflected in the provided answers. The survey was conducted on 1106 people in the period from January to May 2021. Students in the age cohorts (in the age of 15 up to 18 years, = 18 people, between 19 and 25 years = 970 people, between 26 and 30 years = 118 persons) with sex distinction (218 females and 888 males) at the following universities: the AGH University of Science and Technology in Kraków, the Military University of Land Forces in Wrocław, the Military University of Technology in Warsaw, the Rzeszów University of Technology, the Silesian University of Technology, and the University of Warsaw took part the study. The issues of renewable energy sources including prosumer energy and the economy of green capitalism were undertaken as part of specializations and dedicated programs. The members of the Youth Climate Council (the Council), an opinion-advisory body operating under the Minister of Culture and Environment, also participated in the survey. The survey was conducted using a survey questionnaire consisting of 20 questions, of which eight were open to the student respondents to share their thoughts, views, and preferences.

An essential issue in quantitative research is determining the minimum size of the research sample to obtain a fully representative study. The determination of the above was possible based on the formula below [38,39]:

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

where

n_b = necessary sample size;

N = size of the population, which is of interest to the researcher;
 Z = standard value for a given significance level p ($Z = 1.96$ for $p = 0.05\%$); and
 D = assumed estimation error ($4\% = 0.04$).

The assumed research sample consisted of 1798 people, as many people from the listed universities and the Council discussed renewable energy issues during program classes. The research was performed between January and May 2021. The minimum sample size was $n_b = 450$ people; 1106 were surveyed. The largest group of students surveyed, 985, was between 19 and 25 years old. The members of the Youth Climate Council were between 15 and 18 years old. The respondents were 20% women and 80% men. Experts with experience in the energy sector and in the formulation of energy policy, who work on these issues academically, were also interviewed. The qualitative research method was designated for interviews with the chosen experts. The quantitative research method was used for gathering views of young Poles, university students. The in-depth interviews with experts took place through an online application in the form of a guided conversation based on an interview questionnaire, the content of which the experts could read in advance. They provided a reference point for the questions addressed to the students in the closed questionnaires. They were informed that their answers were anonymous. The questionnaire did not contain personal questions, and no means were used to determine the identity of the respondents.

The questionnaire with open-ended questions was the method chosen to determine the professionals' opinions on which low-carbon competencies future professionals would need. In addition, it provided an opportunity to verify the practice of the New Green Deal policy implementation in terms of socio-social change against the background of innovative technologies for the energy generation, distribution, and use identified by students.

The deliberations on renewable energy sources and, in fact, on the respondents' knowledge of them began with the question How do you assess your knowledge of renewable energy sources? Only 8.7% of the respondents declared their knowledge in this area to be very good, 26% good, 46.9% sufficient, and 18.4% insufficient (Figure 2 and Table 1).

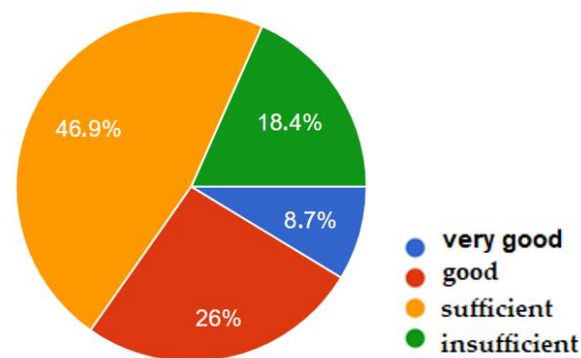


Figure 2. How do you assess your knowledge of renewable energy sources?

Table 1. Question no. 1, research results.

		The Possibility of Choosing the Answer			
Question		Very Good	Good	Sufficient	Insufficient
No. 1	How do you assess your knowledge of renewable energy sources?	8.7%	26%	46.9%	18.4%

This state of affairs is due to students verifying their knowledge in relation to that indicated in the questionnaires.

In response to the question What do you identify with the European Green Deal in the context of renewable energy sources? 98% of the surveyed persons indicated their ignorance. The remaining 2% presumed that these were waste segregation, ecology, windmills,

wind energy, care for the environment, photovoltaics, climate neutrality, taking care of the planet, and replacing thermal power plants with wind hydroelectric ones, and reducing greenhouse gas emissions.

Another area of knowledge reviewed concerned forms of energy generation. When answering the question Which forms of energy production do you think are the most environment, social and human friendly in Poland? (Table 2) the respondents indicated that the most environment, social, and human friendly forms of energy production were photovoltaic (240 respondents), geothermal energy (197 respondents), wind energy (159 respondents), wave energy (152 respondents), and water energy (102 respondents). Biomass energy, understood as burning biomethane plant waste, was indicated as the least environmentally friendly (51 respondents).

Table 2. Question no. 2, research results.

		The Possibility of Choosing the Answer					
	Question	Photovoltaic	Geothermal Energy	Wind Energy	Wave Energy	Water Energy	Biomass Energy
No. 2	Which forms of energy production do you think are the most environmentally, social and human friendly in Poland?	26.64%	21.86%	17.65%	16.87%	11.32%	5.66%

The knowledge about renewable energy sources, awareness of their use, advantages, and disadvantages depends on the information and educational activities. When asked Which information and education activities regarding renewable energy sources have you encountered in the educational process? they underlined that they had already participated in several initiatives aimed at promoting knowledge on renewable energy sources. A total of 62.5% of the respondents indicated that they had obtained such information during school classes, 50.3% took part in Earth Day, 26.9% participated in environmental workshops, and 23.3% attended meetings with environmentalists. The remaining group also declared that they had encountered information and education activities on the Internet, during family discussions, within the subject of environmental protection, as the formula of activities of private companies, during additional and compulsory classes, in social media, during competitions of ecological knowledge, education in the field of biology including tree planting, and within their interests using brochures and books.

According to all interviewed experts, Tomaszewski, Pachniewski, and Umeda, the education on renewable energy sources should be systematic and start at preschool age. With the development of children and then young people, the curriculum content should be expanded and discussed more frequently. The education process is closely connected with information activities, about which experts expressed the same conviction as for educational activities: content provided during school classes, participation in Earth Day, ecological workshops, and meetings with ecologists.

The public's awareness of renewable energy sources is not comprehensive. In response to the question of What forms of information and education activities could increase public awareness regarding renewable energy sources? the surveyed persons answered that they could by conducting information activities as part of educational campaigns on public and private television, Internet portals, posters, and brochures. The idea is that these activities should cover different areas of knowledge in an interdisciplinary way. Apart from short information, according to the respondents, it is necessary to extend the educational offer by, for example, creating educational programs during which ecologists and energy experts could speak about the advantages and disadvantages of using renewable energy sources. Demonstrations of physical phenomena in the form of experiments, which can occur as the consequence of not using renewable energy sources, would be very valuable.

The experts draw attention to the need for organizing and conducting discussions in this area in academic circles, during scientific events, exchange of information, and additional education provided by scientific circles. Moreover, they stress that an essential element is to strive for changes in the curricula from kindergartens to universities. Like the students surveyed, they believe that environmental awareness can be increased through information campaigns in the media, through which it is possible to reach a broad audience. Information campaigns can take the form of advertisements, entertaining films, spots, posters, or quizzes. Second, it should be achieved through education, which should start in kindergarten and continue at every educational level. The knowledge gained could be verified, for example, through competitions dedicated to ecology, the high results of which could lead to benefits such as exemption from exams or admission to secondary schools.

At the secondary school level, knowledge about renewable energy sources should be taught in an interesting manner and show the possibilities for development in this field. During their studies, young people should acquire knowledge on, for example, constructing renewable energy installations, which should lead to a degree as a hydrogen car technician.

As far as students are concerned, the experts propose two solutions to raise environmental awareness. The first are programs that will build up knowledge about renewable energy sources and awareness about their non-use or use comprehensively. The experts also emphasize that, in addition to basic knowledge, it is indispensable to raise the possibility of producing hydrogen from renewable energy sources, which will be a source of further transformation because hydrogen can be an energy store. It can be used to store energy because its energy value is 3–4 times higher than that of natural gas or fuel oil. Given these facts, it should be pointed out that the solution is certainly better than using combustion processes that produce greenhouse gases, dust, and all kinds of other substances that poison the environment. Experts also emphasize that there are already plants in Poland that use renewable energy technologies, and these facts should also be passed on to the public while encouraging people to use them.

If it is not possible to introduce the first solution, the second is to implement, as part of the faculties, selected subjects dedicated to renewable energy sources. Another solution that can support the two above proposed ones is to saturate the content with ecology provided by experts, employees of the energy industry, and ecology branches within standard subjects and through the activities of scientific circles, which are dedicated to security in the broad sense or directly to energy or ecology.

Experts also stress that there are no courses in Poland where specialists in low- or high-temperature fuel cells would be educated. The most critical issue in the case of renewable energy sources is their storage. It is necessary to develop studies that show how to store energy from unstable sources such as PV or wind and how to use it when it is not available. In addition, economic faculties should link theory with practice (e.g., currently generated energy is accounted for within the national energy system, and the right solution is for a potential buyer of a storage facility designed by an engineer to enter into an agreement with the Polish Power Grid for using this energy storage facility for e.g., 15 years). Provided that this storage has sufficient capacity, it will generate a profit of PLN 240,000 per year.

The experts believed that regardless of the forms of studies, the most effective solution would be a systemic one that would include all social groups. This solution would build the entire society's knowledge and awareness of renewable energy sources.

In response to the question of How would you like to care for the environment? (Table 3) the respondents indicated that there were many different forms of taking care of it and ways of doing it. The most effective method was waste segregation (336 respondents), participation in "farm to table" food consumption (213 respondents), saving water (130 respondents), using recycled materials (86 respondents), living in an energy-efficient building (74 respondents), and using biodegradable materials (56 respondents). The least effective way was saving electricity (54 respondents). In response to the question of What convinces you to introduce low-carbon technologies in your immediate environment? (Table 4) the

respondents mentioned financial savings in the first place (712 respondents), followed by eco-empathy (229 respondents), and eco-fashion (102 respondents).

Table 3. Question no. 3, research results.

The Possibility of Choosing the Answer								
No. 3	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
	How would you like to care for the environment?	35.4%	22.44%	13.7%	9.06%	7.8%	5.9%	5.7%

Table 4. Question no. 4, research results.

The Possibility of Choosing the Answer				
No. 4	Question	Financial Savings	Eco-empathy	Eco-fashion
	What convinces you to introduce low-carbon technologies in your immediate environment?	68.26%	21.96%	9.78%

Respondents also referred to the question concerning the use of renewable energy sources at home. They considered photovoltaics to be the most valuable renewable energy source, followed by heat pumps and biomass energy. In their opinion, the use of solar collectors ensures lower operating costs of residential buildings by replacing a traditional heat source for heating water such as a coal or gas boiler or an electric heater. In addition, it reduces the household's dependence on energy suppliers. Respondents indicated that photovoltaic panels generate electricity to operate appliances, lighting, and heat water, which primarily replaces the furnace needed to heat the house and water, thereby reducing the level of pollution produced during combustion; additionally, this generates savings over time.

Respondents also indicated heat pumps as heating devices acquiring renewable energy accumulated in the ground, water, and air. The energy extracted by the heat pump is transferred to the heating system and used for heating interiors and domestic water. Modern heat pumps can also provide cooling for a building in summer. The main argument for installing a heat pump is the low operating costs. Although it needs electricity to work, with a well-designed installation, its consumption is low.

According to the respondents, burning biomass (i.e., plant fuels such as woodchips, wood in the form of logs, pellets, cereal grains, straw, and energy crops such as fast-growing willows and poplars) is considered neutral for the environment, as the amount of carbon dioxide absorbed by the plants during their growth is released into the atmosphere. Energy generated by wind turbines can also be used for lighting rooms or pumping water. However, own electricity (i.e., a home power plant) is still rare and is connected to high expenses for the purchase of necessary equipment and restrictive energy laws that occur when implementing such systems.

In the experts' opinion, photovoltaics is the most popular renewable energy source among consumers. It stems from the fact that the technology is easily accessible and discounts under the "My electricity" program and thermo-modernization relief. Above all, it is due to the possibility of even a 10-fold reduction of energy bills. Photovoltaics is an alternative to natural gas and lignite; in combination with a heat pump, it allows one to obtain sufficient energy for space heating.

The expert pointed out that biomass (i.e., burning wood from a fireplace) also has heating applications and provides support for gas in space heating. Even though wind energy is the most significant for Poland, it has not met with as positive a reception as photovoltaics. In turn, the government wants to invest in offshore energy, but the public has no opinion on that.

Technologies can also be applied in the so-called ‘hydrogen smart homes,’ which allow hydrogen to be produced at home. It is estimated that it is possible to produce 5 kg of hydrogen per day. In 2019, such a house cost PLN 2,000,000; currently, the price oscillates below PLN 1,000,000. Hydrogen can also be used for personal transport. A hydrogen highway is currently being designed, and there are plans to launch two hydrogen stations in Warsaw and Konin on H35 and on H70, which will allow cars and trucks to be re-fueled. It will also be possible in Poland to use hydrogen for heavy transport such as trucks and buses, which will enable zero-emission transport. It is estimated that in a few years, hydrogen will be at the price of 1 L of petrol or diesel fuel.

Furthermore, the surveyed people also referred to applying renewable energy sources at work. From their perspective, the use of these sources is a positively perceived strategy. Modern companies must care about the high quality of goods and services and corporate social responsibility.

According to the respondents, the most considerable benefits for a company that uses renewable energy sources include:

- (1) positive image of the company as one that cares about the environment and easy access to EU subsidies;
- (2) lower electricity bills and fixed costs of power supply;
- (3) well-thought investment in renewable energy sources constitutes a high cost, but at the same time guarantees quick return (electricity from wind or solar power is practically cost-free);
- (4) independence from external conditions, self-sufficiency; and
- (5) in the long term, energy from wind, sun, or water can allow a company to gain a dominant position in the market. Some of the advantages of renewable energy can be seen immediately after its implementation in a company such as buying energy from sellers offering electricity with a RES guarantee. Others imply likely benefits in the long-term. However, there is no doubt that renewable energy sources represent the future of the economy.

The interviewed persons believe that renewable energy sources can also be used, for example, for space heating, sports halls, and heating water in halls. They reduce emissions, decrease the carbon footprint, and increase the competitiveness of products. Wind energy can be used in industrial plants (e.g., for lighting rooms or irrigating fields). Furthermore, they also point out that generating electricity in one’s operations, in which the process is used, can bring significant financial benefits in the form of minimizing production costs.

According to the experts, the use of renewable energy sources in work and business is applicable. In their opinion, a business should be based precisely on these technologies, which are very promising and, above all, zero-emission. These technologies are an opportunity for the development of small companies and multi-family buildings that will use the generated energy and produce it, which will consequently increase the energy balance. Experts see three paths for the application of renewable energy sources:

- (1) Renewable energy sources as an opportunity with entrepreneurship;
- (2) Prosumer energy; and
- (3) Management of those individuals who move from the fossil fuel industry to renewable energy sources.

Experts also point out that, due to European Union regulations, by 2030, it will not be possible to sell a petrol or diesel car in some countries. Hybrid and electric cars will prevail. The latter will be allowed to be used on the condition that they are powered by green energy and there will be zero-emission zones in Poland.

As far as the question of What kind of car would you like to drive? (Table 5) is concerned, the respondents pointed out that the technological progress made it possible to drive cars powered by different energy sources. They indicated that they would prefer an electric car (285 respondents), followed by a bioethanol car (160 respondents), a petrol car (127 respondents), a petrol–electric car (94 respondents), and an oil car (84 respondents).

The least popular were hydrogen-powered (63 respondents), petrol/gas (61 respondents), and hydrogen–electric cars (48 respondents).

Table 5. Question no. 5, research results.

		The Possibility of Choosing the Answer							
No. 5	Question	an Electric car	a Bioethanol car	a Petrol car	a Petrol-Electric Car	an Oil Car	Hydrogen-Powered	Petrol/Gas	Hydrogen-Electric Cars
	What kind of car would you like to drive?	30.9%	17.35%	13.77%	10.2%	9.11%	6.83%	6.63%	5.21%

The question of How would you like to reduce your carbon footprint when using energy? (Table 6) was answered as follows: using dual-use water technology, for example, by reusing water for hygiene purposes (321 respondents), living in an energy-efficient building (295 respondents), applying energy-efficient heating (143 respondents), and using energy-efficient lighting (134 respondents). Respondents also mentioned an energy-efficient building in which people take up work (50 respondents).

Table 6. Question no. 6, research results.

		The Possibility of Choosing the Answer				
No. 6	Question	using Dual-Use Water Technology, e.g., by Reusing Water for Hygiene Purposes	Living in an Energy-Efficient Building	Applying Energy-Efficient Heating	Using Energy-Efficient Lighting	an Energy-Efficient Building in Which People Take up Work.
	How would you like to reduce your carbon footprint when using energy?	34.04%	31.28%	15.16%	14.21%	5.4%

The experts emphasize that under EU directives, coal will not be used after 2049. Regarding the food industry, it will be necessary to show that companies have used energy from renewable sources to produce the product. This applies not only to the food industry but also to cement works, glassworks, distilleries, and breweries. The consequences will be an initial increase in the price of products, but it is estimated that after 7–8 years, both technologies and product prices will decrease. By 2050, the energy production process in Poland will have disappeared. There is a risk of society’s impoverishment in connection with the application of zero-emission technology; therefore, it is crucial to managing the financial resources of the post-COVID economy and from the National Reconstruction Plan.

In response to the question of How would you like to share the electricity you generate? most respondents (386 people) would share their electricity in a free wired and wireless, 247 in a paid wired, 87 in a paid wireless, 64 in a free wireless, 59 in a free and paid wired, 38 in a paid wired and free wireless, and 37 in a free wired manner (Table 7).

Table 7. Question no. 7, research results.

		The Possibility of Choosing the Answer						
No. 7	Question	Would Share Their Electricity in a Free Wired and Wireless	in a Paid Wired	in a Paid Wireless	in a Free Wireless	in a Free and Paid Wired	in a Paid Wired and Free Wireless	in a Free Wired Manner
	How would you like to share the electricity you generate?	42.37%	26.9%	9.48%	6.97%	6.23%	4.02%	4.03%

When asked Which energy-saving model would you and your family prefer? The respondents chose the option of using distributed free forms of energy (45.4%), using grid centric free forms of energy (38.2%), and 16.5% favored the model of using paid wired and wired free forms of energy (Figure 3 and Table 8).

When asked How do you see your future in a carbon-free society? 60.8% of the respondents saw their future as active energy prosumers and 39.2% as passive energy consumers (Figure 4 and Table 9).

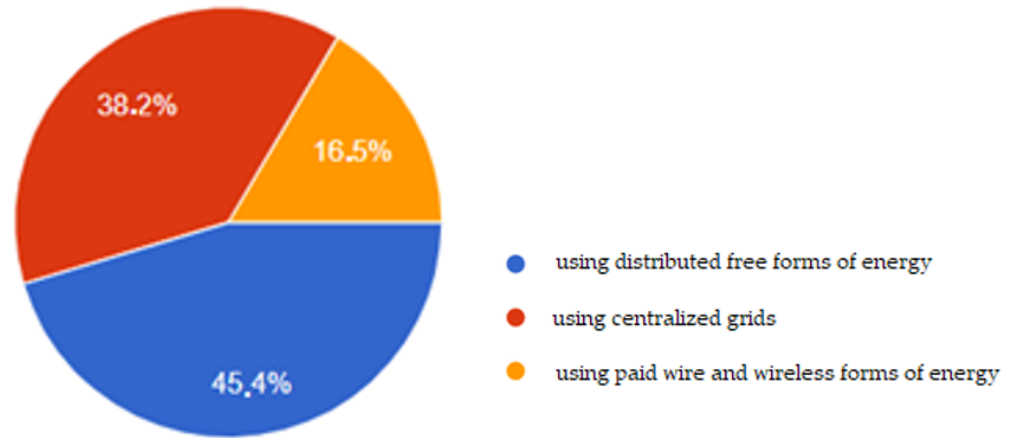


Figure 3. Which energy-saving model would you and your family prefer?

Table 8. Question no. 8, research results.

The Possibility of Choosing the Answer				
No. 8	Question	Using Distributed Free Forms of Energy	Using Grid Centric Free Forms of Energy	Using Paid Wired and Wired Free Forms of Energy
	Which energy-saving model would you and your family prefer?	45.4%	38.2%	16.5%

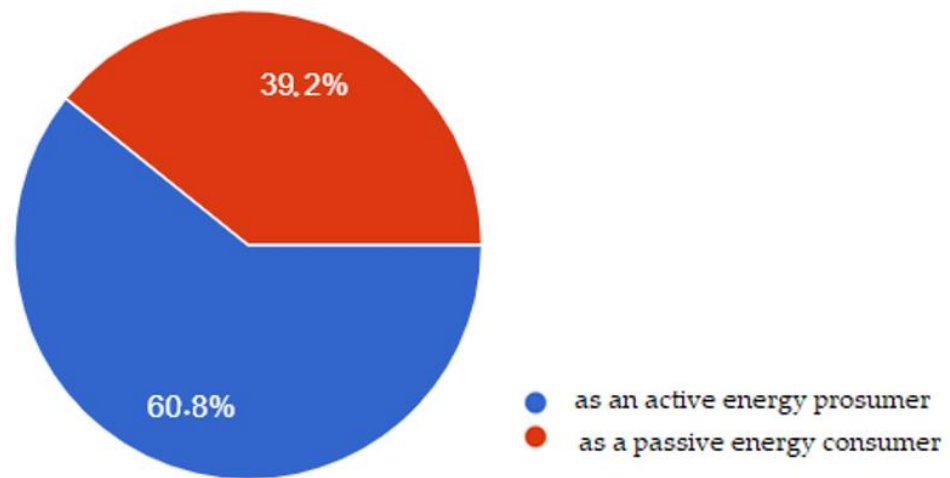


Figure 4. How do you see your future in a carbon-free society?

Table 9. Question no. 9, research results.

The Possibility of Choosing the Answer			
No. 9	Question	Their Future as Active Energy Prosumers	As Passive Energy Consumers
	How do you see your future in a carbon-free society?	60.8%	39.2%

In response to How to encourage society to adopt a low-carbon lifestyle without leaving a carbon footprint? (Table 10) 91.5% of the respondents felt that financial incentives (e.g., discounts on energy-efficient industrial goods (which was ranked first) and discounts on organic food (ranked second)) would be sufficient.

In response to the question Do you think it is possible to encourage society to adopt a low-carbon lifestyle in addition to the suggestions in the question above? 8.5% of the respondents believed that the public could be encouraged to adopt a low-carbon lifestyle

through tax breaks, social campaigns in mass media, government funding for energy source replacement (e.g., coal cookers), tax reduction for people producing energy from renewable sources, abolishing taxes for electric vehicles and introducing privileges for people who use them (e.g., free charging networks (AC), separating a highway lane in Poland dedicated to family cars (2+1) or electric cars, free car parks, motorways), and tax write-off and tax reductions for bio food products. According to both respondents and experts, it appears imperative to raise the public awareness of the dangers of environmental pollution and the related consequences to show their effects and the benefits of a low-carbon lifestyle. The above can be achieved through educational films, which will show two forms:

- (1) the use of renewable energy sources; and
- (2) no use of renewable energy sources.

Table 10. Question no. 10, research results.

The Possibility of Choosing the Answer			
No. 10	Question	Financial Incentives, e.g., Discounts on Energy-Efficient Industrial Goods	Discounts on Organic Food
	How to encourage society to adopt a low-carbon lifestyle without leaving a carbon footprint?	91.5%	8.5%

The answers also indicated meetings with experts, classes at school, kindergarten, educational programs broadcast in social media or TV as forms complementary to the communication.

The respondents made other suggestions concerning financial discounts on housing charges, tax breaks for people leading low-emission lifestyles, allowances for the purchase of electric cars, reductions in the cost of installing renewable energy sources, and discounts for waste sorting (discounts for companies doing so). Plastic bags should also be withdrawn from circulation. According to some respondents, penalties for littering should be increased and, above all, charges enforced for using sources harmful to the environment. Another element encouraging such a lifestyle would be reducing the use of cars through free public transport and collective easy access to it.

In response to the question Which forms of incentives would you prefer most? 65.6% of the respondents indicated financial incentives using collective forms of communication, 31.9% financial incentives using collective forms of feeding, and 2.5% subsidies and no hindrance to installing one's own renewable energy sources (Figure 5 and Table 11).

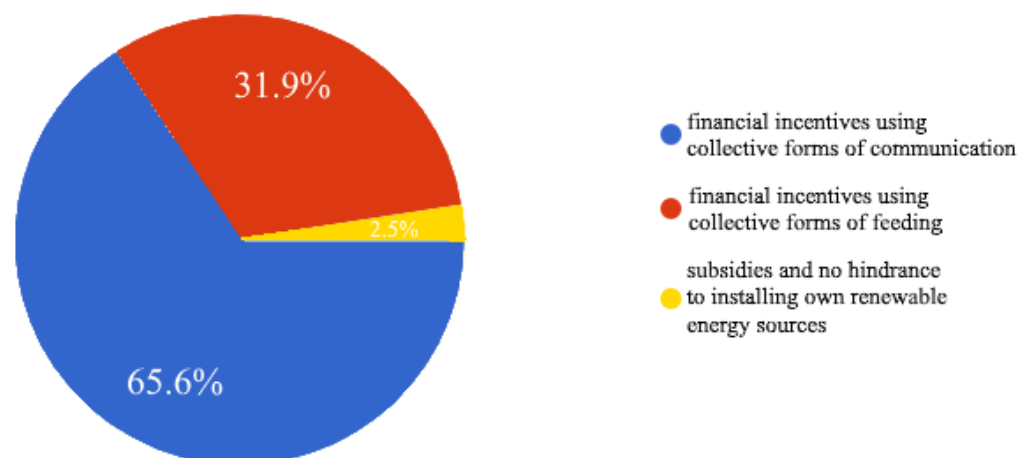


Figure 5. Which forms of incentives would you prefer most?

Table 11. Question no. 11, research results.

The Possibility of Choosing the Answer				
No. 11	Question	Financial Incentives Using Collective Forms of Communication	Financial Incentives Using Collective Forms of Feeding	Subsidies and no Hindrance to Installing Own Renewable Energy Sources
	Which forms of incentives would you prefer most?	65.6%	31.9%	12.5%

4. Application

The survey consisted of 20 questions: nine of them were open-ended questions, and eleven were ranking or optional questions.

The students were asked to answer open-ended questions. The results of the research are presented in the section "Methodology and research results":

- (1) Which information activities regarding renewable energy sources have you encountered in the educational process?
- (2) Which education activities regarding renewable energy sources have you encountered in the educational process?
- (3) What forms of information activities could increase public awareness regarding renewable energy sources?
- (4) What forms of education activities could increase public awareness regarding renewable energy sources?
- (5) What do you identify with the European Green Deal in the context of renewable energy sources?
- (6) What do you think renewable energy is used for at home?
- (7) What do you think renewable energy is used for at work?
- (8) Which renewable energy sources occurring in Poland?
- (9) Do you think that society can be encouraged to adopt a low-carbon lifestyle in addition to the suggestions made in the above question?

(The question asked above was: How to encourage society to adopt a low-carbon lifestyle without leaving a carbon footprint?)

The interviews were also conducted with experts in the field of renewable energy sources. The results of the research are presented in the section "Methodology and research results". The authors of the article asked the following questions:

- (1) How to increase public awareness of the ecological use of energy?
- (2) How to raise students' awareness of green energy use, and what actions should be taken?
- (3) What content should be included in the education process (from kindergarten to university) to increase the awareness of ecological energy use, and what do you think the education process should look like?
- (4) In what areas do you think renewable energy can be used at home and in everyday life?
- (5) In what areas, in your opinion, renewable energy sources can be used in work and entrepreneurship?
- (6) What do you think innovation in low carbon technologies will bring in everyday life?

5. Discussion

The key elements of European Union policies shaping the organization's future actions are a balance between ecology and climate-friendly social development. In a New Green Deal, they are expressed in concrete actions such as increasing energy efficiency, using renewable energy sources, and electricity to decarbonize the energy supply in Europe fully. Furthermore, adopting the principles of clean, safe, and connected mobility, building a competitive EU industry and a closed-loop economy, developing smart grid infrastructure

and connectivity, and harnessing the bio-economy including reducing CO₂ emissions through carbon capture and storage, are the foreseen tools for those actions.

The reinforced narrative of creating a low-carbon society, a green economy, was adapted and evaluated for innovative individual and collective approaches in the research conducted in this paper. In the quantitative and qualitative samples, the assumptions made were double-checked. The former verified the students' views, while the latter, the experts' views. The procedure established the directions of knowledge evolution and approach to technologies and their innovations among students of technical faculties related to the energy sector. Existing individual and collective mental constructs on energy transition and climate neutrality were identified.

Open questions regarding the students' knowledge allowed us to verify the scope of understanding a low-carbon European Union society represented by young Poles. Moreover, research has shown how they perceive climate neutrality. It also, to some extent, testifies to the quality and quantity of education programs designed for the purpose of preventing greenhouse gases emissions. The research allowed us to clarify the preferences and the formula of energy usages. This could serve for future solutions in public policies to increase awareness of climate-friendly social development.

Obtaining knowledge from Polish university students and experts about environmental preferences and achieving climate neutrality enabled an interpretation of actions to implement policies and economic incentives effectively. The researchers indicate the existing gap in student knowledge between the European Union policies and expectations of the organization in the context of the New Green Deal and its practical implementation. The limited scope of young Poles' understanding of energy changes and the European Union's strive for a low-carbon society create demand for structural educational changes in Poland. However, it may apply to the whole European Union, which can testify only after the research conducted in each community state.

The research has indicated that young people recognize renewable energy sources. Furthermore, they are positive toward implementing them in their home and work conditions. In their opinion, the main advantages are from possible limitations to greenhouse gases, financial savings, and protection of the natural environment. Judging the pros and cons of climate neutrality, young Poles' clearly highlight the need for support for a new method of gathering and using the energy in its renewable form. They support new solutions in that regard as well as for a new low-carbon lifestyle. The knowledge verification method adopted in the study defined its form, formula, and final elaboration. Applying it, students as well as experts indicated their competencies and preferences. The results have shifted from academic discussion in classes and on campuses to everyday practice dictated by concrete lifestyle choices.

The research implements the concepts of socio-technical networks and their configurations linked to social forms of energy consumption, extraction, and distribution. The need to strengthen the narrative of creating a low-carbon society and green economy, as defined in the paper, is outlined and assessed for the implications for individual and collective innovative policies within the European Union Member State. The research indicated the need for more improvements in the formula of education. This seems evident to the observer, but starts to become a real tough issue in the details. Significantly, the comparison of experts' and students' knowledge points to gaps in the complex attitude to renewable energy usage.

The authorities should build the system approach through information campaigns, relevant education programs from kindergarten to high schools and universities. The scope should be as wide as pragmatically possible, focusing on case studies, and is easy to understand and use the knowledge coming from the information sources. It could be worth extending the existing and the new education programs, forms of receiving knowledge, and student engagement in shaping a low-carbon European Union society. This issue should be behind the States and the European Union institutions approach focusing on individual and group needs referred to as the Union's New Green Deal.

6. Conclusions

The surveys conducted among university students of energy-related majors and specialties and experts revealed important information. First, it concerned the way the knowledge is communicated and how it is interpreted; second, informing and implementing the European Union's climate policy; third, the creation of a low-carbon society; fourth, the perception of climate neutrality among young Poles, and finally, the preferences in energy generation and use in homes and businesses. Such research focusing on young, university educated people has not been conducted in Poland previously or in the European Union. This generation approach is essential for the organization, its policies, directives, and programs. Due to this situation, it was not possible to compare with other similar researches within the European Union and worldwide. The gathered questions placed in the survey reflect the scope of the knowledge collected from the studies programs.

The knowledge gained in the research allows us to conclude that the energy transition linked to climate change and society toward a low-carbon society and carbon footprint is at an insufficient level. Actions such as climate neutrality, reduction of greenhouse gas emissions, care for the environment, care for the planet, ecology, waste separation, windmills, wind energy, photovoltaics, conversion of thermal power plants to wind and hydroelectric power plants are not identified as a pattern of a comprehensive approach. The research also indicated a selective selection of respondents' knowledge among students. In doing so, it is not linked to a specific interpretation in the area such as social ecology or green capitalism.

The research proved that university students had knowledge of renewable energy sources, awareness of their use, and the advantages and disadvantages identified with them from dispersed sources. It resulted from their previous education and their activity on Internet forums. The experts' opinion that education related to renewable energy sources should systematically occur, starting at preschool age, identified the gap. Moreover, the situational awareness expressed by students is not comprehensive. There is a lack of in-depth discussion involving students and experts from different domains related to renewable energy, climate, and environmental protection.

The respondents' intuitive choices regarding the benefits of low-carbon technologies indicate their readiness to adapt and change their energy use habits in everyday life, namely, at home and at work. The respondents identified photovoltaics and the use of biomass as the most valuable renewable energy source. This indicates the respondents' prosumer approach, which corresponds to the currently conducted and implemented research on heat-absorbing materials that absorb solar radiation and their application in energy production.

The respondents' evaluation of mobility and vehicles indicated preferences that were not the effect of deep knowledge of energy generation methods associated with a carbon footprint. In that knowledge area, there were essential cognitive gaps concerning the extraction of minerals (electric cars), the ability to project the development of specific segments of "green" automotive communication (hydrogen), and their relationship with the generation and deposition of energy in devices such as vehicles. A separate issue was the preferences for users of "green" vehicles in their operation and daily use.

The research identified the respondents' prosumer preferences. Noteworthy was the sharing of energy on a reciprocal basis, without additional charges. Those attitudes corresponded to the forms of using free forms of energy generation and the way of organizing a low-carbon society without leaving a significant carbon footprint. The attitudes toward financial incentives for the purchase of energy-efficient industrial goods and discounts for the purchase of organic food corresponded with these issues.

In the research, a crucial issue for the respondents and experts was to raise public awareness of environmental pollution risks and related consequences. It was interesting to identify ways of generating such knowledge through an experiment showing the advantages and disadvantages of the existing and proposed solutions. The empirical approach of students and experts to this matter identified a cognitive need in Polish society as well

as the potential direction of information campaigns related to the perception of climate neutrality and creating an interpretation of the knowledge of the low-carbon society of the European Union.

When summarizing the research among students with the experts' participation, it should be stated that the respondents are ready to adapt their attitudes to the use of renewable energy sources, increasing energy efficiency and a closed-loop economy. They do not identify the complete decarbonization of energy supply including reducing CO₂ emissions through carbon capture and storage, the development of smart grid infrastructure, the construction of a competitive EU industry, and the bio-economy. It also points to existing knowledge gaps and educational needs to address, especially when we take into consideration the social space transformation code terminated up until now with low-carbon climate policies in Poland and the education formula. This context in pro-environmental education is an integral part of the education of a European Union climate citizen, guided by eco-empathy and environmental protection in everyday life.

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