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ENERGY POLICY AND MINING INVESTMENTS IN ENERGY RESOURCES IN POLAND – HOUSEHOLDS' PERSPECTIVE – SELECTED ASPECTS

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Purpose: Assessment of the state's energy policy and the state of mining investments in Poland's energy resources. Determination of the dynamics of mining investments and their scope, as well as identification of household assessments of energy management issues.
Design/methodology/approach: Analysis of publicly available data in reports on the state of mineral deposits in Poland. Data collection through a survey and presentation of the results, along with the presentation of conclusions drawn from the results - construction of a model of energy policy preferences.
Findings: As a result of the analysis of data on Poland's energy resources and the findings resulting from the survey of Polish households regarding their attitudes towards energy policy, several fundamental conclusions were drawn. 1. Energy resources are a factor positively impacting the country's energy security. 2. Over the last decade, a decline in the share of non-renewable energy sources in the energy consumption structure has been observed. 3. During periods of economic or social crisis, increasing confidence in non-renewable energy sources can be observed. 4. The decarbonization process is likely not an absolute ambition, but it is sensitive to factors other than environmental factors, including national security. 5. Polish society is willing to invest in renewable energy sources and limit investments in non-renewable energy sources, but above all, out of a sense of energy security.
Originality/value: A synthesis of areas considered independent: central-level policy, preferences expressed at the household level, and issues at the intersection of geology, economics, and ecology. The research may be useful in supporting the assessment of public consultations regarding the country's energy transition and educational directions for improving energy security, rather than in addressing trends or dogmatism related to energy transition.
Keywords: energy transition, energy transformation, mining investments, household attitudes, energy resources.
Category of the paper: Research paper.

1. Introduction

A state's energy policy can be implemented under at least several conditions. First, it requires legitimacy. This can be understood in two ways: as the subject of a given state's government's activity, but also as the inclinations of society, which influenced the formation of the government. Second, resources (own or acquired) must be available for management in the course of policymaking.

These conditions constitute the research problem of this article. The first part will examine the existing resources of the main energy resources whose exploitable deposits are located in Poland: natural gas, crude oil, lignite, and hard coal. The resources of these resources will be analyzed, taking into account primarily the quantities that are technically extractable and those whose extraction would be profitable. Data will cover the last decade.

The second part will present the results of our own research, which was conducted in the form of a survey addressed to households from all over Poland and concerned preferences regarding the direction of energy policy, including the assessment of the current policy.

2. The state energy policy and the aspect of energy resources in Poland and their management

Considering the topic of mining investments in energy resources from a household perspective is a process that falls into categories that will ensure a comprehensive approach after taking into account the context of:

- energy security,
- raw material resources,
- energy policy,
- strategies and tools for implementing energy policy.

Energy security can be understood according to the definition provided by the Mining Law: it is the state of the economy that enables the current and future demand for fuels and energy to be met in a technically and economically justifiable manner, while maintaining environmental protection requirements (Mining Law). This understanding is appropriate from the perspective of the party ensuring this state of security, which is, in principle, the state. From the perspective of the end user, security can be considered equivalent to the state of availability. This availability, in turn, can be understood in two aspects: the level of energy prices and the guarantee of reliable supply (Mazurkiewicz, 2008). Analysis of the cited definitions allows us to conclude that the perception of energy security depends on the process of ensuring it,

but two identical and simultaneous statements about the existence of energy security do not necessarily have to be equivalent.

The procedure for determining the state of energy security requires the identification of the following parameters (Kostecka-Tomaszewska, 2024; Nowiński, 2021; Szczerbowski, 2013; Hebda, 2023; Golarz, 2016):

- level of dependence on energy imports,
- structure of the energy mix,
- degree of diversification of energy sources.

In principle, it seems that a country's appropriately diversified and diverse energy sources, with the lowest possible level of dependence on energy imports, should translate into sufficient energy availability. Availability is therefore a desirable condition, but from the perspective of households, it is not necessarily fully understood in the long term. Therefore, it can be concluded that such research is burdened with the risk of inconsistent conclusions from attempts to identify categories with a dual meaning (i.e., energy security). Households may define energy security, but without taking into account future resources and needs, and without necessarily identifying the economic, technical, and ecological conditions of available supplies.

The context of raw material resources allows us to specify that among all mineral deposits found in Poland, from the point of view of mining investments in the context of energy policy, only energy resource deposits are important, among which the following should be distinguished (PIG, 2025):

- nitrogenous natural gas,
- natural gas,
- helium,
- coalbed methane,
- crude oil,
- brown coal,
- hard coal.

Despite Poland's abundance of the aforementioned mineral deposits, the country's energy policy primarily considers deposits of hard coal, lignite, crude oil, and natural gas (MKIŚ, 2021). The author believes that the identification of these energy resources, along with their resource dynamics, can be inferred from data on the quantity of minerals in deposits, broken down into developed, undeveloped, and abandoned deposits, along with a measure of the degree of development of existing deposits and the degree of abandonment. These figures are presented in the graphs – figures 1 to 8.

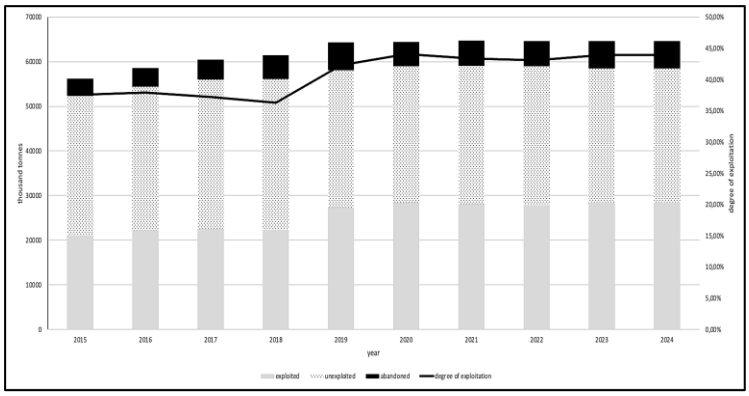

Figure 1. Technically recoverable hard coal resources.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

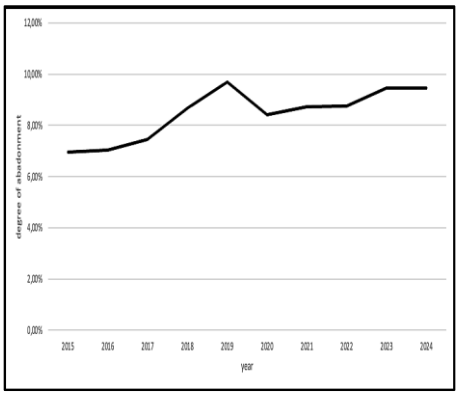

Figure 2. Degree of abandonment – hard coal.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

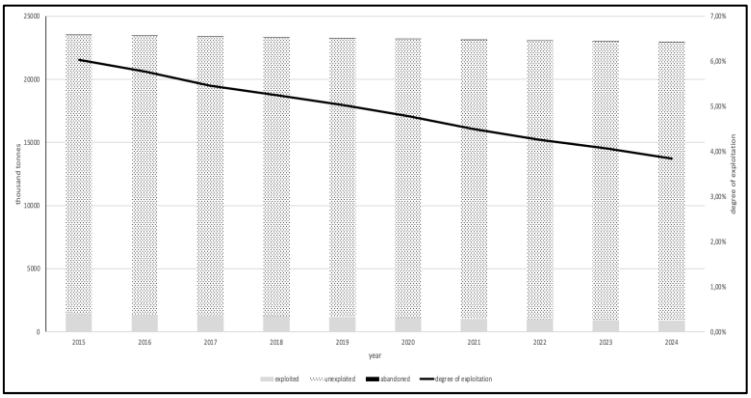

Figure 3. Technically recoverable lignite resources.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

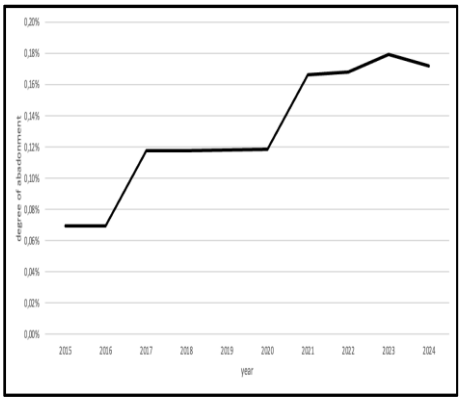

Figure 4. Degree of abandonment – lignite.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

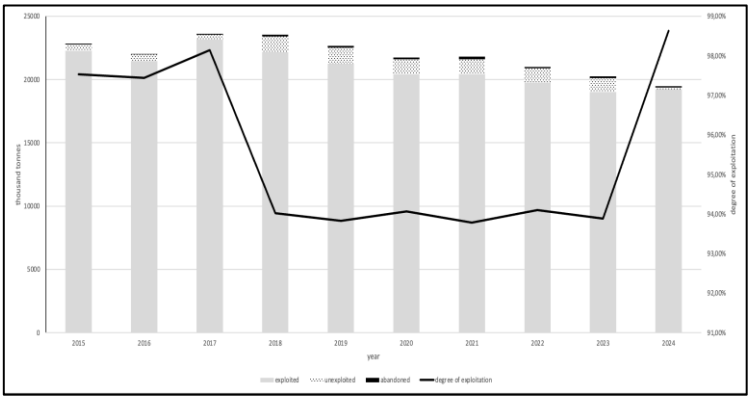

Figure 5. Technically recoverable crude oil resources.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

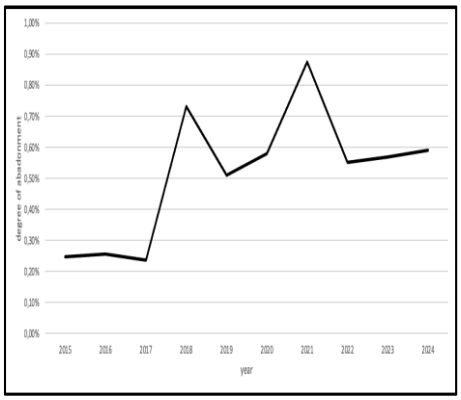

Figure 6. Degree of abandonment – crude oil.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

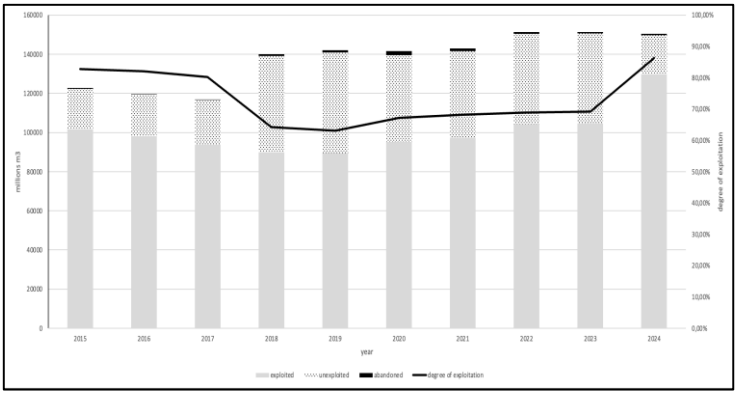

Figure 7. Technically recoverable natural gas resources. Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

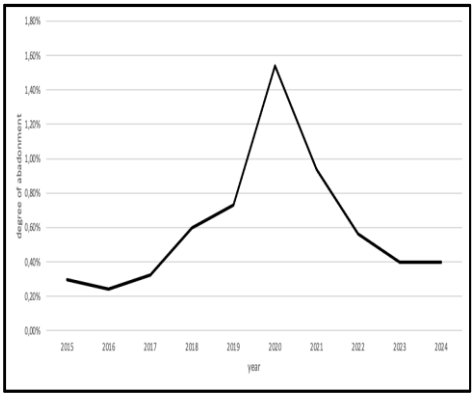

Figure 8. Degree of abandonment – natural gas.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

The data analysis, the results of which are reflected in Figures 1 to 8, is based on the assumption that raw material resources are understood as technically recoverable resources. This category means that we are talking about those resources of a deposit or part thereof whose natural characteristics, defined by recoverability criteria and conditions of occurrence, enable its exploitation (Saługa, 2011). This refers to the technical potential of the resources, for now without taking into account the transitional conditions of exploitation profitability. Furthermore, the data on hard coal were not divided into thermal and coking coal; this approach is based on three reasons. First, coking coal, as a result of coking—and thus indirectly—is used to generate energy. Secondly, from the point of view of mining investments, including the extraction of hard coking coal, the focus is on the overall usefulness of solid fuels, not necessarily solely as fuel in heating boilers – thus, we are talking here about their function as fuel, reducing agent, and carburizer for pig iron in blast furnace processes[1] (Blaschke, Ozga-Blaschke, 2015). Thirdly, if one wishes to compare data on resources with data on consumption, statistical data at the national level are presented on the aggregate consumption of thermal and coking coal (Grudziński, Stala-Szlugaj, 2014; GUS, 2024).

A comparative analysis of the four main energy resources found in Poland indicates that the relatively highest level of exploitation of technically recoverable resources can be observed in the case of crude oil (Figure 5). Existing technically recoverable resources have been depleted over the last decade, and the relative level of development of deposits increased in 2024 after stagnating for five years, when it declined in 2018 (the curve in Figure 5). In turn, the relative size of deposits abandoned in the last decade is on an upward trend.

[1] Coking coal as a reducing agent and carburizer is losing its usefulness due to the limitation of blast furnace processes in favor of Direct Reduced Iron (DRI) technology.

In contrast, the highest level of unused technically recoverable resources can be observed in the case of lignite, whose total resources were relatively stable during the period under review (Figure 3). Additionally, there is a steady downward trend in the degree of utilization of available resources (the curve in Figure 3) with a simultaneous upward trend in the degree of abandonment of exploitation of available resources (Figure 4). The reason for the stable level of technically recoverable resources may be the fact that not only there is no priority for its use or exploration, but also the small potential for new deposits, with its extraction being decreasing and small.

In the case of natural gas resources, their overall resources have been increasing over the last decade (Figure 7), and the degree of their development was at a relatively high level, which was stable until 2023; in 2024, there was a relatively large increase in the degree of field development (curve in Figure 7). In turn, in the years 2016-2020, the degree of abandonment of exploitation of technically recoverable resources increased significantly, reaching a maximum in 2020, from which it is decreasing at a comparable rate until 2024 (Figure 8).

The analysis of the structure of hard coal resources indicates two possible basic conclusions: (1) hard coal is treated as an important component of the energy mix, which is to ensure security in terms of availability - the technically recoverable resources have not fluctuated significantly in the last decade, and have increased slightly since 2018 (Chart 1), while the degree of deposit development has changed proportionally to the amount of resources (curve in Chart 1); (2) the decarbonization process is noticeable, the relative amount of resources whose exploitation has been abandoned is the highest among all the analyzed raw materials (from about 7% to about 10%) and a constant but weak upward trend is noticeable. The increasing share of abandoned exploitation results from a chain of causes, the links of which include both the legal regulations regarding the possibility of using coal and the resulting development of alternative energy sources replacing coal technologies.

A study conducted in a similar convention can be found in the work of Gawlik and Mokrzycki, however, one can find there a comprehensive analysis of all energy resources, but only in one year, i.e. 2016 (Gawlik, Mokrzcki, 2017).

Energy policy is a synthesis of means and goals, i.e., natural resources that can be useful in achieving energy security. Energy policy can be defined (as with security) from various perspectives. From the perspective of a household, which in principle has the freedom to allocate funds for goods and services, energy policy can be a calculation with a single-season time horizon, comparing heating needs with the possible fuels available for a given heating installation, their quantity, and price. From a formal perspective, conceptualized as the state's energy policy, the issue is addressed more broadly and with a long-term perspective.

The assumptions of Poland's energy policy are expressed in the document "Poland's Energy Policy until 2040" and the "Assumptions for the Update of Poland's Energy Policy until 2040". These documents articulate the framework for Poland's energy transformation, based on three pillars (in the version before the update): a just energy transition, a zero-emission energy

system, and good air quality. These pillars are linked to eight specific objectives, including (energy policy):

1. optimal use of domestic energy resources,
2. expansion of electricity generation and grid infrastructure,
3. diversification of supplies and expansion of the grid infrastructure for natural gas, crude oil, and liquid fuels,
4. development of energy markets,
5. implementation of nuclear energy,
6. development of renewable energy sources,
7. development of heating and cogeneration,
8. improvement of energy efficiency

and after the update – taking into account the fourth pillar: energy sovereignty. A key element of the fourth pillar is the rapid independence of the national economy from imported fossil fuels (Assumptions for the update). For the remaining eight goals, the primary area of modification would be the issue of sovereignty and reducing dependence, primarily on the Russian Federation. It is worth noting that one of the methods of implementation would be to increase the capacity to use domestic coal resources, which would slow the pace of decarbonization.

In this paper, the specific elements of national energy policy considered are Objectives 1 and 6. The final element of the planned analysis will therefore be data on the changing resources whose extraction is profitable and the degree of their extraction during the period under analysis – in terms of the tools used to implement the national energy policy. The results of this analysis are presented in graphs – figures 9 to 12.

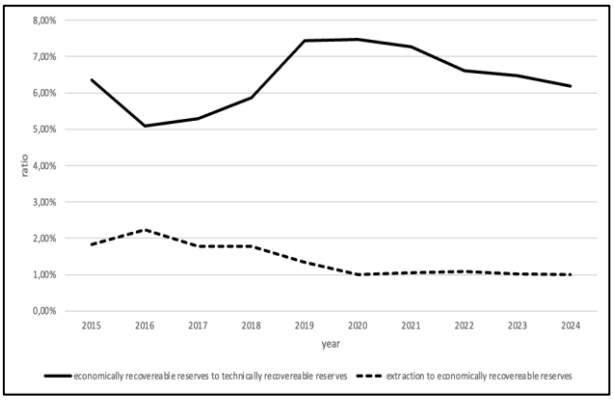

Figure 9. Economically recoverable reserves of hard coal and its extraction.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

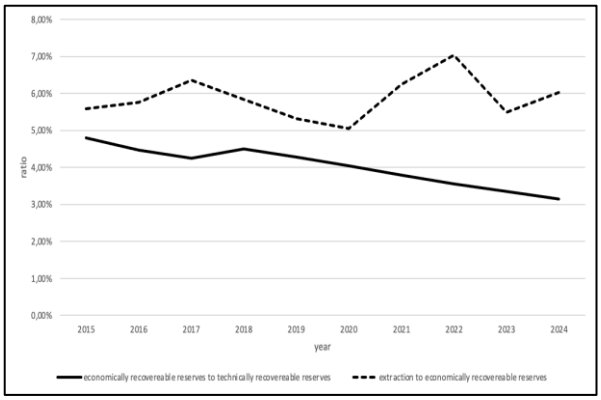

Figure 10. Economically recoverable reserves of lignite and its extraction.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

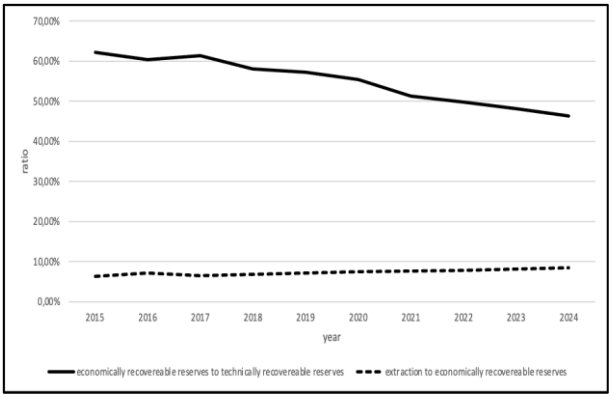

Figure 11. Economically recoverable reserves of crude oil and its extraction.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

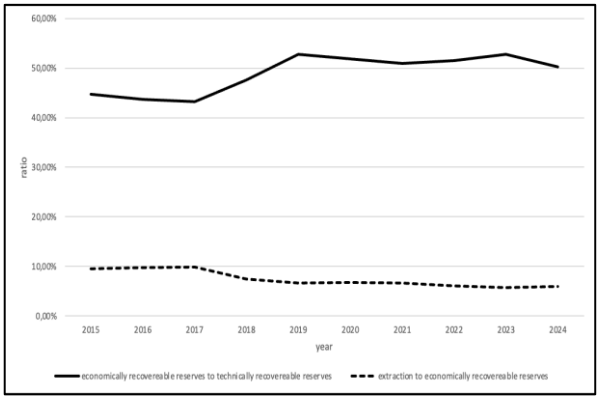

Figure 12. Economically recoverable reserves of natural gas and its extraction.

Source: own study – based on The Balance of Mineral Resources Deposits in Poland 2016-2025.

Two measures were used to analyze the implementation of energy policy between 2015 and 2024: the ratio of technically recoverable resources to economically viable resources, and the ratio of a given resource's production to economically viable resources in subsequent years.

It can be noted that over the last decade, economically recoverable resources have fluctuated relative to technically recoverable resources. A significant increase was observed between 2017 and 2019, which may be related to increased activity in the coal sector caused by the COVID-19 pandemic crisis (Montrone, Steckel, Nemet, 2023; Zhang, Lu, Chen, 2023). At the same time, this was associated with a decline in relative hard coal production, so the potential for available resources was not associated with a proportional increase in production (absolute production values – which are not presented in the graph – indicate a decrease in the number of tons mined).

For lignite, the amount of economically recoverable resources relative to technically recoverable resources is steadily declining. Considering the low variability of the absolute amounts of technically recoverable resources presented in Figure 3, it can be concluded that the attractiveness and, consequently, the profitability of lignite mining is decreasing. Despite the above, production relative to resources has fluctuated, and in the period 2020-2022, an increase in production can be observed.

In the case of crude oil, the ratio of economically recoverable resources to technically recoverable resources is also in a downward trend in the period under analysis, while its production, also in a downward trend, was not proportional to the general decline in the profitability of extraction. This observation can be seen as evidence of a policy aimed at reducing import dependence. The study did not analyze the intensity of exploration and discovery of new resources, but the data indicate that this activity was conducted effectively. The relatively high level of extraction may be related to the high importance of this resource, despite the stagnant profitability of extraction.

Both natural gas and crude oil are characterized by a high ratio of resources whose extraction is profitable to those whose extraction is feasible – while in the case of hard coal and lignite, this level ranged between approximately 3% and 7.5%, in the case of natural gas and crude oil, it is between approximately 43% and 62%. In the case of natural gas, this measure indicates stabilization since 2019, with the level being lower before 2019. Natural gas production is on a downward trend, even considering the increasing profitability of this resource.

3. Household preferences towards mining investments and the state's energy policy – survey results

The category of mining investments may address several issues. The link between energy policy, in the sense of investment projects in the form of raw materials, and household preferences does not appear to be close. However, in the author's opinion, it can be assumed that existing beliefs and judgments held by households may reflect the rationale for the state's energy policy. Proof of this and the results of research conducted in this area will be the subject of the second part of the article.

The category of mining investments can refer to several issues. Mining investments and household preferences for them can be considered indirect investments, such as shares of mining companies or commodity futures contracts. This approach can be seen in the work of Pera (Pera, 2020). Another understanding of investing is the strategy adopted by a company engaged in mining activities. This approach can be found in the work of Zochorek (Zochorek, 2021). In a similar context, but at a higher level of generalization—that is, conducting a business that could potentially involve mining—this problem is described in the work of Kulczycka and Nowaczek (Kulczycka, Nowaczek, 2016).

This article adopts yet another perspective. Based on the assumption that the mining problem is not solely a matter of Poland's geological characteristics, nor merely a form of capital investment or a business concept. Instead, it is strongly linked to tradition and the labor market, and simultaneously to capital held by the State Treasury, it can be assumed that household preferences may be clear and that Polish society has a sense of responsibility and influence on the development of energy policy – for example, in the assessment of mining activities in Poland. Social conflicts over the access to raw material deposits in Poland can be found in Badera's work (Badera, 2010). This context is also highlighted in the discussion of the development of the lignite industry in Kasztelewicz, Ptak, Sikora work (Kasztelewicz, Ptak, Sikora, 2016). Mining and its development in the social and economic context of the global economy are described, for example, by Ranosz (Ranosz, 2014). As mentioned, the mining industry in Poland is strongly linked to the employment context, and the decarbonization process is considered a significant factor in the increase in unemployment, as can be read in the

report Decarbonization and employment in hard coal mining in Poland (Sokołowski et al., 2021).

Own research, conducted in the form of a survey addressed to adult household members, allowed us to determine household preferences regarding mining investments in Poland and the state's energy policy. The survey included questions on the following areas: values, knowledge of the state's energy policy, assessment of energy policy, preferences regarding the direction of energy policy development, and personal habits regarding household heat and electricity management.

In this article, in addition to the analysis conducted in the first part of the article, there will be described the results obtained from one part of the survey, which concerned the preferred shape of the state's energy policy. The questions asked were as follows:

1. As a taxpayer who finances energy policy, I support spending on phasing out non-renewable fuel mines while supporting the development of renewable energy sources.
2. As a taxpayer who finances energy policy, I support spending on phasing out non-renewable fuel mines regardless of the possibilities of obtaining energy from renewable sources.
3. As a taxpayer who finances energy policy, I support spending on supporting the operation of non-renewable fuel mines and increasing their number while supporting the production of energy from renewable sources.
4. As a taxpayer who finances energy policy I suport spending on supporting the operation of non-renewable fuel mines and increasing their number regardless of the development of opportunities to obtain energy from renewable sources.

All questions included suggested responses on a five-point Likert scale ("strongly agree", "agree", "neither agree nor disagree", "disagree", "strongly disagree"). The results were presented in graphs – figures 13 to 16.

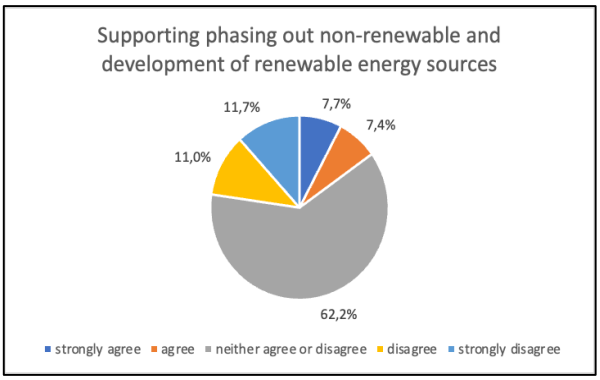

Figure 13. Supporting phasing out non-renewable and development of renewable energy sources.

Source: own study – based on survey results.

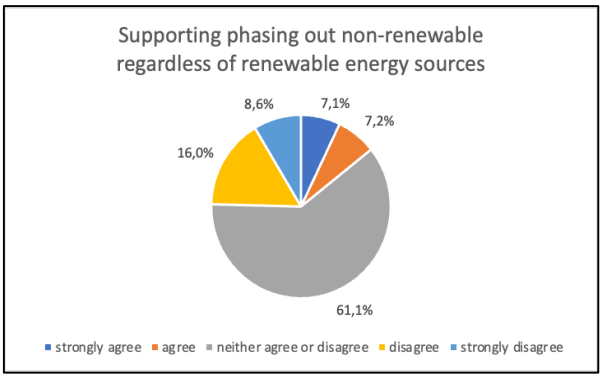

Figure 14. Supporting phasing out non-renewable regardless of renewable energy sources.

Source: own study – based on survey results.

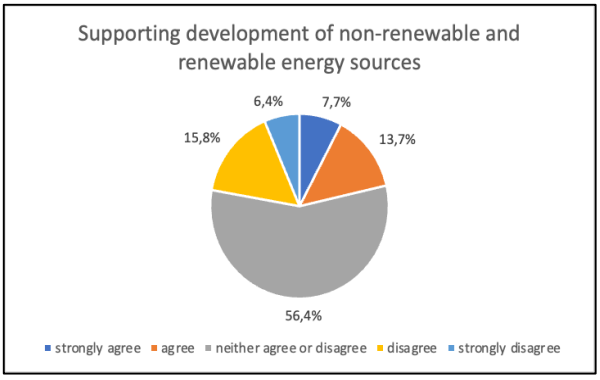

Figure 15. Supporting development of non-renewable and renewable energy sources.

Source: own study – based on survey results.

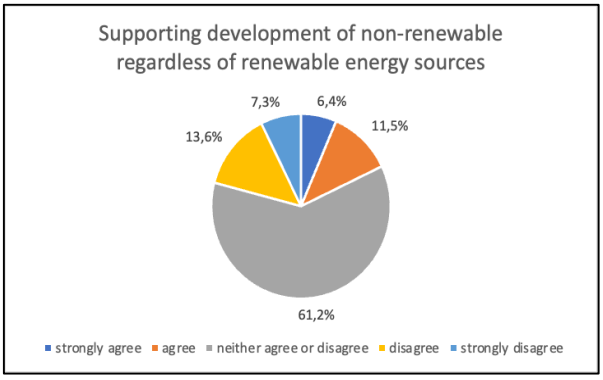

Figure 16. Supporting development of non-renewable regardless of renewable energy sources.

Source: own study – based on survey results.

The presented results allow for the construction of an intuitive model of preferences regarding the implementation and direction of national energy policy development. Analysis of the collected data can be translated into four household attitudes, which, along with the results, are presented in Table 1. It was assumed that the approval attitude would be determined by the sum of the "agree" and "strongly agree" responses, while the disapproval attitude would be determined by the sum of the "disagree" and "strongly disagree" responses.

Importantly, a potential drawback of the study and its conclusions may be the lack of a more precise definition of renewable energy sources in the survey. At the same time, the primary focus of the study was mining investments – their current status, development dynamics, and phase-out dynamics. The study's conclusions are therefore biased by an asymmetric examination of specific energy policy strategies based on the extraction and consumption of fossil fuels and ecological, renewable energy sources. Nevertheless, the author intends to conduct the missing research in the future and supplement the existing conclusions.

Table 1.

Types of energy policy and household preferences towards them

	non-renewable fuel mines renewable energy sources	non-renewable fuel mines renewable energy sources	non-renewable fuel mines renewable energy sources	non-renewable fuel mines renewable energy sources
agree and strongly agree	15,1%	14,3%	21,4%	17,9%
disagree and strongly disagree	22,7%	24,6%	22,2%	20,9%
neither agree nor disagree	62,2%	61,1%	56,4%	61,2%

KEY:	
	supporting development
	supporting reduction
	neutral

Source: own study – based on survey results.

The table presents the results of the responses, subordinated to four types of energy policy. In accordance with the structure of the questions and the actual possibilities of selecting energy sources in implementing energy policy, it was assumed that one of the cross-sections of this policy is a combination of non-renewable and renewable sources. Furthermore, it was determined (as indicated in the legend with markings) that three possible approaches can be distinguished: support for the development of the use of given energy sources, support for their abandonment, and a neutral stance. While the author is aware that defining only two stances would be easier in terms of scientific reasoning, after analyzing the literature and considering his own position on energy policy strategies, a neutral stance seems justified given the current trend towards the attractiveness of renewable energy sources. Therefore, in the final form of the study, it was possible to express approval or disapproval of non-renewable energy sources, and approval or indifference towards renewable energy sources.

Preliminary conclusions from the respondents' responses (N = 1000) indicate a high degree of indecision. Despite the large number of neutral responses, it can be seen that the most preferred energy policy for households would be simultaneous support for the development of energy production from both renewable and non-renewable sources. Furthermore, the least preferred solution would be to abandon non-renewable sources without developing energy production from renewable sources.

Such observations suggest that Polish society is sensitive to energy acquisition and its environmental impact. However, given the desired state of energy security (as defined from the perspective of final energy consumers at the beginning of this article), non-renewable sources are considered a factor stabilizing both energy availability and costs. Considering that the topic of decarbonization has been present in public discourse for a long time, and that Poland is simultaneously subject to European Union legislation, but also takes responsibility for Poland's abundance of energy resources (of course, there are also significant imports of energy resources), the preferred energy policy in Poland is balanced, and the cautious approach to energy transition reflects a strong concern for energy security.

4. Conclusions and discussion

This article presents two fundamental areas from the perspective of the research problem of energy policy. Firstly, the possibilities of conducting policy, i.e. the question of the resources at disposal, including objective possibilities (geological and technological conditions for fuel extraction and consumption) and subjective possibilities (economic conditions that will allow for the financially efficient exploitation of deposits and the subsequent use of resources for energy production). Second, in correspondence with the first part, which indicates the possibilities and changes analyzed over the last decade in the area of resources and extraction

of Poland's main energy resources, it identifies preferences regarding the selection of energy sources for the energy mix.

The first part of the study involved analyzing and drawing conclusions from data on the dynamics of the abundance and exploitation of energy resource deposits in Poland. Additionally, based on literature, the potential of Poland's energy resources was identified in light of the four pillars of the national energy policy. The structure of the energy resource balance, the dynamics of changes in the resources of deposits that were exploited and those that were abandoned, were considered. The issue of resources whose exploitation would be economically justified, along with the dynamics of change, was also examined, as well as the degree of extraction of deposits relative to potentially profitable deposits.

The second part presents the results of our own research, conducted using a questionnaire survey addressed to households across Poland. The survey results presented here outline household preferences for mining investments as a tool of the state's energy policy. The intensity of support for the development of renewable and non-renewable energy sources was determined.

Analyses of the state's energy policy, conducted in two contexts, led to the following conclusions:

1. Energy resources are a factor positively impacting the country's energy security.
2. Over the last decade, a decline in the share of non-renewable energy sources in the energy consumption structure has been observed.
3. During periods of economic or social crisis, increasing confidence in non-renewable energy sources can be observed.
4. The decarbonization process is likely not an absolute ambition, but it is sensitive to factors other than environmental factors, including national security.
5. Polish society is willing to invest in renewable energy sources and limit investments in non-renewable energy sources, but above all, out of a sense of energy security.

The study also identifies several areas requiring further development. The author believes it would be worthwhile to compare Poland's energy resources with those of other countries and analyze the volume of energy imports and exports, including energy resources. Secondly, the study should be supplemented with investments in technologies that reduce the negative environmental impacts of consuming fuels from non-renewable resources. Thirdly, in the area of household preferences, a separate analysis of preferences for specific forms of energy generation from renewable sources would be warranted. Fourthly, prospective resources and the trends in European Union energy policy should be considered to identify possible scenarios for the possibilities and legal conditions of energy policy in the future. Bearing in mind the weaknesses of the conducted research, the author plans to continue research on these issues.

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