

The Future of the Polish Energy Mix in the Context of Social Expectations

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Abstract: Currently, Poland has been facing a process of intensive changes in the energy sector, motivated by the strengthening of the goals of the climate and energy policy at the European level. A key challenge for energy transition in Poland is to build an energy system that corresponds with social needs not only in terms of energy demand, but also environmental protection, with a strong role of local initiatives. The aim of this study is to present the expectations of the Poles regarding the optimal energy mix, especially representatives of local governments, and their awareness of the needs and expectations of their local communities. According to the authors, local governments are extremely important links, responsible for the development of the energy economy and energy security at the local level. The authors set themselves the task of verifying whether local authorities are prepared to create a substantive energy policy at the local level in accordance with the directions of the Polish energy policy and on the basis of local conditions, including the opinions of the inhabitants of a given region. The objective of this work was achieved by reviewing the available sources and the adopted survey method. A review of the literature, in particular in terms of the conducted research on the social acceptance in terms of energy policy, showed that there are no comprehensive surveys of the opinions of local government representatives. The results of study conducted by the authors showed that although the vast majority of respondents know the assumptions of the Polish energy policy until 2030, almost a quarter did not realize that the energy policy will be changed in the near future. At the same time, the vast majority of respondents believe that the Polish government should prepare a social campaign related to the energy policy. According to the authors, this proves the need to improve the awareness of this research group, which may bring benefits in the process of shaping the energy economy of the regions. The survey also showed preferences of the representatives of local governments for the optimal energy mix in Poland and their subjective assessment of the knowledge of public opinion in the region on the expected shape of the energy policy. From the findings, it can be concluded that more in-depth research is needed on the preparation of local governments to shape energy policy at the local level, including more detailed research on how opinions of the inhabitants of a given region and the specificity of a given region are taken into account while shaping local energy policy.

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1. Introduction

The transformation of the Polish energy sector has become a reality not only due to the need to keep pace with the path set out by the European Union's climate and energy policy, but also through support of society, which has created an impulse of initiatives and measures aimed primarily at increasing energy security at the local level and reducing the environmental pressures of the energy sector. An important reason for the growing interest of local communities in the energy sector is the increasing environmental awareness. The European Commission's 2014 study showed that most respondents asso-

ciate the quality of their lives with the state of the environment and believe that environmental problems have a direct impact on their lives. People watch their governments more closely as regards their actions related to the energy sector, expressing their opinion and taking action in support of central action [1]. Despite income disparities between Poland and Western Europe, Poles also try to take action; hence, there is a growing number of prosumers as well as micro and small installations and community energy cooperatives in this country.

By 2040, Poland's electricity demand is expected to increase by up to 50%, to 240 TWh [2], which is a huge challenge for the energy sector. Achieving the objectives of the new energy policy, including the development of the renewable energy sector and reduction of the share of coal in power generation, will require effective measures, including those initiated at the local level. By 2032, approximately 12 GW of generation capacity is to be decommissioned in Poland, to be replaced by a similar new capacity in the energy system, approximately 32% of which is expected to come from wind sources [3]. Poland faces the risk of missing capacity, which may result in capacity shortages and difficulties in meeting a growing demand for energy [4].

The crisis caused by the COVID-19 pandemic will have an impact on the energy sector, and experts stress that the economy should recover in a sustainable manner, with as little impact as possible on the environment and natural resources. Recent IEA studies show that global energy demand will decrease by about 5% in 2020, which is directly linked to recent developments. However, economic recovery is likely to lead to considerable increases in energy demand, which needs proper preparation [5]. The European Green Deal climate actions and in particular the climate target plan's 55% net reduction target presented under the Fit for 55 package set the direction for the development of the European energy sector with its ambitious new goals: increasing the emission reduction target to 55% (compared to 1990 level), setting a target of spending 37% of the €750 billion NextGenerationEU recovery fund on Green Deal objectives, and increasing the RES share up to 38–40%.

On July 14, the European Commission announced the climate and energy legislative package—Fit for 55. In line with the EU's climate ambitions, greenhouse gas emissions are to be reduced by 55% by 2030 (compared to 1990). By 2050, the European Union aims to achieve zero net emissions. Such ambitious plans require changes in all areas of social and economic life. The European Green Deal sets out a detailed vision to make Europe the first climate neutral continent by 2050. The new climate target, along with the Fit for 55 package, are part of the European Green Deal adopted in December 2019. The European Commission's proposals must be approved by EU governments and the European Parliament. The package consists of 13 legislative proposals, some of which are new, others presenting changes to existing legislation. The current EU regulations are updated: revision of the EU Emissions Trading System (EU ETS), reform of the LULUCF regulation (Land Use, Land Use Change and Forestry), review of the Effort Sharing Regulation (ESR), amendment to the renewable energy directive (RED), amendment of the Energy Efficiency Directive (EED), revision of the Alternative Fuels Infrastructure Directive (AFID), amendment of the regulation defining CO₂ emission standards for passenger cars and vans, and revision of the Directive on energy taxation. The new legislative proposals include the EU's new forest strategy, the Carbon Dioxide Limit Regulating Mechanism (CBAM), the Social Instrument for Climate Action, ReFuelEU Aviation (for sustainable aviation fuels), and FuelEU Maritime (for greening the European maritime space). The EU's goal of achieving net zero emissions by mid-century will require a massive increase in Europe's renewable energy generation capacity. The main aim of the reform will be to raise the RES targets for the EU. The current target for the share of renewable energy in the EU energy mix will be increased from 32 to 40 percent thanks to Fit for 55. All Member States will have to contribute to achieving this goal, which is an ambitious task for Poland and for the implementation of Polish energy policy. In addition, the directive will raise specific objectives, e.g., concerning the share of renewable energy sources in transport, heating, as well as the

share of advanced biofuels. The issue of reducing emissions from the energy sector is one of the key problems of the Polish energy sector. The implementation of the fit for 55 package in Polish conditions will be difficult; however, the authors believe that the vision presented in the updated energy policy will support the ambitious European goals.

Therefore, the potential of local communities and special role of cities in the process of Poland's energy transition should not be overlooked [6]. The European Commission points to the phenomenon of 'community energy initiatives'. The Joint Research Centre (JRC) of the European Commission has examined the activities undertaken by "community energy initiatives" within the European Union. Research has shown that, owing to legislative support to community action, they undertake a number of initiatives—from power generation (mainly with RES) to energy saving and storage and electromobility [7]. This shows not only huge ambitions of communities for their place in the energy sector, but also how much support the EU and the governments of individual Member States should offer for this type of action. Local communities can play a significant role in the process of transformation of the energy sector in Poland; they can also actively participate in the EU energy market by generating electricity at the local level, using it or reselling it to the market. Furthermore, one of the tasks of the internal energy market is to strengthen the rights of consumers and citizen energy communities [8]. It is also important that regional energy planning is balanced and based on the available renewable raw materials, so as to take into account the constraints imposed by environmental requirements and natural conditions at the lowest cost [9].

A study conducted by the European Commission shows that, by 2030, energy communities could own about 17% of installed wind energy and 21% of solar capacity [10]. By 2050, almost half of EU households are expected to be producing renewable energy [11]. This shows that the potential of citizens is substantial, which, combined with increasing awareness and willingness to act and support from the government, can yield spectacular results, supporting the European and Polish climate and energy objectives.

Local governments are an important element of the complex system of shaping the energy policy in Poland, with their competencies in the field of:

- Identification of key energy resources and energy demand in the regions;
- Setting directions for the energy development of the regions based on a strategy defined at the national level (development of distributed energy, including RES, prosumers, etc.);
- Support for the development of intelligent solutions in the field of the energy systems in cities, including sustainable mobility, energy efficiency, education, smart cities concept, etc.;
- Supporting innovative initiatives and cooperation between local authorities, businesses, and research institutions;
- Shaping the local, sustainable energy economy, and supporting the goals of sustainable development;
- Building awareness of local communities.

The available research on public opinion about the expected shape of energy policy, conducted in Poland, lacks references to the perspective of local governments. The authors attempted to fill this gap by showing preferences of representatives of local governments for the optimal energy mix in Poland and assessing their preparation to create an energy policy at the local level. According to the authors, this preparation should take into account the knowledge of the preferences of the inhabitants of a given region, as well as an in-depth analysis of the implemented local initiatives (energy cooperatives, prosumers) and local energy resources. There are no in-depth analyses in this area in Poland. The authors emphasize the importance of shaping conscious attitudes in the local government environment, as well as building knowledge and skills and constantly improving the competences of local government employees in the field of energy policy and sustainable development.

2. Literature Review

2.1. Energy System in Poland in Figures

The specific nature of the Polish power system stems mainly from a high share of conventional, coal-based energy sources. In 2019, the installed capacity in the Polish Power System (PPS) amounted to 46,799 MW, while the generating capacity amounted to 46,991 MW, an increase by 1.9% and 2.9%, respectively, compared to 2018. The average annual demand for capacity was 23,082 MW, with a maximum demand of 26,504.4 MW (an increase by 1% and 0.2%, respectively, compared to 2018). The ratio of available generating capacity was 64.5%—a decrease by 1.6% compared to 2018 [3].

Figure 1 presents the structure of PPS's installed capacity in 2017–2019. In the last 3 years, there was a small increase in RES, which in 2019 accounted for approx. 16% of the entire capacity installed in the PPS. In total, approx. 47 GW of the capacity was installed in the PPS at the end of 2019 [12].

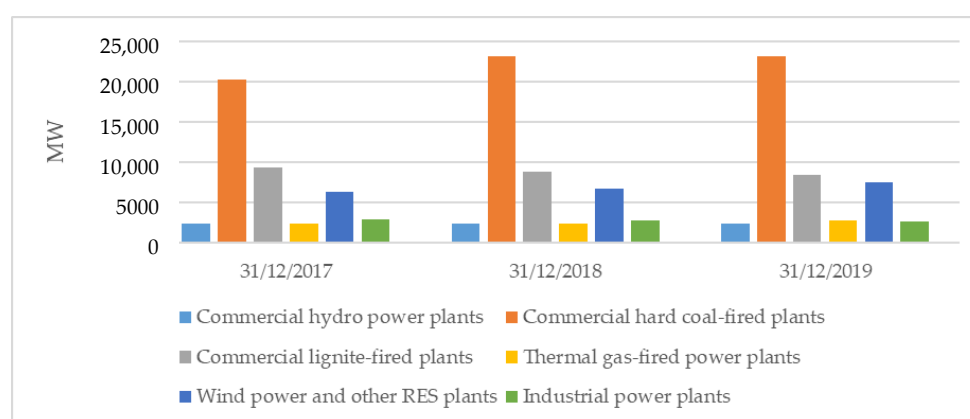


Figure 1. Structure of the Polish Power System's installed capacity in 2017–2019 [MW]. Source: developed by the authors, based on Reference [12].

In 2019, the average annual demand for capacity amounted to approx. 23.082 GW, while the maximum demand for capacity amounted to—approx. 26.5 GW [12]. Despite the fact that the highest historical level of the maximum demand for capacity was in 2019, the average annual demand for capacity in that year saw a slight decrease (by 0.9% compared to 2018). Due to the COVID-19 pandemic and the reduction in activity in certain sectors, the average annual demand for capacity is likely to follow the downward trend in 2020.

At the end of 2019, 9.5 GW was installed in RES, of which 1.5 GW in PV installations. Over the last two years, the development of RES has been supported by the development of prosumer installations. Wind energy clearly stands out among all RES—it has been developing dynamically from 2005, following the introduction of the support system (green certificates), until 2016, which is when the so-called a 'Distance Act' came into force (The Act of 20 May 2016 on wind farm investments) and the sector faced a major problem resulting from the oversupply of green certificates. This all led to the largest crisis in the history of the development of this sector in Poland, faced by both well-established companies and smaller investors [13]. At the end of 2019 the total installed capacity in onshore wind farms amounted to approx. 6 GW (Figure 2), which ranked Poland on the very high, 9th place in the European Union (Europe now has around 195 GW of onshore wind energy capacity installed) [14].

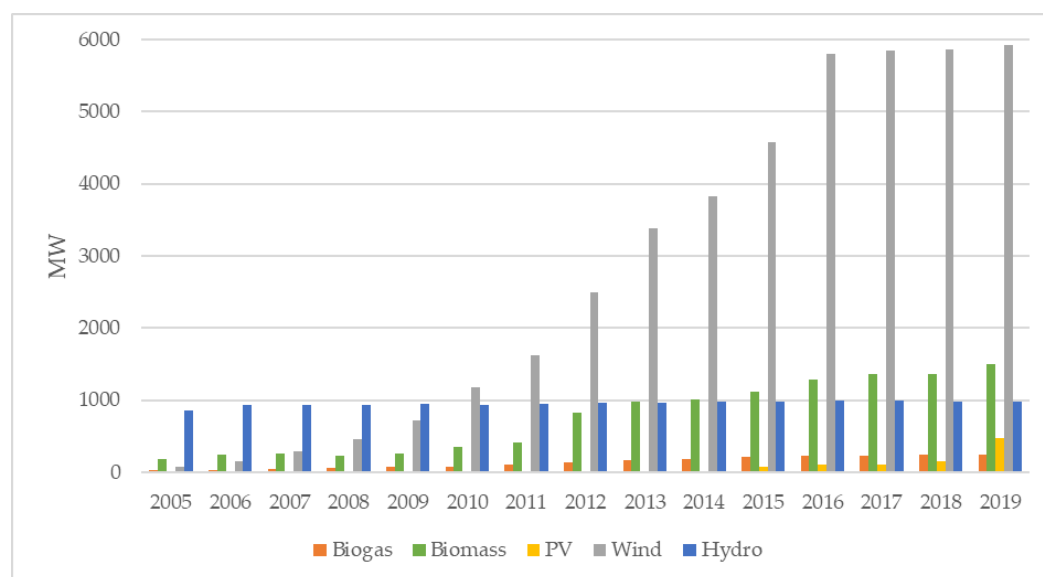


Figure 2. Renewable energy capacity installed in Poland in 2005–2019 [MW]. Source: developed by the authors, based on Reference [15].

Despite the increasing share of electricity generated from RES, this type of energy still accounts for only about 9% of Poland's electricity generation and covers approx. 8.5% of domestic electricity consumption (see Figure 3). According to the Polish National Renewable Energy Action Plan, prepared and submitted to the European Commission in 2010, by 2020, Poland is obligated to increase share of renewable energy in gross final consumption to 15%, but experts have pointed to the possible difficulties in achieving this target due to the specific nature of the Polish energy sector and the significant share of coal in energy production since its very adoption. In the last decade, the RES sector in Poland initially developed dynamically, increasing its share in the energy mix (mainly due to legislative changes and the introduction of the aforementioned support system in the form of green certificates). However, starting from 2012, large energy utilities have lobbied against RES, pointing to difficulties in balancing the power system and high costs of energy production, which resulted in annual RES capacity increases far from spectacular. The government's policies since 2015 have halted new investments, which threatened the achievement of the 2020 target [16].

Pursuant to Article 6a of the Act of 20 February 2015 on Renewable Sources, the President of the Energy Regulatory Office (hereinafter: ERO) shall prepare a report on the electricity fed into the grid by renewable energy prosumers and sold to the obligated seller referred to in Article 40(1) of the Act, which was generated from renewable energy sources in micro-installations and fed into the distribution grid, as well as informing about the type of micro-installations and their installed capacity [17]. This obligation has been in place for two years. The report prepared by the ERO President in 2020 [18] shows that there were 149,309 prosumers in Poland in 2019 (Table 1), and the total electricity fed into the grid by the prosumers amounted to 324,333.174 MWh, while the total amount of electricity fed into the grid by micro-installations was 47,896.048 MWh. In 2018 [19], the number of prosumers was 51,163 (the total electricity fed into the grid by prosumers in 2018 was 130,370.162 MWh), which means an increase by nearly 300%.

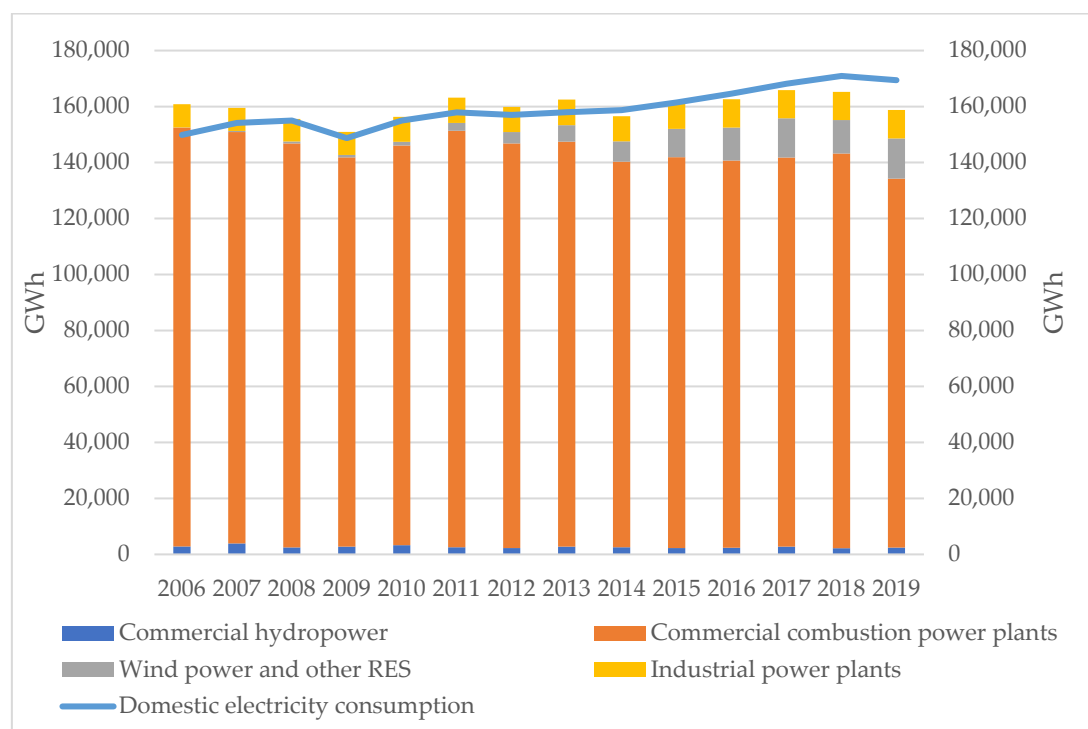


Figure 3. Domestic electricity production and consumption in Poland in 2006–2019 [GWh]. Source: developed by the authors, based on Reference [15].

Table 1. Number of micro-installations and total installed capacity in 2018–2019.

Type of Micro-Installation	Total Capacity Installed [MW]			
	2018	2019	2018	2019
Non-agricultural biogas	3	5	0.073	0.024
Agricultural biogas	16	25	0.42	0.665
Biomass	4	5	0.142	0.173
Solar	55.098	155.189	344.239	990.506
Solar/wind	29	40	0.181	0.359
Wind	68	73	0.37	0.384
Water	284	289	8.038	8.258
Total	55,502	155,626	353.463	1,000.369

Source: Developed by the Authors, Based on References [19,20].

The number of small installations has also been steadily increasing in Poland. In 2019, small energy producers generated energy in a total of 817 installations (one energy producer may hold several installations). Their total installed capacity was nearly 163 MW. In terms of the number (341) and installed capacity (51.5 MW), small hydropower plants were the most prevalent in Poland. They were followed by photovoltaic installations both in terms of the number of installations (247) and installed capacity (47.5 MW). The least popular, on the other hand, were small biomass power plants. At the end of 2019, there were only two such sources in Poland. Owners of small installations (697 entities) generated more than 342 GWh of energy in the previous year, of which 70% (238 GWh) was sold to the obliged sellers and 30% was used for own purposes or sold to other sellers. One year earlier, such installations generated 208 GWh of electricity, selling 142 GWh (more than 68% of the energy generated) to the obliged sellers to the distribution grid. The largest amount of energy—over 158 GWh—was produced by small hydropower plants—

almost 46% of energy produced by all small RES installations came from this source. Bio-gas plants using non-agricultural biogas generated more than 102 GWh of energy, of which only 29 GWh were sold to the obliged sellers. Ranking third were small wind power plants, which generated more than 51 GWh of energy [21].

2.2. Energy Policy in Poland

The Energy Policy of Poland presents the government's long-term strategy for the energy and fuels sector. Such a document is required by Articles 13–15a of the Energy Law. The document currently in force in Poland was adopted by the Council of Ministers in 2009 and covers the perspective until 2030. Due to the fact that the conditions affecting strategic decisions in the energy sector have changed in the last decade, and the document currently in force takes into account neither European trends nor public expectations, the Ministry of Climate and Environment has developed a project titled 'Energy Policy of Poland until 2040'. As the Ministry stresses, the European Union's climate and energy policy, including regulations under the 'Clean energy for all Europeans' package, is important in the context of work on the new draft [22]. On 2 February 2021, 12 years following the adoption of the previous Policy, the Council of Ministers adopted the Draft. The experts pointed out that, given the current trends and directions of development, without updating the 2009 policy, it would be very difficult to anticipate the future shape of the energy mix in Poland, which is why the new draft energy policy was a long-awaited document [23].

On 10 November 2009, the Council of Ministers adopted the Energy Policy of Poland until 2030, a document which was supposed to address serious challenges faced by the Polish energy sector at that time. These challenges were mainly related to high energy demand, inadequate level of development of fuel and energy generation and transport infrastructure, significant dependence on external supplies of natural gas and nearly complete dependence on external oil supplies, as well as environmental commitments, including climate commitments [24].

For the purposes of developing the energy strategy for Poland, a forecast of fuel and energy demand until 2030 [25] was prepared. Following an analysis, it was concluded that the projected increase in the final energy consumption in 2030 would grow by around 29% compared to 2006, with the largest increase, i.e., by as much as 90%, expected in the services sector. A 15% increase was projected for the industry sector and a 64% increase for the transport sector [25].

Regarding the final energy demand by carrier, by 2030, the final electricity consumption is expected to increase by 55%, gas by 29%, district heating by 50%, petroleum products by 27%, and renewable energy by 60%. Particularly evident against this backdrop is the expected increase in the consumption of renewable energy, which, according to the authors of the forecast, will result from the fulfilment by Poland of its obligations under the European Climate and Energy Package [25].

Since 2005, there has been a steady increase in the generation of energy from renewable sources. The climate and energy package until 2020 assumed a 20% reduction in greenhouse gas emissions (from 1990 levels), a 20% share of renewable energy in total energy consumption in the EU, and a 20% increase in energy efficiency [26]. In 2007, targets were set for Member States, including the target of a 15% share of RES in gross final energy consumption for Poland. In 2014, the European Council approved new targets for the whole EU until 2030, which were then revised in 2018 [26]:

- A 40% reduction in greenhouse gas (GHG) emissions compared to 1990 (expressed as 2005 levels: −43% in EU ETS sectors and −30% in non-ETS sectors);
- At least a 32% share of renewable sources in gross final energy consumption;
- A 32.5% increase in energy efficiency;
- Completion of the EU internal energy market.

One of the main prerequisites for decision-making on energy policy is a forecast of national power supply. The government anticipates that gross domestic electricity demand in 2030 will be 217.4 TWh. By comparison, in 2006 it was 150.7 TWh. Due to EU requirements, a growing share of renewable energy is expected (see Figure 4). In this respect, the forecast net generation of power from renewable sources is set at 38 TWh, which accounts for 18.8% of the total forecast net power generation [25].

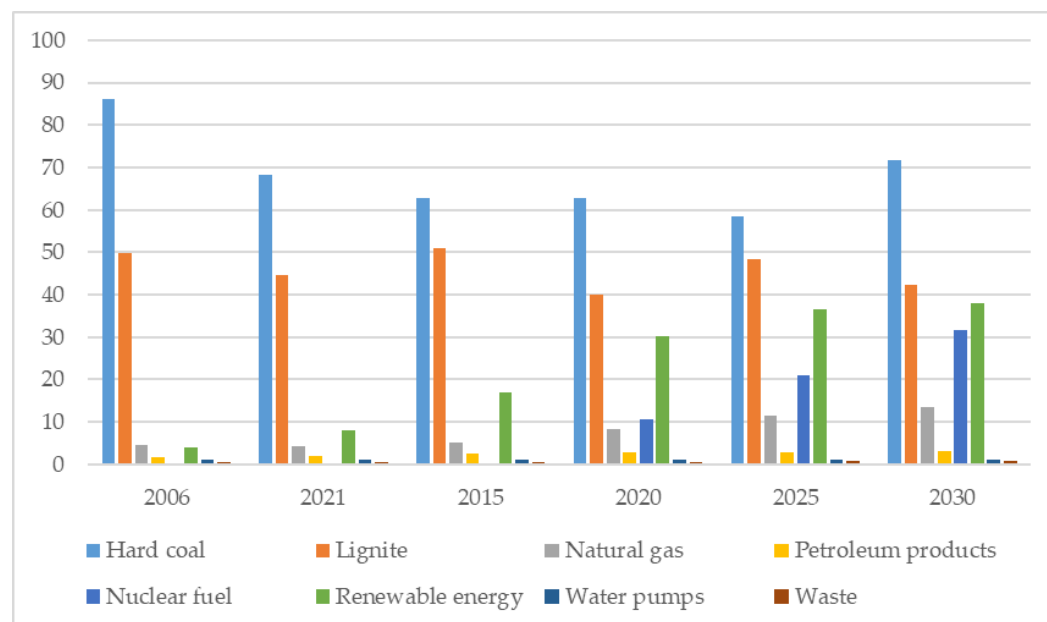


Figure 4. Net power generation by fuel in 2021–2030 [TWh]. Source: developed by the authors, based on Reference [25].

Among all renewable energy sources, wind sources play a dominant role, with an expected increase in capacity to almost 8 GW in 2030 [25].

Poland's specific and characteristic energy system has been the reason for adopting the following six interdependent directions in the Energy Policy until 2030: improving energy efficiency, increasing the security of fuel and energy supply, diversification of the energy generation structures by introduction of nuclear power, developing the use of renewable energy sources, including biofuels, developing competitive fuel and energy markets, and reduction of environmental impacts of the energy sector [24].

The development of renewable energy is vital in the context of achieving climate and energy targets, as well as improving energy security and reducing adverse environmental impacts of the energy sector. Bearing in mind the finiteness of fossil sources and their specific nature, renewable sources are an excellent alternative in the energy transition process of Poland. In addition, the development of distributed renewable energy sources reduces transmission losses and improves local energy security. Positive environmental effects associated with the production of energy from RES and socio-economic benefits that accompany their development are also important in this context. They lead to a steady increase in the support for RES, with growing popularity of local community initiatives aimed at growing the benefits of the local use of small renewable sources (energy cooperatives, development of prosumer energy generation) [24].

On 30 December 2019, the Minister of State Assets submitted to the European Commission the National Energy and Climate Plan for the years 2021–2030, thus fulfilling the obligation imposed on Poland by Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018, which sets out new climate and energy targets for Poland for 2030. These targets are presented in Figure 5.

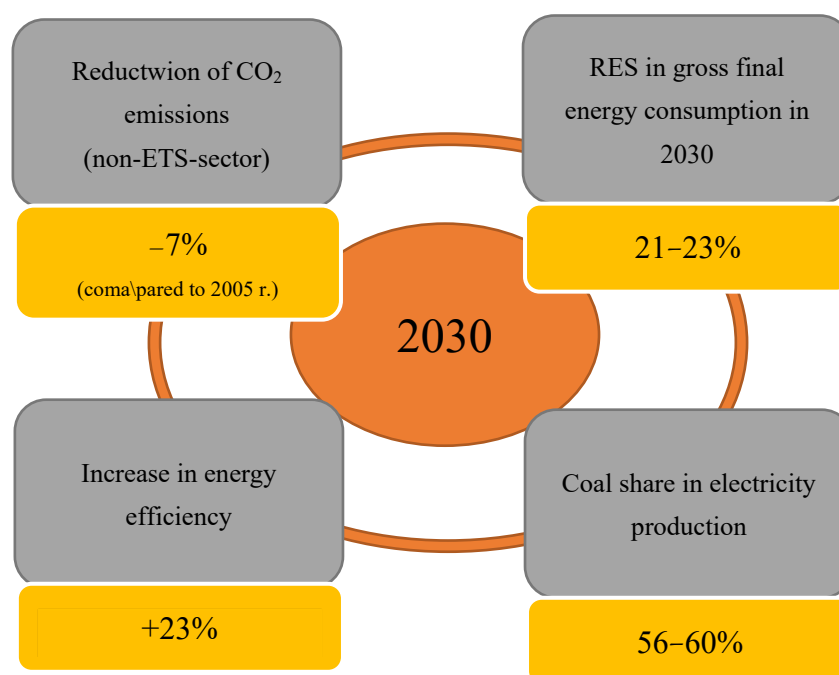


Figure 5. 2030 goals of the National Energy and Climate Plan for the years 2021–2030 for Poland. Source: developed by the authors, based on Reference [27].

The primary objective of the National Energy and Climate Plan for the years 2021–2030 is to act in five dimensions: improve energy security, create and operate the internal energy market, improve energy efficiency, reduce sectoral carbon footprint, and support research, innovation, and competitiveness [27].

The draft of the Energy Policy of Poland until 2040, adopted on the eve of the publication of this article [28], will define the long-term vision of the government for the energy sector. According to the Government's communication, the document will present a path towards the just transition of the energy sector, energy security, a stable labor market, sustainable development of the economy and strengthening its competitiveness, and recovery from the COVID-19 pandemic. Changes in the international context (Paris Agreement, so-called Katowice Climate Package, adoption by the EC of the 'Clean energy for all Europeans' package, and adoption of the European Green Deal) and global trends in climate and energy have forced Poland to revise the provisions of the already obsolete Energy Policy of Poland until 2030. These trends led to the revision of the objectives for the energy sector in Poland to support the European path to achieving climate neutrality by 2050 and to reduce adverse environmental impacts of the energy sector. The specific Polish energy sector, which is largely based on conventional, coal sources, requires continuous modernization of generation capacity and diversification of the energy generation structure, in particular while respecting the principle of just transition, which also takes into account its social context. The Polish government intends to allocate approx. PLN 200 billion from the EU and national funds under various mechanisms—such as the Cohesion Policy, the Recovery and Resilience Facility, the Just Transition Fund, and the Modernisation Fund or the Energy Transformation Fund—for the country's energy and climate transition by 2030 [28].

The new EPP 2040 is supposed to provide a foundation for the creation of a modern, sustainable, low-carbon energy system in Poland and is based on three pillars [28]:

- I. Just transition, including: transformation of coal regions, reduction of energy poverty, and new industries related to RES and nuclear power;
- II. Zero-emission energy system, including offshore wind energy, nuclear power, and local and citizen-based power generation;

III. Good air quality, including transformation of the heating system, electrification of transport, and Climate-Friendly Homes.

The specific objectives of EPP 2040 cover the entire energy supply chain, from raw material acquisition to energy generation and supply (transmission and distribution) to its use and sale.

For environmental reasons, the cost-optimal structure of power sources presented in EPP 2040, in line with the government's analysis, includes nuclear power plants, whose development is limited due to organizational and technical constraints. The Energy Policy of Poland until 2030 envisages that there will be three nuclear units with a total net power of 4.5 GW (4.8 GW gross) in operation by 2030 [29]. Today, we already know that this objective will not be achieved, although work on the implementation of the Polish Nuclear Power Programme is underway. Currently, the government maintains that in 2033, the first unit of the first nuclear power plant with a capacity of approx. 1–1.6 GW will be commissioned in Poland, with six nuclear reactors with a total capacity of approx. 6.6 GW operating in Poland by 2045. The share of nuclear power plants in electricity production is set to be 9% in 2035, increasing to 16% in 2040 and to 23% in 2045 [30].

The new scenario for the energy sector until 2040, presented as part of the update of the Energy Policy of Poland, assumes the development of offshore wind farms at approx. 1 GW per year starting from 2025, with the achievement of 8–11 GW in 2040 (a 19% share in the structure of power generation in 2040). The inclusion of the offshore wind energy sector in the draft EPP 2040 and the adoption of the Act on offshore wind energy generation are an important signal for enterprises from the industry (investors and suppliers), confirming the importance of this sector for the country's energy strategy. Offshore wind energy has a huge potential for shaping social and economic benefits for the countries that support it [31]. In addition, it has been assumed that energy generated using photovoltaics would grow to 10–16 GW (at least 5% share in power generation) and the amount of energy generated by onshore wind farms to at least 6.9 GW (at least 11% share in power generation) by 2040 [22].

The draft version of the Poland's new energy strategy also provides for the development of energy storage technologies, smart metering, and energy management systems, and the development of electromobility and alternative fuels and hydrogen-based technology. Electromobility in Poland is currently on the rise, as can be seen both in the development of charging infrastructure for electric vehicles and in the number of these vehicles on Polish roads (year-to-year increase in the number of vehicles is between 1.56 and 2.50) [29,11].

The Energy Policy of Poland until 2040 adopted the following indicators as a measure of achievement of the objective [18]:

- No more than a 56% contribution of coal in power generation in 2030;
- At least 23% of RES in gross final energy consumption in 2030;
- Adoption of nuclear power in 2033;
- A 30% reduction in GHG emissions by 2030 (compared to 1990);
- A 23% reduction of primary energy consumption by 2030 (compared to the consumption forecasts from 2007).

2.3. The Energy System of the Future—Analysis of Social Expectations Based on Secondary Data

The results indicate massive public support for the growth of renewable energy production, a strong policy supporting renewable energy, increasing energy efficiency, and greater active involvement of the Polish government in the efforts to reduce emissions in order to avoid dangerous changes. At the same time, support for coal, nuclear power, and other fossil fuels is much lower (Figure 6).

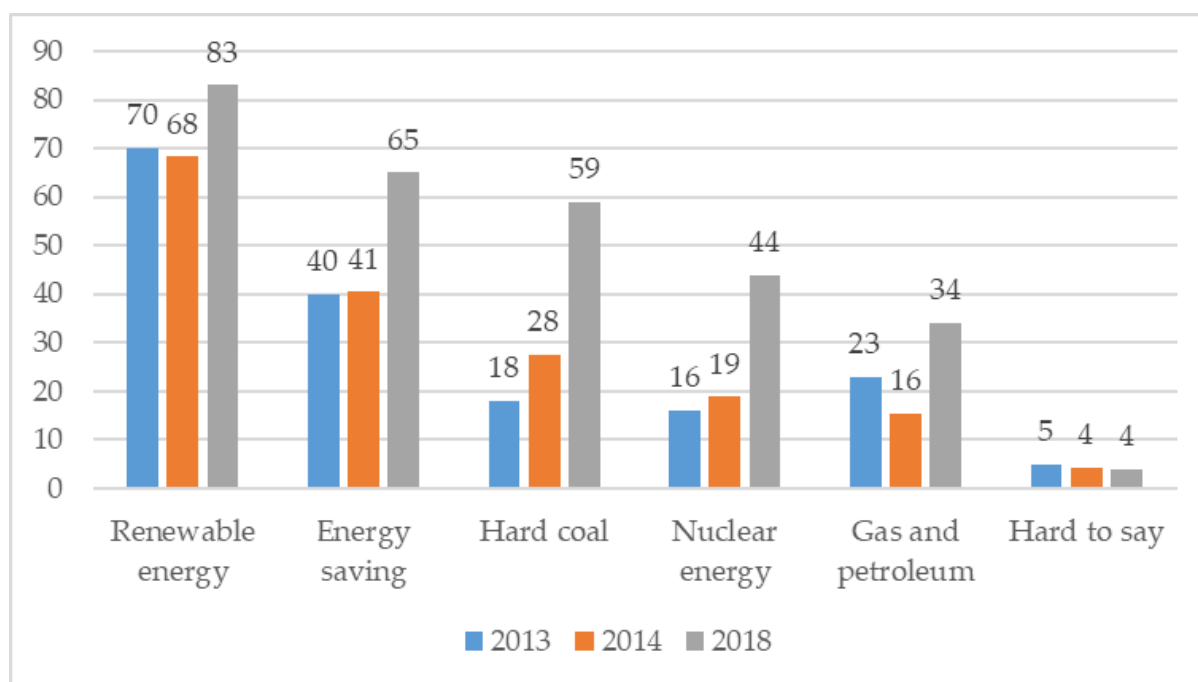


Figure 6. Type of energy that respondents believe should be developed in Poland in the near future (respondents could indicate two answers). Source: developed by the authors, based on Reference [32].

According to public opinion polls on RES carried out in Poland in 2015, one-third of the Poles knew about the existence of the RES Act, but only 7% were aware of what it addressed. A total of 11% of respondents were familiar with the term ‘prosumer’, but only 3% declared that they knew what exactly this term meant. The research also identified the investment potential of the Poles with regard to small RES installations. In 2015, 35% of respondents declared not only their support for the idea, but also their willingness to directly invest in RES, with 13% of respondents reporting willing to start using this technology within 2 years. At the same time, the percentage of those interested in the investment was significantly higher among those familiar with the RES Act (52%) and among those who felt informed about the possibilities of RES financing support (58%). Among those wishing to purchase RES installations, the main reason for such an investment was the willingness to reduce energy bills (over half of the respondents) and the possibility of enjoying cleaner air, as well as the convenience of using RES installations. Other reasons included the current opportunity of benefiting from subsidies, promotion of innovation or prestige, and improvement of one’s image due to the construction of such an installation [33].

Figure 7 summarizes the results of a survey of the opinions of Poles on various energy sources [32,34]. Solar and wind energy are definitely at the forefront of this summary—nearly 80% of respondents see their positive aspects. In that survey, conventional energy based on coal and nuclear sources enjoys the smallest support. The same study shows that in 2020, 75% of all respondents agree that the development of RES supports environmental protection and counteracts climate change. Slightly fewer, i.e., 70%, point to reduced dependence on energy imports and 68% of respondents say that it contributes to the creation of new jobs [34].

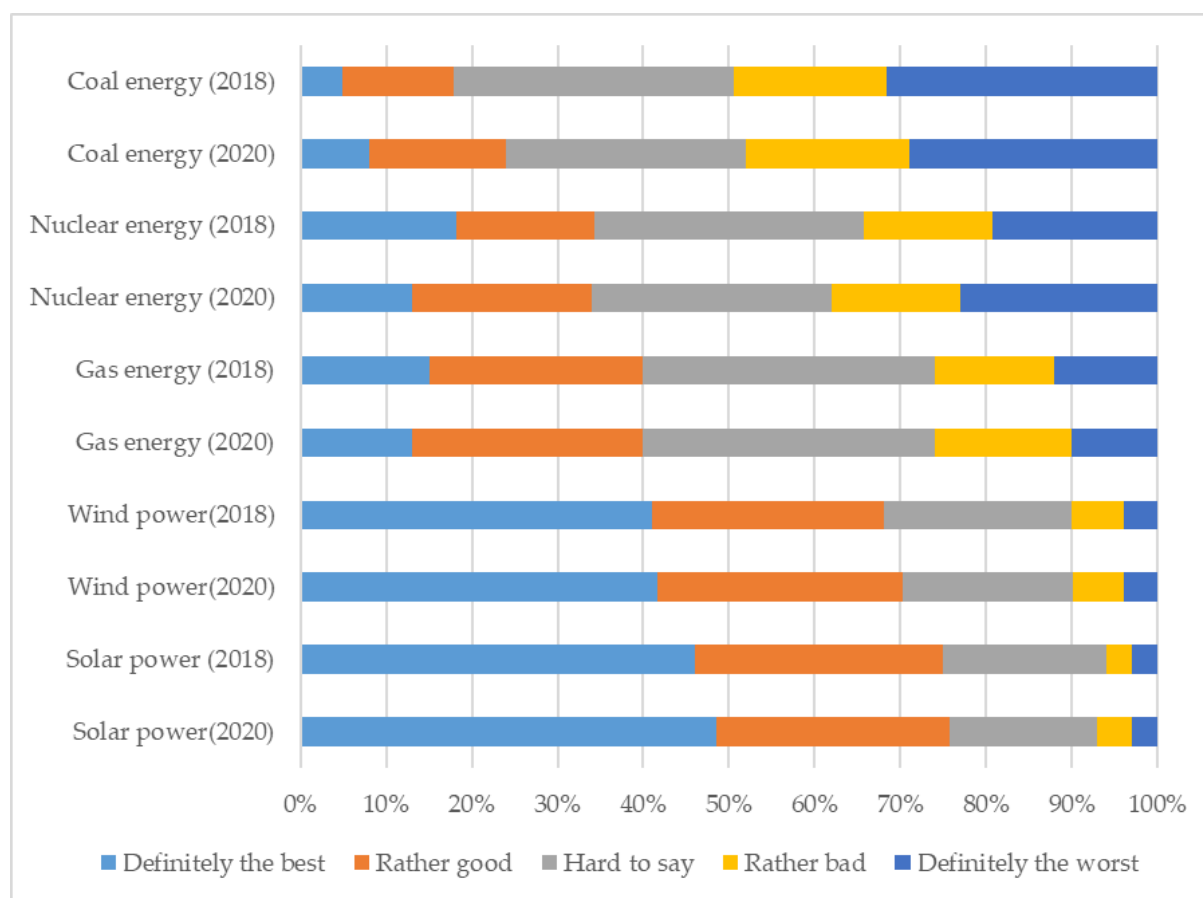


Figure 7. Comparative assessment of the different methods of power generation. Source: developed by the authors, based on References [32,34].

Despite the ambiguous dynamics of public support for RES initiatives, the declared level of support for pro-climate actions is relatively high and growing (Figure 8). In the 2018 social opinion polls [35], more than 80% of respondents agreed that Poland should support the European Union in its efforts to reduce carbon dioxide emissions. This percentage in 2018 was higher than in previous years. The results were similar for the question of whether Poland should support actions to help countries affected by the effects of climate change. At the same time, however, a significant number of people are concerned that Poland is too poor to afford special programs to combat climate change. In 2016, 48.9% of respondents thought so, while in 2018—37.3%. A significant proportion of respondents were also convinced that Poland's contribution to climate change was so low that its reduction would not significantly translate into global change. In 2016, 43.6% of respondents thought so, whereas in 2018 this percentage was lower, with only 37.3% of respondents saying 'yes'.

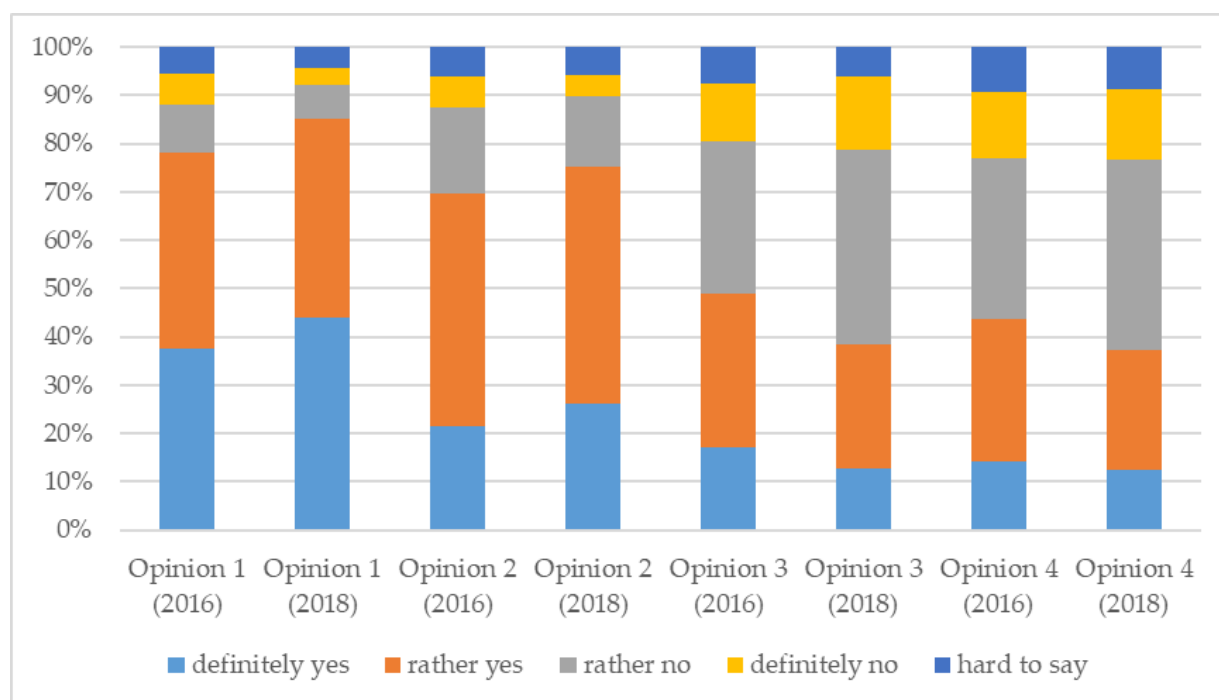


Figure 8. Support for the climate policy in Poland: Opinion 1: Poland should support the European Union in its efforts to reduce carbon dioxide emissions. Opinion 2: Poland should support actions to help countries that have been victims of climate change. Opinion 3: Poland is too poor to afford special programs aimed at combating climate change. Opinion 4: Poland's contribution to climate change is so small that the actions taken by Poland will change nothing. Source: developed by the authors, based on Reference [35].

3. Methods

The authors have used the diagnostic survey method and a critical literature review. This paper has been prepared based on the analysis of source materials such as documents and national and international regulations (in particular EU law), as well as secondary source data made available in reports prepared by energy sector entities, advisory companies, and research centers. To verify the results of the public opinion polls carried out in recent years, the available outcomes of these studies, conducted by renowned public opinion poll centers, were analyzed. The analysis seeks to answer the question of whether the energy policy implemented in Poland has met the expectations and how it has been received by the public, and to verify whether the research took into account opinions of local governments as the entities responsible for long-term anticipation of trends in the demand of the local community for fuels and energy.

The article analyzes the assumptions of the Energy Policy of Poland and changes in the Polish energy sector in recent years, in particular changes in the structure of power generation, based on reports published by Polskie Sieci Elektroenergetyczne S.A., a State-owned company, and then assesses the dynamics of these changes. Public expectations and opinions on energy policy are also analyzed using secondary data (reports on surveys conducted by leading marketing research agencies).

Due to the lack of information on the opinions of local governments in the available secondary data, which the authors deem a group of particular importance due to their contribution to the development of the energy policy—and energy security—at the local level, a survey was conducted in December 2020 involving a group of 274 respondents. The survey addressed current and general knowledge about the Energy Policy of Poland and the respondents' opinion on actions implemented by the local government, as well as the awareness of the needs and expectations of the local community. The respondents answered the questions in person (personal interview) or online.

4. Results

The study of the opinions of representatives of local government units was carried out in December 2020 in the form of a personal interview and an online survey. Answers were received from 274 respondents aged 28 to 62, most of whom were women (154, 56.30%). The age of the vast majority of respondents falls within the range of 36–45 years (111, 40.51%), followed by the range of 46–55 (84, 30.66%) and 23–35 years (68, 24.82%), with respondents aged 56–65 being the smallest group (11, 4.01%). No response was received from anyone aged over 65. The largest number of respondents represent urban municipalities [gmina miejska] (143, 52.19%), cities or towns with county rights [miasto na prawach powiatu] (60, 21.9%), or urban and rural municipalities [gmina miejsko-wiejska] (48, 17.52%), with rural municipalities being the least represented (23, 8.39%). Currently (as of 1 January 2021), Poland is divided into 16 voivodships, 314 poviats, and 2477 municipalities (302 urban municipalities, including 66 in cities or towns with county rights, 652 urban and rural municipalities, and 1523 rural municipalities) [36]. The feedback received covers 11% of all municipalities in Poland, including 47.35% urban municipalities, over 90% cities or towns with county rights, only 7.36% of urban and rural municipalities, and about 2% of rural municipalities.

Respondents were asked about their awareness of the Energy Policy of Poland until 2030. A total of 230 respondents said ‘yes’ (83.21%, of which 58.26% were residents from urban municipalities, 22.17% were from cities with country rights, 16.09% were from urban and rural municipalities, and 3.48% were from rural municipalities), while 44 responded said ‘no’ (16.06%, of which 20.45% were residents from urban municipalities, 20.45% were from cities with country rights, 25.00% were from urban and rural municipalities, and 34.09% were from rural municipalities). For the question for their knowledge of the EU climate and energy policy assumptions, 73 (26.64%) of respondents assessed their knowledge as very good, 43 (15.69%) as good, 87 (31.75%) as moderate, and 71 (25.91%) as poor (see Table 2 and Figure 9).

Table 2. Residents’ knowledge of the EU climate and energy policy assumptions.

Place of Residence	Very Good	Good	Moderate	Poor	Total
Urban municipalities	53	19	51	20	143
Cities with country rights	12	16	17	15	60
Urban and rural municipalities	6	5	11	26	48
Rural Municipalities	2	3	8	10	23
Total	73	43	87	71	274

Source: Own Study.

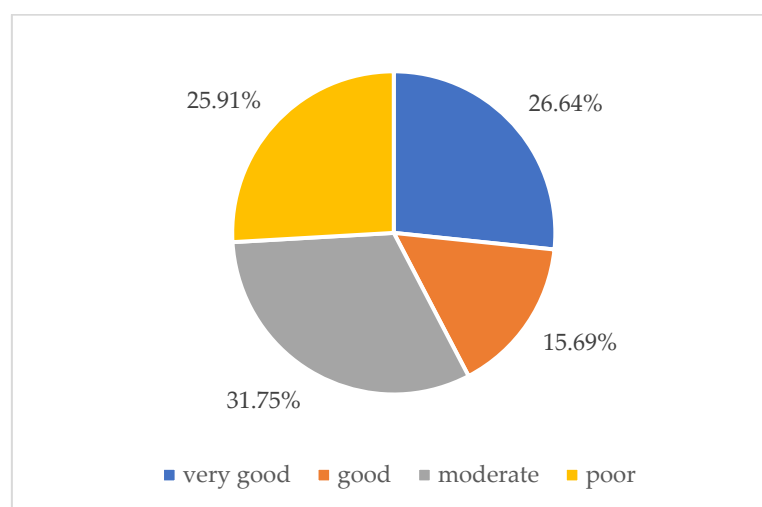


Figure 9. Knowledge of the EU climate and energy policy assumptions. Respondents could select only one answer. Source: own study.

Afterwards, respondents were also asked to assess their knowledge of the assumptions of the draft Energy Policy of Poland until 2040 (still in the project phase at the time of the survey). 63 respondents (22.99%) assessed their knowledge as very good, 85 (31.02%) moderate, and 71 (25.91%) poor. 55 (20.07%) respondents were not aware that the Energy Policy of Poland has been changing (see Table 3 and Figure 10).

Table 3. Residents' knowledge of the assumptions of the draft Energy Policy of Poland until 2040.

Place of Residence	Very Good	Moderate	Poor	Not Aware That the	Total
				Energy Policy Has Been Changing	
Urban municipalities	38	54	41	10	143
Cities with country rights	21	18	10	11	60
Urban and rural municipalities	4	10	12	22	48
Rural Municipalities	0	3	8	12	23
Total	63	85	71	55	274

Source: Own Study.

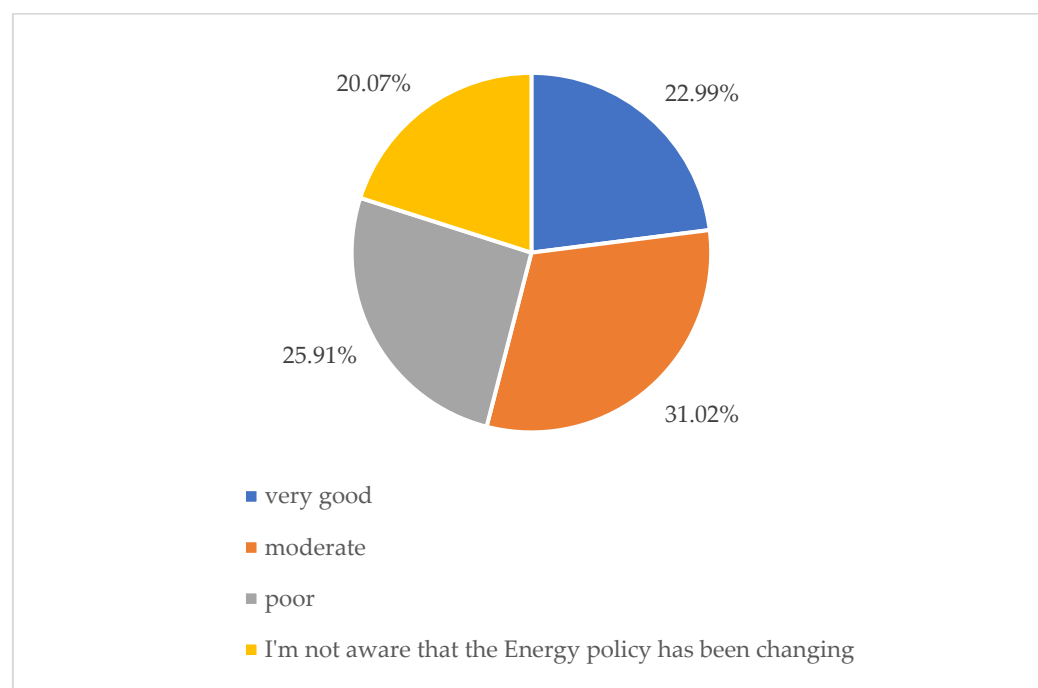


Figure 10. Knowledge of the assumptions of the Energy Policy of Poland until 2040. Respondents could select only one answer. Source: own study.

The respondents were also asked whether they knew what Poland's energy mix currently looks like, and their task was to tick the energy sources currently used in Poland (each respondent could select more than one answer). All respondents ticked hard coal (274, 100%) and almost all respondents (273, 99.64%) ticked lignite. A vast majority also ticked onshore wind energy (270, 98.54%), biogas (211, 77.01%), and biomass (194, 70.80%). A total of 150 (54.74%) respondents ticked gas and hydropower. Only 87 (31.75%) respondents selected photovoltaics and 67 (24.45%) ticked RES micro installations. Furthermore, 4 (1.46%) respondents ticked nuclear power, while 2 (0.73%) ticked offshore wind energy (see Figure 11).

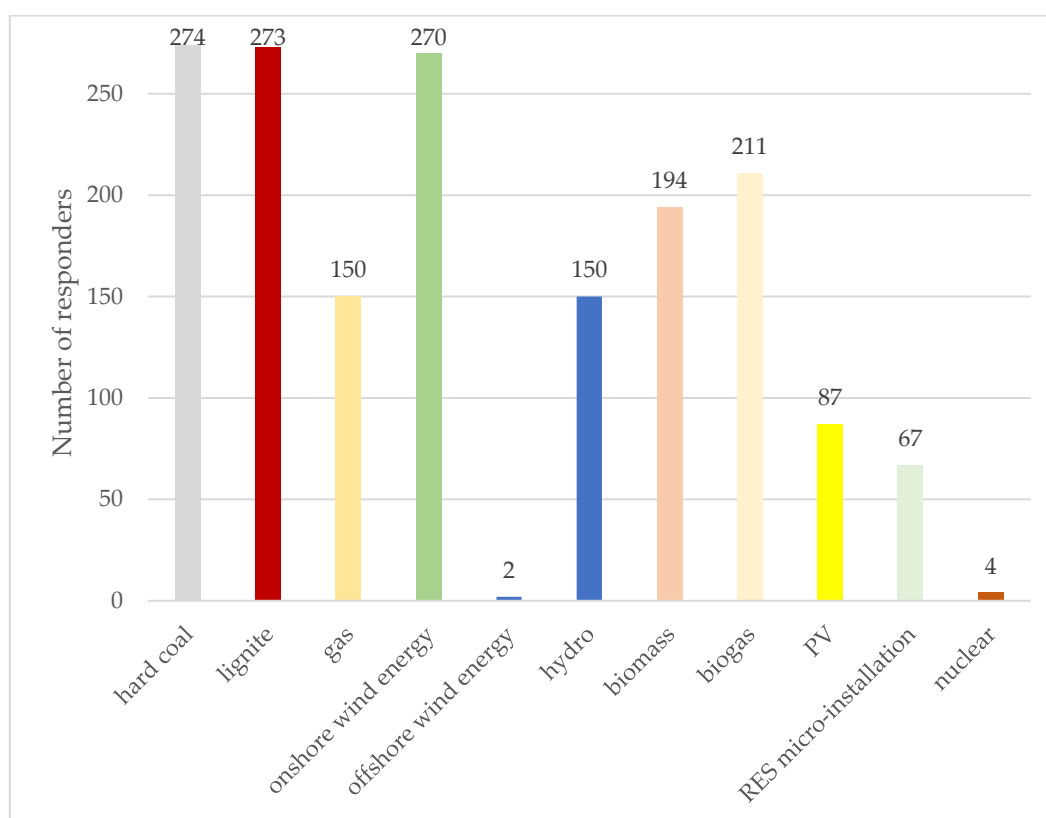


Figure 11. Energy sources currently used in Poland. Respondents could select more than one answer. Source: own study.

Respondents were also asked to express their opinion on what the optimal energy mix for Poland should look like, by indicating the relevant scenario (see Table 4 and Figure 12). Respondents could select only one answer. A total of 47 (18.29%) respondents indicated the scenario with a dominant role of RES, 45 (17%) respondents selected the scenario based mainly on coal, 15 (5.84%) opted for the scenario in which prosumers predominate, 10 (3.89%) indicated that the focus should be primarily on energy efficiency, and 5 (1.95%) selected the scenario based on nuclear power. A total of 118 (43%) respondents indicated that the optimal mix should be based on all previously indicated sources apart from nuclear power, while 34 (13.23%) were in favor of all previously indicated sources apart from RES.

Table 4. Residents' opinion on the optimal energy mix for Poland.

Place of Residence	Urban Municipalities	Cities with Country Rights	Urban and Rural Municipalities	Rural Municipalities	Total
Scenario based primary on coal	9	9	25	2	45
Scenario based solely on nuclear energy	0	3	2	0	5
Scenario based solely on RES	25	12	5	5	47
Scenario based solely on prosumer energy	9	5	1	0	15
Scenario based solely on energy efficiency	8	1	1	0	10
Coal, nuclear, prosumer, and energy efficiency scenario	15	14	5	0	34
Coal, RES, prosumer, and energy efficiency scenario	77	16	9	16	118
Total	143	60	48	23	274

Source: Own Study.

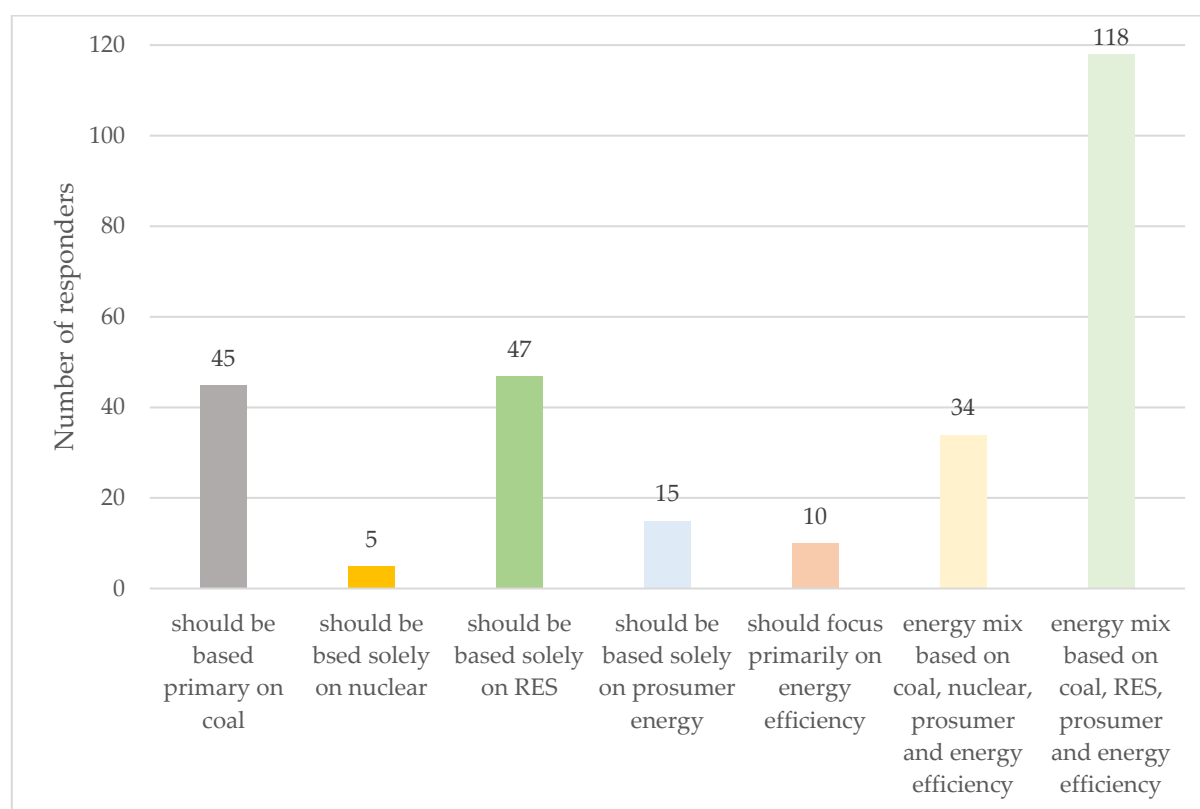


Figure 12. Opinion on the optimal energy mix for Poland. Respondents could select only one answer. Source: own study.

The respondents were also asked whether they knew what opinions the local community in their city/municipality had on the optimal energy mix (Figure 13). A total of 160 (58.39%, of which 41.25% were residents from urban municipalities, 25.63% were from cities with country rights, 23.75% were from urban and rural municipalities, and 9.38% were from rural municipalities) said yes, while 114 (41.61%, of which 67.54% were residents from urban municipalities, 16.67% were from cities with country rights, 8.77% were from urban and rural municipalities, and 7.02% were from rural municipalities) said no. Another question concerned the knowledge of the number of prosumers registered in the respondents' city/municipality (Figure 14). The vast majority (240, i.e., 87.59%, of which 59.17% were residents from urban municipalities, 24.17% were from cities with country rights, 15.42% were from urban and rural municipalities, and 1.25% were from rural municipalities) responded in the negative, while 34 respondents (12.41%, of which 2.94% were residents from urban municipalities, 5.88% were from cities with country rights, 32.35% were from urban and rural municipalities, and 58.82% were from rural municipalities) had knowledge on this figure. The respondents were also asked to say whether they had ever heard of energy cooperatives (Figure 15). A total of 150 respondents (54.74%, of which 42.67% were residents from urban municipalities, 27.33% were from cities with country rights, 20.00% were from urban and rural municipalities, and 10.00% were from rural municipalities) affirmed, while 124 (45.26%, of which 63.71% were residents from urban municipalities, 15.32% were from cities with country rights, 14.52% were from urban and rural municipalities, and 6.45% were from rural municipalities) had never heard of them.

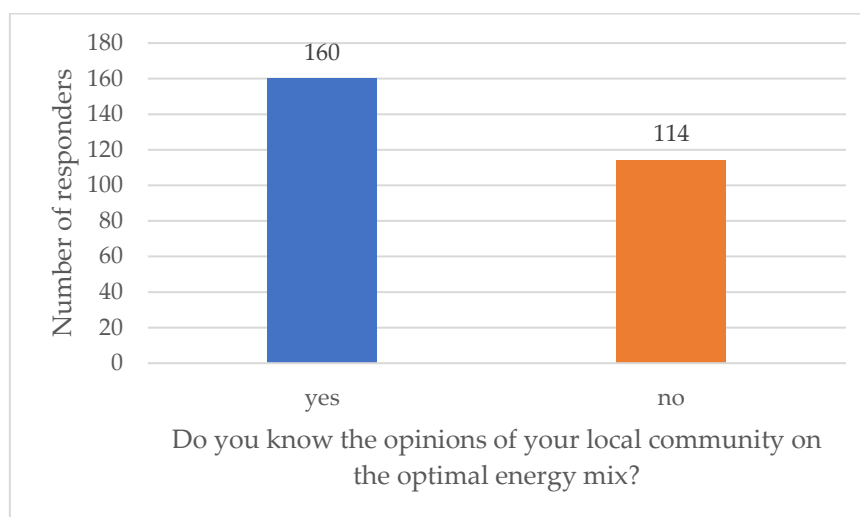


Figure 13. Knowledge of concepts and phenomena. Respondents could select only one answer—‘yes’ or ‘no’. Source: own study.

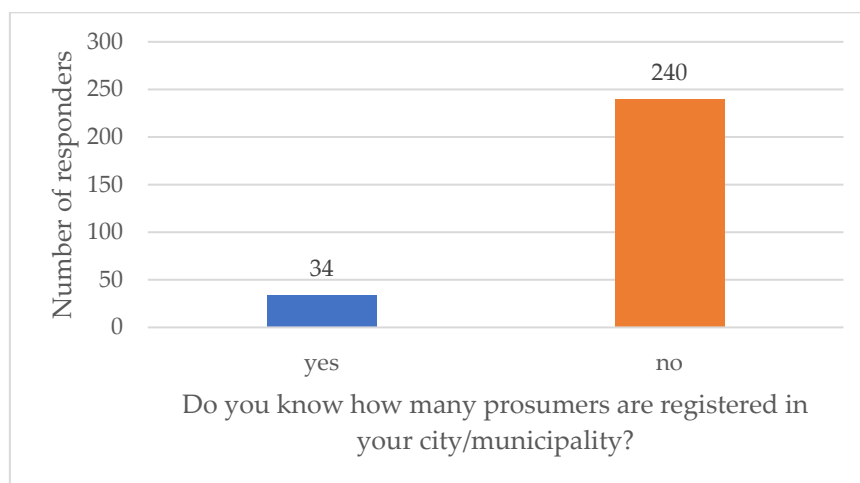


Figure 14. Knowledge of concepts and phenomena. Respondents could select only one answer—‘yes’ or ‘no’. Source: own study.

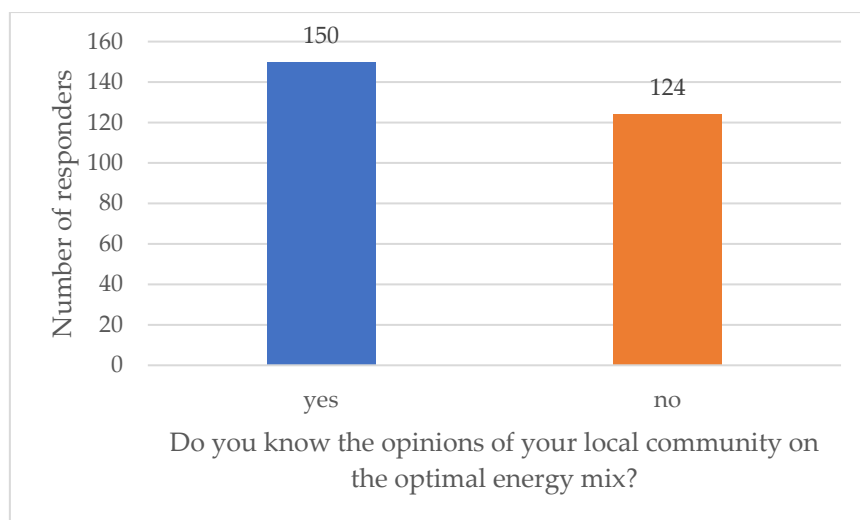


Figure 15. Knowledge of concepts and phenomena. Respondents could select only one answer—‘yes’ or ‘no’. a—do you know the opinions of your local community on the optimal energy mix, b—

do you know how many prosumers are registered in your city/municipality, c—have you heard the term ‘energy cooperative’. Source: own study.

Most respondents (112, 40.88%) had no concerns related to the implementation of EU climate and energy requirements in Poland (see Table 5 and Figure 16). A marginally smaller number of them (106, 38.69%) did have such concerns. A total of 56 respondents (20.44%) had no opinion on this.

Table 5. Residents’ concerns related to the implementation of EU climate and energy requirements in Poland.

Place of Residence	Yes	No	No Opinion	Total
Urban municipalities	35	80	28	143
Cities with country rights	35	4	21	60
Urban and rural municipalities	20	23	5	48
Rural Municipalities	16	5	2	23
Total	106	112	56	274

Source: Own Study.

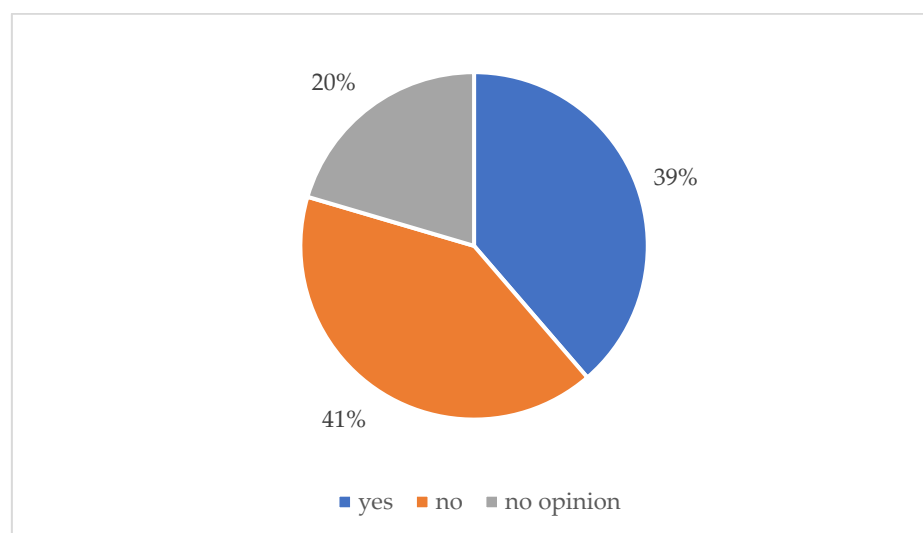


Figure 16. Concerns related to the implementation of EU climate and energy requirements in Poland. Respondents could select only one answer. Source: own study.

5. Discussion and Conclusions

Transformation of the energy sector in Poland is a current topic that has been developing before our very eyes. Both the Polish government and its citizens recognize the need to change the structure of power generation in Poland, and the path taken by the recently adopted draft Energy Policy of Poland until 2040 coincides with the expectations of Poles.

The authors made an attempt to check the development of the energy sector in Poland and verify the public opinion on the energy policy implemented in Poland. The authors also decided to check whether the available public opinion research include the expectations and knowledge of representatives of local governments, as a group particularly relevant from the point of view of their role in shaping energy policy and energy security at the local level.

The analysis of secondary data shows that the support for the European climate and energy policy among Poles is on the rise, as is the support for clean power such as solar and wind energy. There has been a slight decrease in the support for nuclear power, which may be due to the lack of a clear and consistent action plan and results. Social expectations are in line with the shape of the updated energy policy. As shown in [32–34], renewable energy sources, mainly wind and photovoltaics, are seen as the best ways of generating

energy. Additionally, our own research showed that the optimal energy mix for Poland is expected to be based on RES or on RES together with prosumer initiatives and energy efficiency actions. This corresponds with the new goals of the energy policy in Poland, assuming no more than 56% of coal in power generation in 2030, at least 23% of RES in gross final energy consumption in 2030 a 30% reduction in GHG emissions by 2030 (compared to 1990).

Taking into account the information obtained in the survey, a majority of respondents have a moderate or low level of knowledge of the EU climate and energy package or the assumptions of the Energy Policy of Poland until 2040. At the same time, the vast majority of respondents know the assumptions of the Polish energy policy until 2030, but almost a quarter did not realize that the energy policy will be changed in the near future. According to the authors, the vast majority of respondents from this group come from rural areas, which may constitute a major barrier to initiatives taken by local governments or to the shaping of the local strategy for sustainable development due to the lack of knowledge of strategic paths for the development of the energy sector. The vast majority of respondents believe that the Polish government should prepare an awareness-raising campaign related to its energy policy and train local governments in this regard. The majority of respondents declare knowledge of the opinion of the local communities they represent—nearly 60% of them know their community's views on the optimal energy mix. It is worth emphasizing that 65% of the respondents from rural areas know the views of local communities. This shows that local governments in urban areas should take measures to better understand local communities and learn about their views on the preferred shape of energy policy. Given the current trends in the development of prosumer energy and support of the Polish government for the creation of energy cooperatives, it is also positive that a vast majority of respondents have heard of energy cooperatives. However, the lack of knowledge about the number of micro installations operating in a given city/municipality is unfavorable. The survey also showed preferences of representatives of local governments for the optimal energy mix in Poland and their subjective assessment of the knowledge of public opinion in the region on the expected shape of the energy policy. From the findings, it can be concluded that more in-depth research is needed on the preparation of local governments to shape energy policy at the local level, including more detailed research on how opinions of the inhabitants of a given region and the specificity of a given region are taking into account while shaping local energy policy.

Many local governments see RES as an opportunity for the development of their own region. The analysis of sectoral statistical data shows that both the share of renewable energy sources in the structure of power generation and the number of micro installations or prosumers have been gradually increasing, in line with the expectations of the public, as confirmed by the mentioned secondary research and the survey carried out by the authors. This has a positive impact on energy security, also at the local level, and in the long term, it will reduce the adverse environmental impacts of the energy sector. It is known that caring for the natural environment is gaining importance because ecological products are available, the consumption and processing of plastic is reduced, and the waste segregation process is implemented. To help nature, the use of renewable energy sources is also being developed, i.e., those based on natural and inexhaustible resources. The developed methods of obtaining them guarantee not only emission-free electricity production, but also endless possibilities of its use. However, it should be noted that it will be very difficult to achieve a dominant role of RES in the power generation structure in Poland—not only due to the persisting belief of some citizens in the infinity of conventional resources, but mainly due to major technological, financial, or legal barriers. With growing adoption of RES technology in Poland, legal barriers are gradually reduced by the government, an example of which is the adoption of the Act on offshore wind energy generation in early 2021, which is expected to give impetus to the Polish renewable energy industry and form a part of Poland's energy security system.

A review of the literature, in particular of the conducted research on social acceptance in terms of energy policy, showed that there are no comprehensive surveys of the opinions of local government representatives. The authors point to the great role and responsibility of the local government in the context of building local energy strategies based on locally available energy resources, knowledge resources, and the level of activity of local communities. There is no in-depth research in Poland that would show not only the opinion of local government representatives, but also the existence and main assumptions of local energy strategies, as well as the way of creating these strategies. The survey showed that representatives of local governments, who mostly assess their knowledge of the EU's energy and climate policies as moderate or poor (the vast majority of respondents with poor knowledge come from rural areas), are not fully prepared to create energy plans for their regions. The authors emphasize, however, that for a thorough examination of this issue, a study covering a much larger research group and a wider range of issues is necessary. The authors also emphasize the importance of shaping conscious attitudes in the local government environment, as well as building knowledge and skills and constantly improving the competences of local government employees in the field of energy policy and sustainable development.

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