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RES Market Development and Public Awareness of the Economic and Environmental Dimension of the Energy Transformation in Poland and Lithuania

Ewa Chomać-Pierzecka , Anna Sobczak  and Edward Urbańczyk

Faculty of Economics, Jacob of Paradies Academy in Gorzów Wielkopolski, 66-400 Gorzów Wielkopolski, Poland; asobczak@ajp.edu.pl (A.S.); eurbanczyk@ajp.edu.pl (E.U.)

* Correspondence: echomac-pierzecka@ajp.edu.pl

Abstract: Energy transformation in the European Union countries is progressing. Its scope is defined by formal and legal regulations and its effectiveness by the position of decision-makers, legitimised by public support for a particular type of challenge. Both issues are the focus of this article. The promotion of environmental protection measures is currently strongly promoted globally. Hence the widespread acceptance in principle of the changes associated with the implementing of the Green New Deal in the energy sector is not surprising. However, to what extent is knowledge of the solutions constituting the mainstream transition (renewable energy sources) ingrained among communities? Does the level of public awareness influence individual consumer choices, modelling the market? The threads outlined above inspired deliberations focused on analysing the assumptions behind energy transition in the EU, with particular reference to the countries directly bordering the line of the ongoing conflict in Ukraine (Poland, Lithuania), in the light of the resulting and escalating restrictions exacerbating the energy crisis. The immediate neighbourhood of the adopted countries, and their similar socio-economic conditions, provided the basis for comparisons and conclusions. The motivation for the choice of the issue and research area was to fill the clear information gap in this study area, strictly in relation to the adopted configuration of these countries. The research proceedings in the outlined area were primarily based on the methodology appropriate for capture and analysis of economic phenomena, enriched with the results of our own findings (questionnaire survey regarding general knowledge of the ZE market and consumer preferences), in order to assess the economic and environmental dimensions of energy transition in Poland and Lithuania and to assess the level of public awareness in this respect in the countries under study. The presented research is an important complementary element of the authors' series of studies devoted to the analysis of the development of the renewable energy market in Poland and the Baltic States, related to the individual dimensions of RES. Their results give rise to the conclusion that increased social awareness in these countries determines the popularisation of RES solutions in individual use, regardless of their type, stimulating the progress of the energy transformation process.

Keywords: renewable energy; energy transition; energy security; energy policies; electricity prices



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1. Introduction

Due to man's negative impact on the environment, irreversible climate change poses a real threat to human existence. Over-exploitation of deposits resulting in an imbalance in ecosystems, combined with critical levels of discharges and emissions of toxic substances—with particular reference to greenhouse gases—are the primary conditions for the global warming taking place, changing the world in an absolutely undesirable direction. Wide-ranging protection of the planet and care for the environment are currently critical priorities in modelling economic changes, finding their outlet in the creation of numerous innovative solutions [1]. These priorities, to a particular extent, refer to energy production, for decades occupying an infamous place in the world ranking of industries

with the strongest negative impact on the climate and the planet. The classic methods of energy production—based on fossil fuels and high-carbon technologies—are currently unacceptable. The policy of opening up to ecology and building an innovative approach to energy production based on renewable energy sources has become an absolute necessity.

Overexploitation of natural resources permanently reduces their availability [2]. The prices of fossil fuels are rising and with them the cost of producing 1 KW of energy by conventional means. The increase in energy prices is further stimulated by increasing environmental charges for greenhouse gas emissions. As a result, conventional energy becoming more expensive has significantly burdened the functioning of economic entities which strongly rely on this energy supply formula.

The outbreak of the COVID-19 coronavirus has disrupted the financial economies of both households and businesses. The rising cost of purchasing electricity, coupled with continued high demand for it, began to drain consumer budgets increasingly. The energy crisis was perceptibly aggravated by the outbreak of war in Ukraine and the limited availability of energy resources due to this conflict, pushing up energy prices on world markets. The world faces urgent challenges in finding energy security solutions appropriate for economies and energy consumers. The economic consequences of the increase in energy prices are evident. Prices of products and services are rising, and inflation is skyrocketing. The above applies particularly strongly to countries whose energy supplies are derived most extensively from traditional production, and re-modelling the production formula requires major investment challenges that will, by definition, create additional growth in the market price of energy.

The problem of rising energy prices has been observed in the world for a long time, with the COVID-19 pandemic and the outbreak of war in Ukraine making the situation in the global energy market extremely complicated, essentially reinforcing the negative trend of rising prices, along with a set of economic consequences of these increases, affecting consumers. This situation implies an urgent need to implement measures to limit the growing increase in energy prices and the negative effects of this process. One of the measures in this field is the promotion of energy from renewable sources and the strengthening public awareness in this regard. With the above in mind, the authors considered it an important research problem to analyse the directions of obtaining green energy in the countries directly bordering the area of the Russian-Ukrainian conflict (Poland, Lithuania), together with an assessment of the degree of knowledge of RES solutions, and of openness to their implementation by the local community. Increasing limitations on the energy market, and deepening of the energy crisis, are the key arguments outlining the current relevance of this issue, the study of which can support the process of social education in the RES sphere, as well as the promotion of this dimension of the energy transition in these countries. The popularisation of RES solutions is a key factor in the development of RES for individual use, which undoubtedly increases the degree of energy independence and reduces the energy cost for individual consumers. The argument above shaped the main objective of the study, which was to analyse the directions of energy market changes based on the review of assumptions of industry reports, and to diagnose the state of knowledge and orientation towards RES by Polish and Lithuanian inhabitants, based on the results of the questionnaire survey. Partial findings were subjected to critical analysis to establish a causal relationship between the level of public awareness and openness to RES.

The research revealed a causal relationship between the level of social awareness and individual use of RES, indicating a more favourable situation in this respect in Lithuania compared to Poland.

It should be emphasised that, within the scope of the study in question—strictly in relation to the adopted configuration of countries—there is a diagnosed information gap, the filling of which may contribute to the improvement of the RES development sphere in individual use. Hence, the research aims to outline the level of public awareness, creating support for implemented changes and motivating individual consumers to reach

for solutions increasing energy and financial security—especially important in the realities of the energy crisis.

The available literature is relatively poor in results of current analyses of RES development directions within the scope of the subject of this study and in relation to the adopted configuration of countries. Hence, in the authors' opinion, the results obtained may enrich the existing literature with useful knowledge on the explored topic, enriching the potential to assess the set of challenges regarding renewable energy in Poland and Lithuania, and indicating the benefit of their implementation.

The structure of this paper adopts the following layout: Section 1 is an introduction to the research issue, and Section 2 is a review of the literature addressing the issue of green energy in the global energy market. Section 3 discusses the economic–environmental aspects of the development of the renewable energy market in Poland and Lithuania, considering the formal and legal framework, and the assessments of the local community (results of own research). Section 4 covers discussion and conclusions.

2. Renewable Energy in the World–Literature Review

Public awareness of renewable energy sources is increasing globally [3–5]. The benefits of using green energy are contributing to a change in the energy policies implemented so far [6–8].

The primary motivator for opening up to green energy is to live increasingly in harmony with nature by caring for the environment [9]. This direction is supported by the continuous development of technology and techniques and the increasing availability of the solutions in question, enabling today's consumers (including the energy market) to make informed choices.

The general global openness to the RES dimension is emerging against the background of the need to increase the share of energy from renewable sources in the global energy mix, along with continued growth in global energy demand [10,11]. This results from the search for low-cost and environmentally friendly technologies that combine the expectations of providing adequate energy supply at a reasonable price [12], with the lowest possible adverse environmental impact [13]. RES is therefore a response to contemporary expectations in social as well as economic terms (energy security [14–16], sustainable development [5]). In fact, ensuring energy efficiency at a widely available cost determines the very existence of economies [17], and their development [18,19]. Hence, the energy industry is considered to be a pillar of the world's economies, the capacity of which determines the development of other areas.

The problem of the security of energy production and the energy efficiency of economies in harmony with the expectations of the environment was a fundamental impulse for the creation of the evolving [20] idea of sustainable development. The harmonisation of the economic and socio-economic and socio-environmental dimensions [21], taking into account technical as well as cultural or ethical aspects [22], is intended to secure effective action for a stable present and secure future in terms of energy and environmental security. The formal framework for this concept is set out in the 2015 UN agenda 'The 2030 Agenda for Sustainable Development', which articulates the core objectives of sustainable development, together with a set of sub-targets and a set of metrics [23], outlining a framework for assessing progress at local, regional and national levels—taking into account key aspects that touch on social challenges, economic conditions and environmental requirements [20,21]. The solutions in question correspond to regulations undertaken at the level of international treaties (e.g., European Union regulations), which are transferred to the level of national economies. Securing energy in maximum harmony with nature has become a current priority challenge.

Energy from the sun [24], wind, earth, rivers and oceans, or from biomass, is energy drawn from nature, with enormous renewable potential [25]. They are deposits of energy supply, which are a valuable resource with relatively widespread availability, determined by the geographical position and geo-requirements of the location concerned, with simul-

taneous availability of the required solutions in the area of technical and technological development. The prism of availability of selected RES sources contributes to the orientation of the world's economies towards obtaining energy from renewable sources, which is referred to in international regulations in the sphere of contemporary approaches to energy production [26]. The area of research and development in this field is strongly promoted, and the popularisation of these solutions is intended to ensure a world that is safe—both in terms of the availability of energy supplies and in terms of existence, by constantly reducing emissions, which are lethal to man and the planet, in connection with energy production [27–30]. Indeed, renewable energy sources represent an important alternative to conventional energy production, offering the possibility to remodel the classical energy supply system and to become independent of fuel supplies from unstable or sanctioned fossil fuel markets. The above assumes particular importance for a number of economies during the current Russian-Ukrainian war and the legacy supply chains restricted as a result, which provides a strong motivation and justification for undertaking the research thread explored within this study.

A number of determinants models the energy market—the geopolitical situation and political considerations [31], international agreements and contracts [32] in the sphere of obtaining energy resources, the public-legal sphere, which defines the energy security model [33] at the level of individual states, and socio-environmental considerations, which determine the energy regulatory systems [34] of various economies.

The energy policies of the world's countries or their agreements (e.g., the energy policy of the European Union [35]) regulate the conditions for undertaking actions oriented towards the development of energy from renewable sources. By defining the scope of the formal and legal framework, they create a space for actions for the reconstruction and development of existing energy systems, directly translating into the system of available solutions—including the area of RES, outlining the field of initiatives both at the level of institutional and individual consumers, the subject of many researchers' inquiries [36–40]. The driving force for change in this area is the broadly understood dimension of research and development in this sphere, but also education and promotion in the subject of existing solutions in this area, together with the dimension of financial support (under government support programmes) in the procedure of implementing the changes in question. The above is an outline of currently important research threads.

A literature review on the subject proves that the problem of energy security based on renewable energy sources is an important topic. However, the search for sources providing answers to questions on specific solutions in individual countries requires significant effort. At the same time, the level of public awareness and social openness to RES in Poland and Lithuania is only hinted at and not sufficiently discussed in this configuration of states. The above inspired the authors to undertake the research threads explored within the framework of this study (in relation to the objective set out in the introduction), in order to fill the gap observed in the literature, by supplementing the research that can be used in decision-making processes or as part of further analyses on the subject.

3. Materials and Methods

The comprehensibility and relevance of these themes determined the scope of the study, which was adopted to maintain the expected informative quality of the results, in order to develop correct conclusions. The above discussion shaped the character of the study, the initial stage of which assumed a conceptual dimension, followed by an empirical-analytical one—for a reliable diagnosis of the state of affairs, taking into account the principles of decomposition and systematisation of phenomena, and substantive conclusions on the subject of the research threads defined in the introduction.

The research was supported by data obtained from sector reports on energy markets in Poland and Lithuania, as well as statistical studies on energy markets of the analysed countries and the European Union.

The research dimension was based on a diagnostic survey method with the use of a questionnaire, the scope of which enabled the measurement of knowledge and the collection of individual opinions on RES among the Polish and Lithuanian communities—inhabitants of both towns and villages. The survey mode took the form of a direct survey among the Polish community and an online survey among the Lithuanian community. The survey focused on RES issues with reference to theoretical aspects and general issues of consumer practice in this field in order to determine public preferences. The survey in question, limited in its scope and subject matter, was conducted in April–May 2022, with a sample of 248 respondents—152 from Poland and 96 from Lithuania. Importantly, the analytical material obtained in the course of the survey in question for the purpose of this article was used only in the required part, and its subsequent dimensions will serve for separate analyses, according to the assumptions adopted by the authors. Hence, the results obtained do not exhaust the scope of the issues explored, providing inspiration and input for further in-depth research in this area.

The presented concept determined the following structure of the research:

1. Analysis of the current literature on energy market issues in the international dimension, with a particular focus on renewable energy. In this regard, the variety of simple methods applicable in the analytical process was used to move from experience in the global dimension to study at the level of the countries accepted for analysis (Poland, Lithuania).
2. Cause-and-effect, situational and comparative analysis of the energy market, including RES, in the countries included in the study (Poland, Lithuania), for critical analysis.
3. Diagnosis of the level of public awareness and analysis of the social openness to RES in Poland and Lithuania, with reference to the results of our own research (questionnaire survey of Polish and Lithuanian communities), to assess the progress of modelling processes in the energy systems of Poland and Lithuania, in line with current trends of change.
4. Easing energy security through gradual decoupling—conclusions and recommendations.

The authors' main goal for this study is to extend and update knowledge in the field of renewable energy technology development to model a vision of energy development in the region in harmony with the environment, using RES solutions. In addition, it is important to answer questions such as: to what extent is knowledge of mainstream transition solutions (renewable energy sources) ingrained among communities? Does the level of public awareness influence individual consumer choices modelling the market? In this respect, the quantitative data established during the research process is intended to be useful.

4. Results and Discussion

4.1. *The Economic and Environmental Aspects of EU Energy Policy and the Objectives of Poland and Lithuania*

In the light of progressive pollution of the environment, decision-makers of individual countries began to adopt an orientation towards the promotion and expansion of the use of energy obtained from renewable sources in economic processes [41]. Sustainable development of the world's economies has become an important topic [42], and its essence is captured in the agenda already referred to in this article signed by the nations associated with the United Nations in 2015—"The 2030 Agenda for Sustainable Development", specifying the headline (16) and sub-goals (169) of the development in question, with correlated measurement indicators (232) [23].

In Europe, especially in countries associated with the European Union, a new energy production approach started to gain momentum. There have been gradual changes in the EU energy legislation concerning electricity generation, e.g., Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market [43], or the use of renewable fuels in transport; eDirective 2003/30/EC of the European Parliament

and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport [44], which has strongly evolved over the recent years. Renewable energy sources have started to play an important role in modelling the future of energy security of EU Member States. A new look at energy supply which protects the environment to the maximum extent has initiated a trend of transformation of energy systems based on conventional production system, and in 2009 a fundamental goal of the European Union was established in this respect, which stipulated that 20% of energy consumption in the EU Member States should come from renewable sources by 2020 (Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC [45]). The adopted policy will contribute to [42]:

1. An increase in the energy security of EU Member States due to the use of RES.
2. Market integration of energy economies, based on the use of new technologies for the production of cheap and environmentally safe energy.
3. Increasing innovation in and promotion of energy from renewable sources to stimulate progressive change in the energy sector,
4. Increasing energy efficiency using energy supplies from renewable sources,
5. Decarbonisation, in order to protect the environment.

These aspects underpinned the creation of the EU Energy Strategy [46], adopted on 25 February 2015, oriented towards generation security, sustainability and competitive prices in the European energy market [47], creating a clean energy dimension (“Clean Energy For All Europeans”) within an energy union [48]. Individual EU member states have established national plans to implement the EU’s renewable energy promotion policy, supported by a set of individual targets, reportable on a biennial basis [25]. As of February 2017, the increase in the share of RES in the energy mix of EU Member States contributed to a €16 billion reduction in fossil fuel import expenditure in 2015, giving rise to projections of further savings that could reach €58 billion in 2030 [49].

In 2018, the objectives of the European Union in the energy sphere (Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources [50]) were revised, setting the planned share of energy from renewable sources in the energy mix of the Member States at 32% by 2030, which is expected to directly contribute to increasing the reduction of greenhouse gas emissions and to increasing energy efficiency through the development of RES [26].

The pro-climate activity of the EU is gaining momentum, and the targets for the continuous increase of renewable sources are becoming increasingly ambitious. In 2019, the “European Green Deal” [51] was adopted, on the way to energy neutrality for the European continent. In 2021, it was proposed to change the adopted target for the share of RES in the energy mix of EU countries to 40% by 2030 [25]. Moreover, member states have agreed to reduce emissions by 55% by 2030 compared to the 1990 results [52]. A key determinant of the promotion of the above actions is their financing. This dimension of actions is regulated by a number of formal and legal instruments, including, among others, Commission Implementing Regulation (EU) 2020/1294 of 15 September 2020 on an EU Renewable Energy Financing Mechanism [53], oriented to support initiatives related to the established targets—in the overall EU dimension and at the Member State level, by feeding in investment activities in the area of RES.

The EU Member States are obliged to implement the current provisions, and the strategies adopted in this respect should be consistent with the objectives set for these countries.

The European Union’s energy objectives established in this way have posed a huge transformation challenge for many countries, including Poland. The Polish energy sector, 70% of which is based on coal, has faced major challenges associated with the need to remodel the existing energy system towards less harmful methods of generating energy. It should be stressed here that the coal-based power industry in European Union countries is

a major contributor to carbon dioxide emissions, accounting for almost a quarter of total emissions. Among the potential directions of actions in order to achieve the established EU targets, the following were indicated at that time [54]:

- modernisation of coal-based power generation towards Carbon Capture and Storage technology, oriented towards capturing about 90% of CO₂ and its storage in the energy production process,
- nuclear power generation,
- renewable energy sources,
- improvement of energy efficiency (increasing the degree of energy use in the process of transmission and consumption).

In the area of RES solutions implementation, Poland has committed itself to [55]:

- achieve a 15% share of renewable energy sources in the country's energy balance by 2020, with an option, in the event of failure to meet environmental targets, to purchase 'green certificates' from countries that have generated a surplus of clean energy with respect to the thresholds set by the EU [56],
- increasing the share of biofuels on the market to 10% in 2020, including stimulating the use of generation II biofuels (transport),
- increasing the diversity of sources of supply and developing infrastructure for domestic production based on available energy sources (orientation towards distributed energy).

Following the above, the directions of green energy generation in Poland were mainly conventional biomass power plants and hydroelectric power plants (with a share of approximately 75% in renewable energy sources in Poland), as well as the opening up of wind power plants, strongly developed in the period 2007–2011, with an increase in their capacity in this period by 829% to 1180 MW [52]. Among the RES sources in Poland, the share of solar energy (photovoltaics) and geothermal energy (geothermal) in the energy portfolio also started to be marked. Furthermore, efforts were oriented towards:

- promotion of the construction of agricultural biogas plants with the assumption of one commune/one biogas plant,
- establishment of formal and legal conditions for undertaking investment activities in relation to the construction of offshore wind farms,
- support for technical and technological development, including in particular the development of RES concepts and production in the area of RES solutions,
- financial support of activities related to the construction of RES installations, including drawing on European funds, environmental protection funds, or preferential rates or tax exemptions,

In order to:

- reduce the country's dependence on energy imports,
- diversify the structure of energy supply sources,
- strengthening local energy development based on renewable energy sources,
- environmental protection due to the use of green technologies [57].

These are extremely important aspects of energy policy, oriented toward the security of supply and affordability of energy in a competitive energy market.

The energy policy of Lithuania is fully in line with the EU energy strategy. Lithuania is orientating its activities in this field [55]:

- Increasing energy security through gradual decoupling from the energy supply based on raw materials imported from Russia (e.g., by cutting off the "Brell" transmission ring) and diversification of energy sources—including strengthening of the role of domestic energy production coupled with the policy of increasing the share of renewable energy sources in its energy mix,

- Participation in the market integration of energy economies, with a focus on the electricity and gas sectors (synchronisation with the European transmission network by 2025),
- development of innovation in the energy sphere and increasing the degree and scope of utilisation of new technologies in energy production processes based on renewable sources—environmentally safe and attractive in terms of production costs
- stimulation of RES increase in the energy mix and improvement of the country's energy efficiency,
- reducing consumption of energy derived from conventional forms of production and increasing the level of environmental protection (decarbonisation).

These actions outline the specific dimension of Lithuania's energy transition, oriented towards the path of energy self-sufficiency and strengthening of energy security in the region through energy production for export to the Baltic countries, including Finland and Poland. It is worth noting that a few years ago the level of domestic electricity production estimated in relation to its final consumption in Lithuania was only about 5%, thus the outlined path towards increasing the competitiveness of the state energy sector in Lithuania is a necessary but very costly measure—the implementation of the energy development objectives requires significant investment and modernisation efforts, related to the provision of technical facilities for the efficient and effective functioning of the energy market, taking into account the capacity and security of supply chains. The cost of the process of synchronisation of the Lithuanian energy system with the European energy transmission grid is an investment burden oscillating around EUR 1.5 billion. At the same time, the EU strongly supports this activity, and 75% of the financing source for this project is from EU funds [58]. It is worth mentioning that, for this transformation only in the period 2014–2020, the European Union has allocated funds in the amount of 564.4 million euros, and the modernization of infrastructure in the period until 2027 will burden the leading network and gas pipeline operator with investments to the value of about 2.1 billion euros, hence Lithuania's ambitious goals in this regard [58]:

- to increase the share of renewable energy sources in Lithuania's final energy consumption to 45% by 2030 and 80% by 2050,
- to change the relationship in the energy balance by RES share in energy production to 70% by 2030 (with EU targets of 32%) and 100% by 2050.

The correctness of this direction of action is confirmed by the growing interest in purchasing of Lithuanian energy in the region (e.g., by Poland), along with the opening up to investments in RES, implemented via international cooperation, including with Poland (mainly wind farms).

The energy policy of the European Union is oriented towards creating a low-emission energy market—safe for energy consumers (availability of energy at affordable prices) and the environment (reducing greenhouse gas emissions, limiting the extraction of non-renewable resources disturbing the functioning of ecosystems, etc.). The directions of the challenges undertaken at the level of Member States in their assumptions directly relate to the established main objectives of the EU in this area, which can be undoubtedly confirmed based on the analysis of the cases of Poland and Lithuania. They constitute a path for improving the efficiency of energy supply mechanisms at the country level in line with sustainable development, strengthening the energy security of economies and the competitiveness of the European Union energy market.

4.2. RES Development Directions in Poland and Lithuania

The Polish and Lithuanian energy sectors are facing a number of challenges in the energy transition of their respective economies. Growing energy demand makes the transformation processes absolutely necessary, and the implementation of RES solutions is becoming increasingly important in the modelling of energy systems in line with contemporary socio-economic expectations. The above assumes particular importance in the realities

of the currently observed energy crisis and rising energy prices, particularly significant in the recent period affecting Poland.

There are a number of possibilities for obtaining energy from renewable sources. These include solar energy, wind energy, and energy from the Earth's interior, etc. Among the sources mentioned above, photovoltaics is becoming increasingly popular in achieving sustainable development goals. Currently, the total installed capacity of photovoltaic (PV) systems in Poland is estimated at over 8.76 GW (which, according to forecasts, may reach 12 GW by 2024), which currently accounts for approximately 48% of this source of energy supply in the Polish structure of RES sources [58] and for over a 3% share in the Polish energy mix [59]. To a significant extent, the growth of photovoltaic solutions is related to the increasing interest of Poles in small PV installations (private micro-installations with a limited connection power of up to 10 kWp [53], driven by friendly formal and legal instruments in this field, directed to a wide range of potential investors who are individuals (e.g., "My Current", "Clean Air", "Thermomodernization Relief"), economic entities (e.g., "Energia Plus") or farms (e.g., "Agroenergia").

The development of the photovoltaic installation market also concerns the Lithuanian market. As in Poland, PV micro-installations, dedicated to private users at a household level, enjoy a significant interest in this country, while the market also shows business interest in constructing high-power photovoltaic farms. This, motivated by government support programmes, has contributed to the fact that the share of PV in the energy mix in Lithuania is 2.3% and, according to forecasts, the connection capacity of PV installations may reach 1 GW by 2025 [51].

Another dimension of RES that is being rapidly developed in Poland and Lithuania is wind energy. Currently, the installed capacity of wind installations (the on-shore dimension of wind energy) in Poland has reached 7.18 GW, which gives a 40% share of the RES energy structure [58]. The connection capacity of wind installations in Lithuania exceeds 0.53 GW, giving more than 11% of the energy volume consumed in Lithuania [60]. Both in Poland and Lithuania significant attention is focused on offshore wind energy. This is a reasonable direction, as the offshore wind energy potential is estimated at 90 GW with an estimated capacity for Poland of 5.6 GW and for Lithuania of 0.7 GW (25% of electricity demand) for 2030, when energy from offshore wind is expected to flow into the power grids of these countries [61]. This is a very important dimension of activities in the area of energy transformation of these economies. The potential of offshore wind is recognised as an important instrument for reducing carbon dioxide emissions, as per the European Green Deal principles.

The potential of wind energy is increasingly being exploited. However, the needs of consumers interested in small wind installations are still worthy of attention, along with the support of market activities and from the area of regulation and support (arrangement of formal and legal frameworks) under the criterion of ensuring broader knowledge and access to the solutions in question [61].

An important, dimension of the implementation of solutions oriented at drawing energy from renewable sources is geothermal energy, drawing energy from the heat of the Earth. The energy potential of the Earth is huge, but the availability of the Earth's heat for utilisation varies from country to country. Due to Poland's favourable geothermal conditions, energy is successfully drawn from deep and shallow geothermal sources, supporting Poland's energy security (share in RES less than 1%). In the case of deep geothermal, plants with maximum water temperature of 61–86 °C, with a share of geothermal power in the total installed capacity ranging from 0.3 to 40.7 MW and with a share of geothermal power in the installed capacity ranging from 31–100%, are in operation [62]. In the case of Lithuania, the availability of geothermal resources is relatively limited to the western regions of the country, outlining the future potential for their development in this area [63]. However, there is availability of 150 °C deposits in the form of rock heat at a depth of several kilometres, from which a heat plant in Klaipėda draws energy, with an installed capacity of 17 MW and a useful temperature of 38 °C [64].

The potential of the Earth's energy is described as the absolute future of RES development, which, according to the authors, will be more widely used in the area of deep geothermal, after solutions giving higher economic efficiency drawing from geothermal deposits of different quality have been worked out. Undoubtedly, a more widely developed practical solution for tapping energy from the earth is shallow geothermal energy, using low-temperature heat from the earth due to drilling, creating a market for heat pumps of various types (water-air, air-air, others), which are widely available. The installed capacity for drawing from Earth's heat in direct mode in 2020 in Poland was 756 MWt, while in Lithuania it was 125.5 MWt [65]. The interest in heat pump installations up to 390 MW with an annual capacity level of 2000 TJ is steadily growing [66]. A particularly intensive growth of heat pumps is observed in the Polish market (173,146 pump installations installed in 2019, with the share of air heat pumps in relation to ground heat pumps in the ratio of 2:1), with a significant share in Lithuania (7456 pump installations in 2019 with the predominant share of air pumps in the total pump volume) [67].

The study results conclude that renewable energy sources are an important subject relating to the challenges of implementing of the European Green Deal policy in Poland and Lithuania. An interesting observation is the growing demand for solutions from small-scale, generally widely available installations drawing from renewable sources—photovoltaics, shallow geothermal energy or interest in domestic wind installations. The above testifies to the growing social awareness in the field of energy from renewable sources and the need to function in accordance with current pro-environmental trends. This is a very positive public orientation, indicating a cause-and-effect relationship between increased public awareness and the popularisation of RES solutions for individual use.

4.3. Social Openness to RES in Poland and Lithuania—Research Results

Conventional energy production contributes to the overexploitation of fossil fuels, which are limited resources [68,69]. The prism of limited goods creates a higher cost of acquisition, which in turn increases the cost of energy production and increases the market price of 1 KW of energy. Complementing the above with the environmental aspect [70] and charges for discharges and emissions of harmful substances, the economic justification of maintaining conventional energy production in the long term raises a number of doubts. Hence, the search for alternative energy production solutions was oriented towards the aspect of environmental safety correlated with the economic safety of the consumer. In this respect, the role and importance of renewable energy sources in energy production is widely exposed [71] in modern environmental and economic realities. This is because renewable sources are considered a reliable, safe and cost-effective way to achieve the objectives of sustainable development of economies [72].

A strong increase in the price level per 1 KW is currently affecting a number of countries. This situation is created by the increase in the demand for energy as a result of the increase in the consumption of electricity globally, including the countries of the Baltic Sea region, the increase in the cost of CO₂ emission allowances and, absolutely, the state of the Russian-Ukrainian war which changes the current functioning of the energy market [73]. In the outlined situation, the orientation towards RES is fully justified. Consumers are looking for access to energy at a competitive price, hence the production of green energy must be based on technologies that justify this action from the economic side [74]. At the same time, it is worth emphasising that energy derived from RES, excluding investment outlays, is considered as cheap. This perspective drives sustainable energy development, basing on RES the challenges of optimising the cost of energy production and distribution costs. The above is an important goal for the transformation of this economic dimension [75].

The success of implementing these changes is created by understanding and accepting the needs of the environment, regarding the actions taken. Hence, public education and promoting solutions beneficial to the environment and consumers plays an important role in the implementing of sustainable development and its objectives. Increased public awareness contributes to increased interest in RES solutions for individual use, strength-

ening the development of the green energy market, which is confirmed by the conducted research “Analysis of RES solutions in Poland and Lithuania” (April–May 2022), based on a diagnostic survey formula. The results of the research (survey of knowledge and consumer preferences regarding RES, Table 1) indicate that 79% of the surveyed Polish community is in favour of the development of the green energy market globally, while only 54% associate the issue of sustainable development with energy transition. In this regard, a survey of the Lithuanian community revealed that 97% of respondents support a global orientation towards RES, and 73% link this activity with the idea of sustainable development.

Table 1. Consumer knowledge and preferences in the field of Renewable Energy Sources—research results.

Research Thread	Poland % of Indications	Lithuania % of Indications
Support for the development of green energy in the world	79	97
Linking the issues of sustainable development with the energy transformation	54	73
The justification for green energy as the basic direction of the development of the energy market	64	71
Justification for price changes resulting from restrictions due to the transformation process	28	72
Positioning renewable energy sources in the group of environmentally safe	96	98
Recognition of RES as a source of cheap energy (excluding investment outlays)	16	18
Recognition of financial support for RES investments as a key factor in the development of the green energy market	86	91
Confirmation of individual preferences for the selection of energy sources from RES	22	38
Assessment of progress in the implementation of renewable energy sources in the country at an average or poor level	60	91
Assessment of the progress in the implementation of renewable energy sources in the country compared to other European Union countries at an average or weak level	48	73

On the subject of attitudes towards restrictions on conventional energy production in connection with the transition, and rising energy prices in connection with this measure, only 28% of Polish respondents found these justified, stressing, however, that green energy should be the primary direction of development of the energy market in Poland (64%). In the case of the Lithuanian community, 72% of respondents considered the introduction of restrictions in this area as justified, and almost the same percentage (71%) considered RES energy as the basic and appropriate direction for the country’s energy transformation.

The vast majority of Polish respondents (96%) confirmed that renewable energy sources are oriented towards obtaining energy in an environmentally safe manner, with only 16% classifying the production of green energy—excluding investment in RES installations—as cheap. In the case of respondents from Lithuania, as many as 98% of respondents confirmed RES-based energy production as pro-environmental, while only 18% classified it (excluding investment expenditure) as cheap energy generation.

In this survey, respondents also indicated that financial support for projects is the main motivator for RES investment activities. This position is confirmed by 86% of Polish and 91% of Lithuanian respondents, with a lack of opinion on this issue indicated by approximately 6% of the total surveyed population.

An important aspect of this research is to capture the cause-effect relationship in terms of advocacy for RES development, with a simultaneous declarative interest in choosing the direction of solutions in this area. A hypothetical need to invest in this type of solutions was articulated by 22% of Polish respondents and 38% of Lithuanian respondents, indicating a coupling between the increasing level of social awareness and individual interest in RES investments and confirming the research assumptions made in this respect.

In addition to the presented scope, an interesting strand of research is the assessment of the progress of sustainable development implementation in the energy sphere. In Poland, 60% of respondents rated this process as average compared to progress in other Baltic Sea countries. When comparing the struggle in question to the results other EU member states achieved, Poland's results were assessed by an equal percentage (48%) as average or poor. For Lithuanian respondents, on the other hand, 91% assessed the effects of RES implementation in Lithuania against the background of the Baltic States as average, while 73% considered the results against the background of the EU Member States as average.

The study's results clearly indicate that the Lithuanian community is more open to green energy sources, ahead of Poland in the ranking in this area, and also more strongly emphasises the role of RES in the ongoing energy transition than Poland. A slightly higher percentage of the Lithuanian community described production based on renewable sources as cheap. The survey's results on the progress of RES implementation in the Baltic States and in the EU area can be considered relatively comparable—in the case of both countries, in the social assessment the results are at an average level.

The results of the assessment of the level of information in the RES sphere are similar to those presented above. In Poland's surveyed community, 37% positively assessed the quality and availability of general information on RES, compared to 63% of the Lithuanian community. On the other hand, only 23% of the surveyed community in Poland assessed as positive the access to information in the sphere of financing RES installations—including analyses of their economic justification, while in Lithuania 61% assessed this scope positively (Table 2).

Table 2. Assessment of quality and access to information in the RES sphere—survey results.

Research Strand	Poland % Indications	Lithuania % Indications
Good assessment of the quality and availability of general information on RES solutions	37	63
Good assessment of the availability of information on RES funding—including analyses of their economic justification	23	47

The visible differences in the Lithuanian community's approach to RES issues, determined by the theoretical and practical knowledge of RES solutions and their essence in supporting the operation of the RES market, can be juxtaposed with the general level of the share of RES sources in the energy mix of the studied countries, which for Poland, with regard to solar energy, wind energy, heat pumps and geothermal energy, currently fluctuates at around 18%, while for Lithuania it exceeds 25%. This is an interesting observation, as the practical activity of Poland, compared to that of Lithuania in the examined dimension of RES solutions (photovoltaics, wind energy, geothermal), is strongly marked in the energy market, although, in the final analysis (in relation to the size of the countries and energy demand), the sustainable development goals facing Poland still pose a major challenge.

With regard to the findings, it should be pointed out that the opening up to RES, motivated by the public's aversion to harmful and expensive conventional production, may contribute to formal and legal decisions taken by decision-makers, promoting a course of action at the national level that coincides with the Green Deal. In addition, as public awareness increases, so does the popularisation of RES solutions in individual use, which undoubtedly reinforces the progressive transformation of the energy market. The above coincides with the observation noted in the literature that the mode of energy transition in individual EU countries is implemented according to the individual approach of the countries [76]. Furthermore, the literature signals the importance of public awareness for the development of RES sources in practical use [77], pointing to its insufficient level as one of the main barriers to green energy development [78].

The observed average 25% difference in the rating at the positive level in relation to the quality and availability of general information on RES solutions and availability of

information on RES financing, taking into account the analyses of economic justification in terms of the results of the survey of the Lithuanian community compared to that of the Polish community, translates into an average 14.65% better results in the sphere of consumer knowledge and preferences in terms of renewable energy sources. The strongest difference in this area (44%) emerges in the justification of price changes resulting from restrictions in the energy transition process, with the acceptance of the Polish community at a level of 28% and in the Lithuanian community at a level of 72%. The detailed distribution of differences in indications of the Polish and Lithuanian communities is presented in Figure 1.

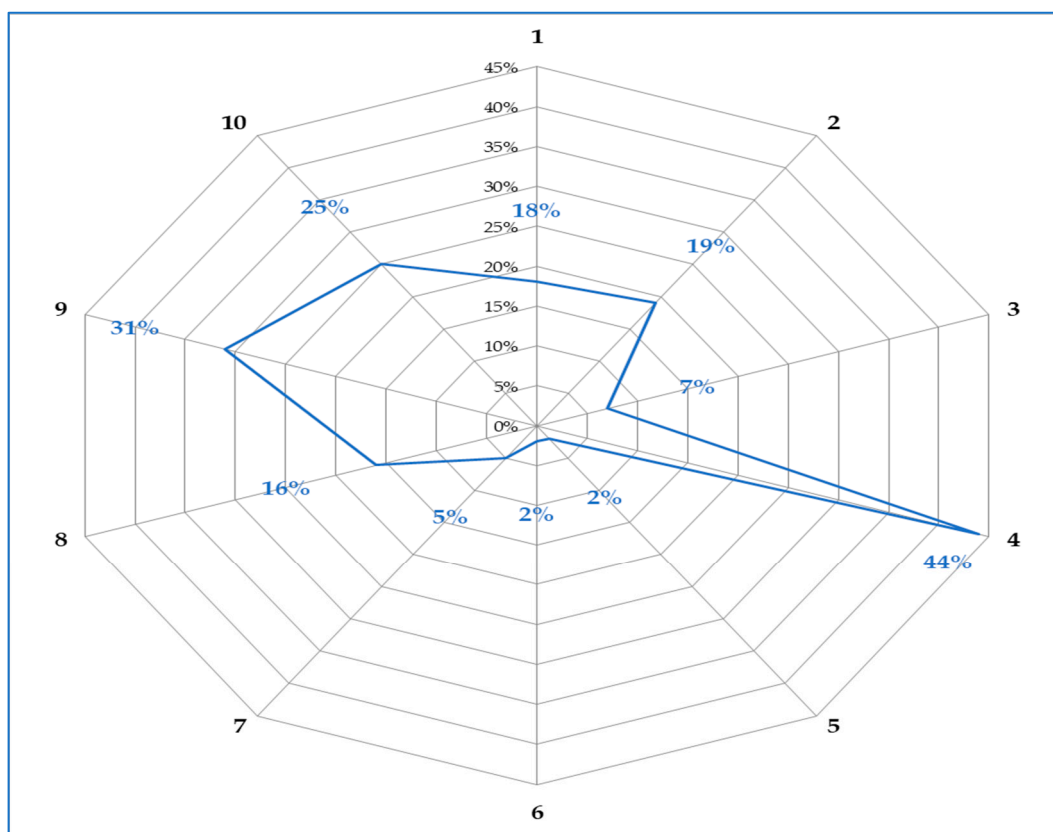


Figure 1. Distribution of differences in indications of Polish and Lithuanian communities in terms of knowledge and preferences and assessment of the quality and access to information in the RES sphere—survey results. Legend: (1) Support for the development of green energy in the world; (2) Linking the issues of sustainable development with energy transformation; (3) The justification for green energy as the basic direction of the development of the energy market; (4) Justification for price changes resulting from restrictions due to the transformation process; (5) Positioning renewable energy sources in the group of environmentally safe sources; (6) Recognition of RES as a source of cheap energy (excluding investment outlays); (7) Recognition of financial support for RES investments as a key factor in the development of the green energy market; (8) Confirmation of individual preferences for the selection of energy sources from RES; (9) Assessment of progress in the implementation of renewable energy sources in the country at an average or poor level; (10) Assessment of the progress in the implementation of renewable energy sources in the country compared to other European Union countries at an average or weak level.

The analysis of quality and availability of general information on RES solutions and their financing reveals the importance of access to information, creating the level of social awareness. Hence, the findings of the research presented in this article in the sphere of social preferences in relation to the forms of obtaining information in this sphere that strengthen knowledge about RES may prove to be significantly useful. Practical orientation

to the key issues in social education in the RES field may contribute to improving the results obtained. Findings in this regard were made in the framework of our own research presented in this article. Respondents from the surveyed countries indicated in 95% of cases that the most useful sources of knowledge in the RES sphere are industry portals (articles and blogs available on the web), and the most demanded are RES consulting points (84%). In addition (with multiple choices), professional industry publications (75.5%), thematic seminars (58.5%), conferences (50%), and distributed information materials (91%) were indicated. The detailed distribution of indications in this area by country is presented in Table 3.

Table 3. Publicly demanded sources of information in the RES sphere—survey results.

Publicly Requested Information Sources on RES	Poland % Indications	Lithuania % Indications
Renewable Energy Action Points	86	82
Thematic seminars	56	61
Information material distributed	47	44
Industry portals (RES)	93	97
Conferences	56	44
Professional sector publications (RES)	78	73

With regard to the findings made in the article, it should be pointed out that the opening up to RES is motivated by public aversion to harmful and expensive conventional production. This orientation may contribute to the formal and legal decisions taken by decision-makers, promoting a course of action at the national level that coincides with the Green Deal. In addition, as public awareness increases, so does the popularisation of RES solutions in individual use, which undoubtedly reinforces the progressive transformation of the energy market. The above positions the social awareness factor in the system of determinants of renewable energy market development.

5. Conclusions

Actions drawing energy from available renewable resources is a green alternative to classical solutions in the field of energy production. The orientation towards increasing this share in the energy supply system is a challenge for many modern economies. Consistent implementation of RES solutions undoubtedly increases the chances of Poland and Lithuania achieving their goals in the area of EU energy policy, changing the orientation from the solutions practiced in these countries for years, characteristic of a centrally planned economy—based on a single energy source (Poland—coal, Lithuania—nuclear energy) [53]. The review of the assumptions of the energy transformation of the European Union and the assessment of the ongoing changes in the energy systems in Poland and Lithuania carried out in this study indicates that the energy transformation direction adopted by the EU, and consequently by Poland and Lithuania, is in the direction of the improvement of the region's competitiveness through strengthening energy security, correlated with the improvement of the quality of social and economic life—considered through the prism of innovativeness of applied solutions, as well as the greening of energy supply routes, together with the optimisation of generation costs shaping the market price per 1 KW. In addition, the above should be complemented by the aspect of stimulating an increase in energy efficiency, in connection with increasing the rationality of energy use in places of its consumption, as well as limiting losses in the process of its transmission, which can be emphasised in the regulations [53]. The elements outlined above create sustainable development, oriented towards seeking and implementing solutions that balance environmental protection objectives with supply security objectives in a competitive energy market (availability of green energy at an affordable price).

The energy transition process in Poland and Lithuania is progressing. Increased awareness among consumers, who are orienting their energy choices towards renewable

energy sources, is driving this change. This awareness grows out of knowledge of the essence of pro-environmental actions, captured in the energy policies of modern economies, corresponding to the assumptions of sustainable development. The promotion of a mode of functioning in harmony with nature, together with the system of instruments supporting pro-environmental solutions, assumes a fundamental significance here, confirmed by research.

The system of changes in the energy market strongly concerns the development of formulas for obtaining green energy. In particular, the importance of individual use of RES solutions is highlighted, where popularisation of this direction is seen in both social education and financial support; hence it is necessary to nurture and strengthen the dimensions of social education in the RES sphere and available RES investment financing instruments. This is because the level of social awareness determines individual consumer choices, modelling the energy market. The above confirms the research assumptions adopted for this study. Moreover, the above is in line with the position generally articulated in the literature on education and support for the local community in the process of green transformation [79], which sees it as a driving force for stimulating its effectiveness.

In view of the above, the authors believe that it is worth strengthening or remodelling the dimension of educational undertakings in the RES area, taking into account the broad promotion of solutions applicable at the level of individual households, as this may improve the practical interest of investors in these solutions in the country, which has been pointed out among the determinants of consumers' investments in the RES sphere, articulating the need for research in this area [80]. The above conclusion coincides with the position noted in the literature about the need for changes in the formula of knowledge transfer [29,81] on the topic of RES potential [82] and its active promotion [83]. Hence, the creation of educational programmes dedicated to different social groups would be worth considering. Furthermore, the need to ensure the availability of information on financial instruments in the field of RES financing, including professional counselling to benefit consumers' potential, is particularly important. The above conclusion is strengthened by the observation of the information deficit of RES customers [59].

Drawing on renewable energy is the most appropriate way to green the energy economy, in line with the idea of sustainable development and strengthening the financial security of energy consumers. An important determinant of the development of this dimension is public awareness of RES. This is an important condition, which should be properly developed at the level of economies, hence it is worthwhile designing solutions in the sphere of RES education to refer to the current preferences of the RES market's potential customers.

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