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Opportunities and Threats for Polish Power Industry and for Polish Coal: A Case Study in Poland

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Abstract: This article analyses opportunities and threats for the Polish power industry resulting from the EU climate and energy policy. The main assumptions of the policy and directives resulting from it with regard to climate protection and the use of renewable energy sources (RES) in the production of electricity and heat are presented. The negative effects (threats) for Poland in meeting the EU requirements are discussed. The paper also discusses the opportunities for Polish coal, proposing solutions to meet EU directives and to maintain energy security without having to give up Polish coal. Reference is made as well to the plans to liquidate the Polish mining industry, indicating solutions opposing such actions.

Keywords: energy security; EU climate and energy policy; mining



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1. Introduction

The strategic objective of every state is to ensure a stable energy system and uninterrupted supply of electricity to consumers. This is undoubtedly one of the pillars of state security and stable economic development. The resulting energy security is defined as the state of the economy that allows for satisfying the current and perspective consumers' demand for fuels and energy, in a technically and economically justified way, while maintaining the requirements of environmental protection [1]. It should be mentioned that energy security is the amount of fuel consumption necessary to meet the consumers' needs and is not the same as energy generation by a given country. Energy security depends on many factors, the most important of which are [2]:

- The degree of balance between supply and demand for energy and fuels;
- Diversification of the structure of energy carriers making up the national fuel balance;
- The degree of diversification for supply sources;
- The technical condition and efficiency of equipment and installations;
- Fuel stocks;
- Economic conditions for the operation of power companies and their financial performance;
- The state of local energy security, i.e., the ability to meet power needs at local community level.

The consumption volume of energy carriers used by a given country depends on such factors as natural resources, economic structure, and state policy. The energy policy of a country should primarily be based on the rational use of domestic energy resources. This gives independence, economic stability, and security to the country. In the case of Poland, this security is provided only by hard coal and lignite. With insignificant resources of liquid and gaseous fuels in Poland and their significant importation, the process of “decarbonisation” would have to be accompanied by a significant increase in import of energy carriers and, thus, deterioration of energy security of the country, increase in foreign trade deficit and increase in unemployment [3]. It is important to diversify the directions of supply when purchasing raw materials from other countries, which will minimise the

adverse effects of a collapse of the energy system in the event of a possible break in the supply chain.

Restructuring programmes for the hard coal mining industry in Poland should relate to strategic, long-term assumptions of the national energy policy, and be based on the rational use of domestic energy resources. At present, Poland is an energy-secure country in terms of the generation of electricity and heat, in comparison to other EU countries. This security is ensured by coal, on which almost the entire power industry is based. The great significance of coal for the Polish economy results from the possession of large deposits of this raw material. Documented balance resources of hard coal deposits (as at 31 December 2020) amount to 64,422.38 million tonnes. Almost 71% of the Polish resource is thermal coal and approximately 28% is coking coal, while other types of coal constitute 1% of all coal resources. The resources of developed deposits currently account for 44.10% of the balance resources and amount to 28,409.26 million tonnes [4]. Hard coal, which is the most important energy carrier, accounts for 61% of the total energy generation. Another significant raw material is lignite with a share of 18%. Natural gas constitutes 5.4%, crude oil 1.8%, and other energy carriers, including, first of all, renewable energy sources, constitute 13.8% (Figure 1) [5].

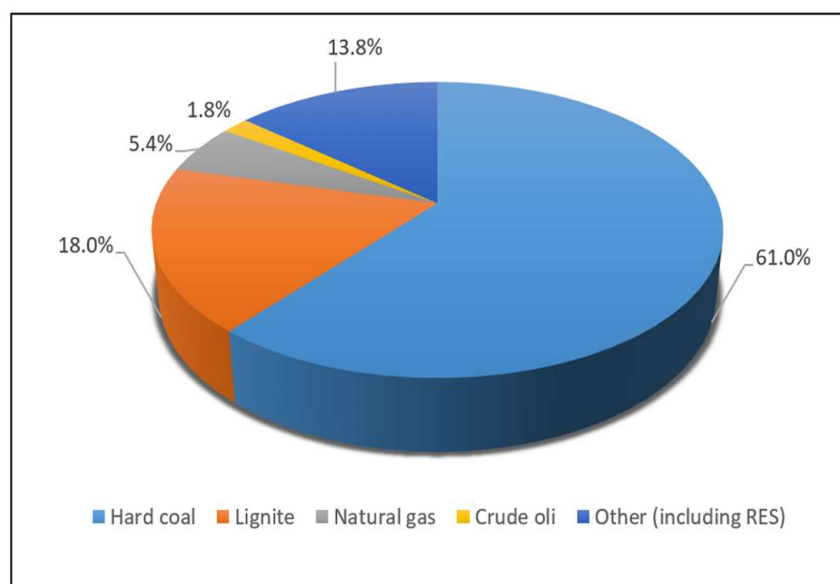


Figure 1. The percentage share of energy carriers in energy production in Poland.

It is obviously important to strengthen Poland's energy security in the area of gas and oil by diversifying not only the suppliers but also the directions of supply and the sources of these raw materials.

Table 1 shows the percentage share of energy carriers in the total energy production of individual EU countries. When analysing these data, one can notice high variability in the energy mix of the member states. A similar situation as in Poland, with the use of mainly coal in the energy sector, can be observed in the Czech Republic (62.16%) and Slovenia (42.83%). In other countries, oil, natural gas, and renewable energy are dominant. It is worth mentioning that although coal constitutes approximately 22% of the German energy mix, Germany is the largest producer and consumer of coal in Europe. Currently, in Germany, power generation from coal is higher than from gas for the first time since 2019. This was decisively influenced by high gas prices and lower costs of CO₂ emissions [6]. According to the adopted EU policy, all countries must give up coal. The Germans closed the underground mines two years ago, and the opencast mines will be closed by 2038 [7]. Poland plans to close the last mine in 2049 in line with the agreement of the government and the miners' trade unions (social contract).

Table 1. The energy mix of the EU Member States, source: own study based on [8].

EU-27 Countries	Solid Fossil Fuels and Peat	Oil and Oil Products	Natural Gas	Renewables	Other Fuels
	(%)	(%)	(%)	(%)	(%)
Belgium	1.37	0.33	66.83	18.29	13.17
Bulgaria	21.20	1.71	39.63	22.34	15.11
Czech Republic	62.16	0.77	12.49	23.03	1.56
Denmark	15.36	1.98	13.20	58.00	11.46
Germany	21.75	2.30	50.37	14.46	11.12
Estonia	4.63	0.00	0.01	90.91	4.44
Ireland	2.09	0.00	94.05	3.66	0.20
Greece	11.99	34.63	44.32	0.64	8.42
Spain	2.07	6.19	82.91	7.92	0.91
France	2.81	5.53	51.53	30.34	9.79
Croatia	1.29	4.80	73.74	20.16	0.02
Italy	3.05	8.07	65.70	16.82	6.36
Cyprus	0.00	5.98	0.00	94.02	0.00
Latvia	0.13	0.00	51.21	48.65	0.01
Lithuania	0.00	8.46	34.61	46.27	10.66
Luxembourg	0.00	0.00	37.32	62.61	0.07
Hungary	9.28	3.03	68.48	12.84	6.37
Malta	0.00	0.00	93.65	4.36	1.99
Netherlands	3.06	4.04	78.63	10.58	3.70
Austria	8.89	7.09	39.48	39.38	5.16
Poland	64.95	7.25	13.57	12.77	1.45
Portugal	0.00	7.23	48.27	44.03	0.47
Romania	22.41	1.97	69.21	6.25	0.16
Slovenia	42.83	0.08	33.19	21.68	2.23
Slovakia	38.05	12.10	30.81	14.31	4.74
Finland	21.39	0.51	9.22	65.11	3.77
Sweden	7.22	0.28	3.03	61.73	27.75

Category "Other Fuels" includes, amongst others, industrial waste and coal gases.

Europe's decarbonisation strategy is being successfully implemented, which can be seen in the decline in coal production in 2020 in most Member States (Figure 2). In the Netherlands, Greece, and Spain, there are strong moves towards a complete phase-out of coal, supported by the growth of wind and solar energy. It is followed by Romania (down 31%), Italy (down 24%), Bulgaria (22%), and Germany (22%). This translates into an approximately 7% reduction in greenhouse gas emissions in Europe. Currently, coal is the source of only 13% of Europe's electricity, and this figure must drop to almost zero by 2030 to achieve the EU's planned reduction in CO₂ emissions to 55% [9].

One-fifth of Europe's electricity was produced from renewable energy sources such as wind and solar in 2020. Wind provided 14% of Europe's electricity and solar 5%. The largest increases in wind and solar energy were recorded in the Netherlands (40%), Sweden (36%), and Belgium (28%) (Figure 3). There was almost no increase in wind and solar energy in Austria, Portugal, the Czech Republic, Italy, Romania, and Slovakia (no data in Figure 3) [9].

Each country's energy policy is strongly influenced by various aspects. Therefore, the author focused on the domestic energy sector. In the literature on the subject, numerous studies can be found, including scientific ones, on the energy policy of Poland in the context of the energy and climate policy of the European Union. The issues raised by the researchers, and in particular the indicated solutions to the problems noticed, often require re-evaluation, because in this research area a large variability of both internal and external conditions can be observed. Described here, among others, are the latest challenges in terms of CO₂ emissions by 2030, the epidemiological situation in the world, fluctuations in prices, and availability of raw materials on the markets, or the social program signed by

the Polish government regarding the closure of mines within two decades. For example, the author quoted a few selected scientific publications.

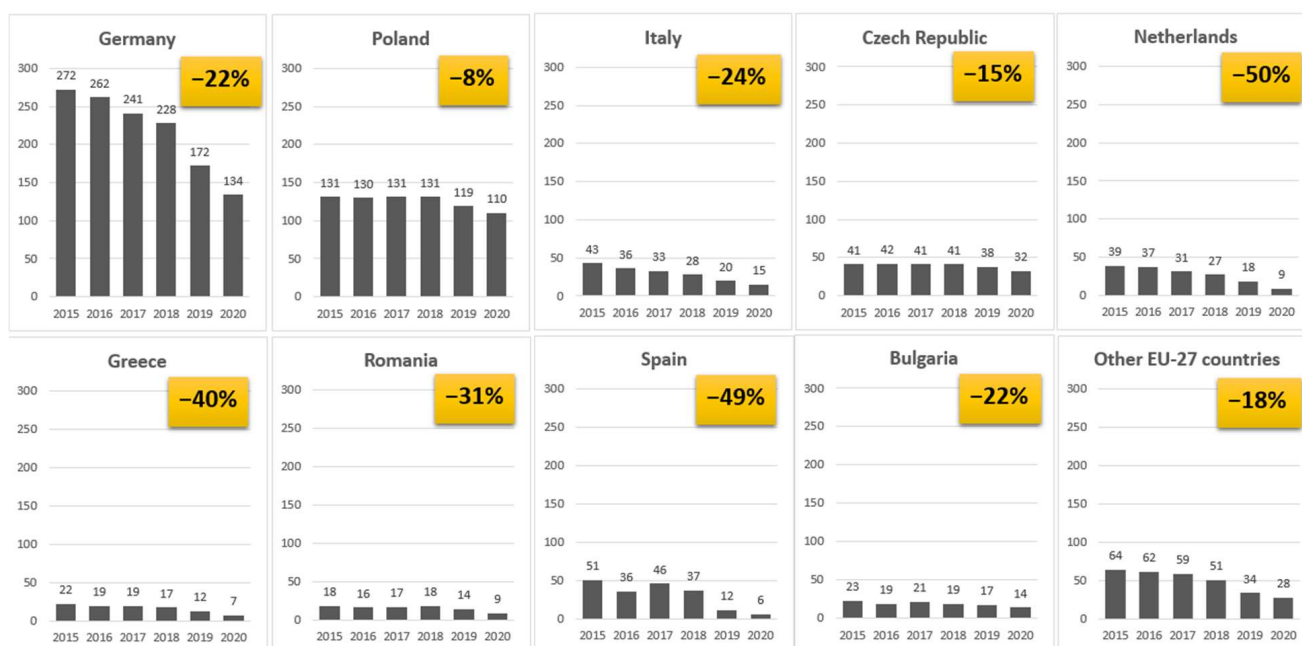


Figure 2. Hard coal and lignite generation, percentage change from 2019 to 2020, source: own study based on [9].

The analysis of the most important problems and challenges facing Poland in light of the necessary adjustments to achieve the priorities adopted by the EU was undertaken in [10]. The analysed research problem concerns the coal sector and the sector of renewable energy sources. The researcher believes that the role of the former should be significantly reduced in the coming decades, while the position of the latter should be significantly strengthened. A similar opinion is presented by the researcher in [11].

The study reported in [12] presents the results of various optimization scenarios for the future Polish energy system through 2050. The aim of the study was to demonstrate, using models, how the level of the applicable targets for the share of renewable energy (RES) in final energy consumption will affect the evolution of the Polish energy sector. In the article [13], the authors made a critical assessment of the directional changes planned by the Polish government in the area of new power for the energy sector, indicating the opportunities and threats in the area of its implementation. Moreover, they suggested that it is not possible to completely abandon coal in the next twenty years.

Another example is the publication [14], in which the author focuses on selected problems of Poland's energy policy, considering it in three aspects, namely: institutional and legal (tasks, model, and elements of energy policy), prognostic (scenarios of policy development are presented), and energy problems (energy dependence, energy monocultures, the level of development of renewable energy sources, emissions, and energy efficiency are presented). On the other hand, in the publication [15], the researchers conducted research aimed at determining the time lag in the development of renewable energy sources between the Visegrad Group (V4) countries and Germany, and identified the main factors behind the time delay, along with a proposal of research areas that could guide future research on these aspects.

Poland and the EU Member States face very ambitious challenges for the 2030 goals and the reduction of greenhouse gas emissions. In some countries, including Poland, it will be necessary to find ways to counterbalance the growing share of RES in conventional energy systems.

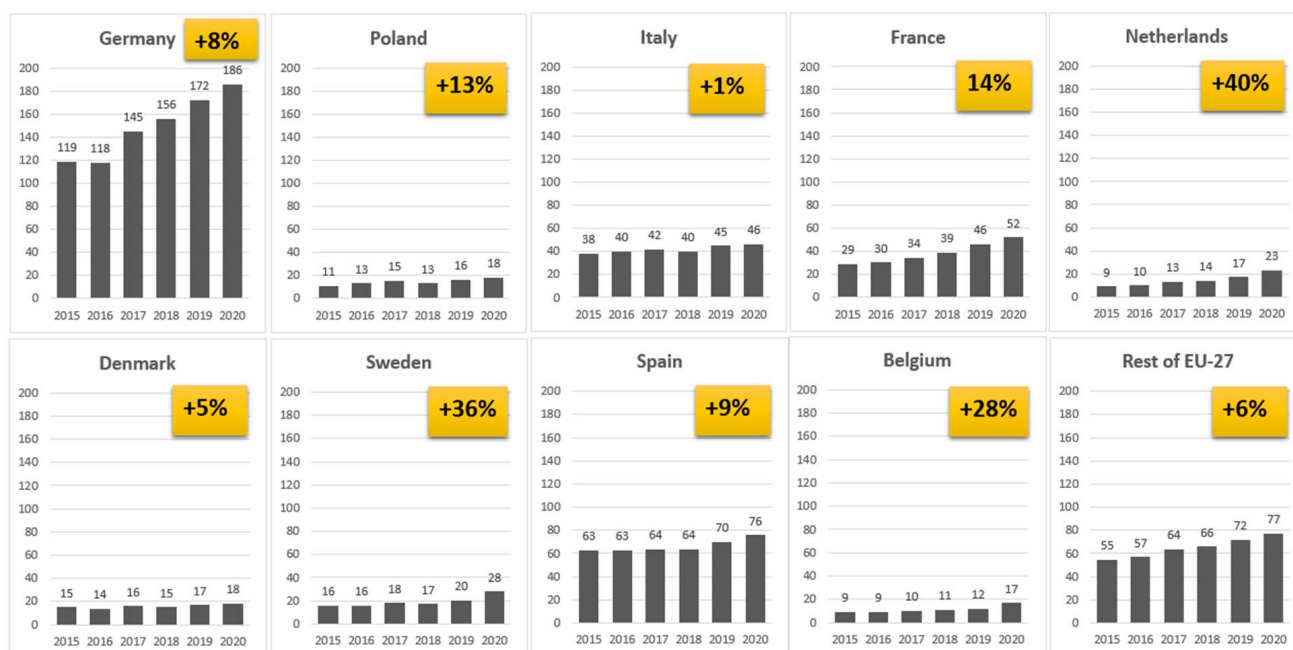


Figure 3. Wind and solar generation, percentage change from 2019 to 2020, source: own study based on [9].

This article refers to opportunities and threats for the Polish power industry and hard coal, which is its basic fuel. A number of solutions have been given, allowing Poland to meet the EU requirements and directives and, first of all, to remain an energy-safe country. It also refers to the plans to liquidate Polish mining industry, indicating solutions opposing such actions.

2. Materials and Methods

Taking into account the current situation of the energy sector and the mining industry in Poland against the background of the EU policy of decarbonisation of Europe, along with rigorous plans regarding CO₂ emissions, the author presented his own proposals for solutions. Some of the concepts presented were supported by references to literature. Scientific literature, analytical studies, and reports, together with government plans and strategies related to the issues discussed were analysed. Some of these studies needed updating. As an outcome, in the Results section, against the background of the specific threats to Polish coal and thus the energy industry, the directions of necessary changes in the energy policy are noted; areas and coal technologies requiring development are indicated so that both sectors have a chance to survive and a chance for smooth reorganisation.

3. Results

The Polish energy sector is based primarily on hard coal and lignite. A quick departure from coal toward the use of renewable energy sources would be very costly for Poland. The following part of the article presents the threats to the Polish energy sector posed by such a change and presents concepts of solutions that are an opportunity for the Polish mining industry, and above all for the energy security of Poland.

3.1. Threats to Polish Coal and Power Industry

The threat to Polish coal, and thus to the Polish power industry, arises from the European Union's policy of decarbonising the economies in the Member States. At the heart of this policy lies the plan to reduce greenhouse gas emissions by 80–95% by 2050 compared to 1990. By 2020, greenhouse gas emissions were to be reduced by 20%, and the figure will have reached 40% by 2030 (currently, the European Parliament is planning 55%). The European Directive on Emissions Trading (EU ETS), introduced within the framework

of this policy, aims at motivating energy producers and other industrial companies to switch from coal combustion to natural gas combustion, which emits almost half as much CO₂ as hard coal and lignite. Each Member State is allocated an individual limit on its carbon dioxide emissions and is allowed to trade these emissions within the European Union. However, the number of allowances will decrease by 1.7% each year and thus their price will rise. Currently, allowance prices have exceeded EUR 50/1 ton of CO₂, with prices below EUR 30 in December 2020 [16]. Companies will therefore have to invest in new technologies or simply trade emissions.

Another measure aimed at eliminating coal from the balance of energy consumption was the adoption of Directive 2009/28 called the “3 × 20” energy package [17]. Pursuant to this document, European Union Member States are obliged to achieve a 20% share of renewable energy sources (RES) in the total energy consumption balance. In the case of Poland, a level of 15% has been negotiated. It is worth emphasizing that the possibilities of using RES for energy generation by a given country are determined mainly by climatic conditions, natural conditions, the level of resources, and possibilities of obtaining them. Renewable energy sources include mainly solar energy, water energy, wind energy, biofuels, biogas, and liquid biofuels. The largest amount of renewable energy in the European Union is derived from solid biofuels (Figure 4), which account for 58.5% of all energy. The rest of the energy is provided by hydro power (12.2% of total energy), wind power (14%), solar power (6.7%), ambient heat (5.5%), and geothermal energy (3.1%) [18].

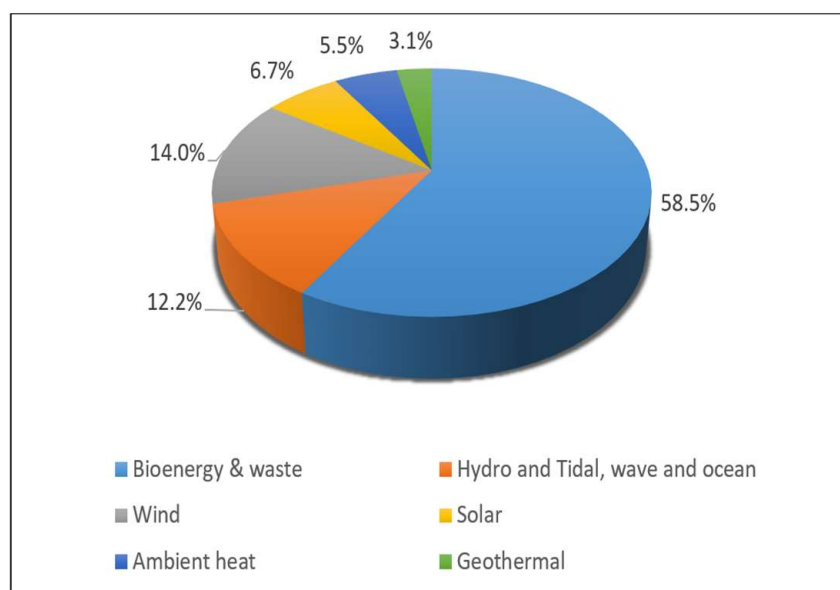


Figure 4. Renewable energy and biofuel production in EU in 2019.

In the energy balance of Poland, RES constitute about 11%. The percentage structure of acquired electricity for individual groups of power plants by fuel type in 2019 follows: commercial hard coal power plants 49.25%, commercial lignite power plants 26.14%, commercial gas power plants 7.62%, wind and renewable power plants 9.03%, industrial power plants 6.41%, and hydro power plants 1.55% (Figure 5) [19].

According to the data from the Energy Regulatory Office (ERO), at the end of 2019, total RES capacity reached around 9.11 GW. The largest contribution came from wind farms (almost 5.92 GW) and biomass installations (1.49 GW). The capacity of hydroelectric plants was 973 MW, biogas plants 245 MW, and solar energy reached almost 478 MW. This sector is currently undergoing intensive development, both in larger commercial farms and in domestic microinstallations, which are experiencing a market boom due to the possibility of obtaining subsidies [20].

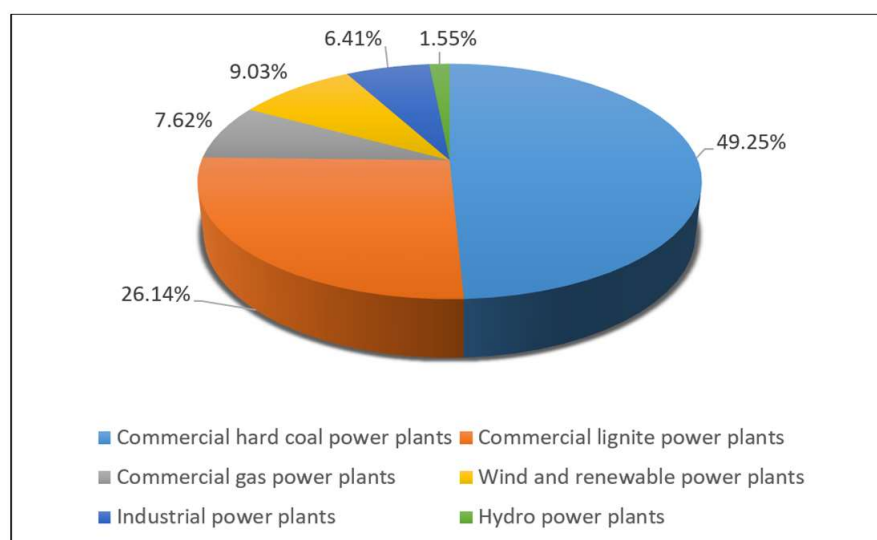


Figure 5. Renewable energy production in Poland in 2019.

According to the IEA (International Energy Agency), offshore wind farms have the greatest potential to meet electricity demand, being much more efficient than onshore wind and photovoltaic farms. High efficiency is achieved by using larger turbines and placing them far from shore. Floating turbines are now being considered, which will make even better use of wind resources. The IEA is of the opinion that it is wind energy, both onshore and offshore, that paves the way for full decarbonisation in EU countries [20].

As already noted, the power industry in Poland is based on more than 70% hard coal and lignite. It is indisputable that burning coal has a local impact on air quality. An excellent example of this may be the Małopolska or Silesia region, and such cities as Krakow and Katowice [21]. Unfortunately, in the near future, Poland will not be able to give up coal and switch to alternative low-emission technologies, so it will be forced to purchase allowances for carbon dioxide emissions into the atmosphere. Partial resignation from coal in favour of RES would probably entail disproportionately higher financial investment, because the change of technology and the structure of energy generation will have an impact on the increase of energy prices, prices of products in the whole economy, and, above all, on the deterioration of the living standard for citizens (energy poverty) [2,22]. This is the path that Poland has embarked on, as a social agreement between the government and miners' unions was signed on 28 May, which anticipates the phasing out of steam coal mines by 2049.

Another threat to the Polish coal industry includes competitive coal from South Africa, Australia, and Russia. Polish coal is losing out to these competitors due to the high cost of extraction compared to the price of imported coal. At present, world coal prices are approximately USD 142 per tonne, and this trend, or an upward trend, is likely to continue in the near future (Figure 6) [23]. Due to the depletion of oil and natural gas deposits and an increase in the prices of these raw materials, together with the fact that not all world economies are "moving away" from coal, it may be believed that coal's bad streak may change.

3.2. Opportunities for Polish Coal and Power Industry

In general, a scientific debate can be observed on whether human-generated CO₂ emissions cause climatic change. Many renowned scientists believe that climate changes result from natural cycles, which are independent of humans and their activities [24,25]. Two hundred seven countries are responsible for carbon dioxide emissions worldwide. EU countries account for about 11–12% of global CO₂ emissions. Almost 88% of CO₂ is emitted by countries that are outside EU structures, i.e., they will not be covered by the so-called "3 × 20" EU directive planned for 2020. In Europe, the most carbon dioxide is

emitted by Germany, which produces almost three times more CO₂ than Poland. The CO₂ problem has long been an object of political games in which environmental protection is only a tool to achieve particular economic goals [24]. The energy policy to date, both at the European and national level, has been excessively focused on climatic aspects, which has had a negative impact on achieving the basic objectives of energy security, energy independence, and affordable energy prices [2]. Apart from the aforementioned opinions, the following solutions are presented below, which will allow Poland, on the one hand, to meet the conditions of the EU Climate Package and to maintain the dominant position of coal in the economy, while bringing economic benefits and ensuring energy security to the country on the other.

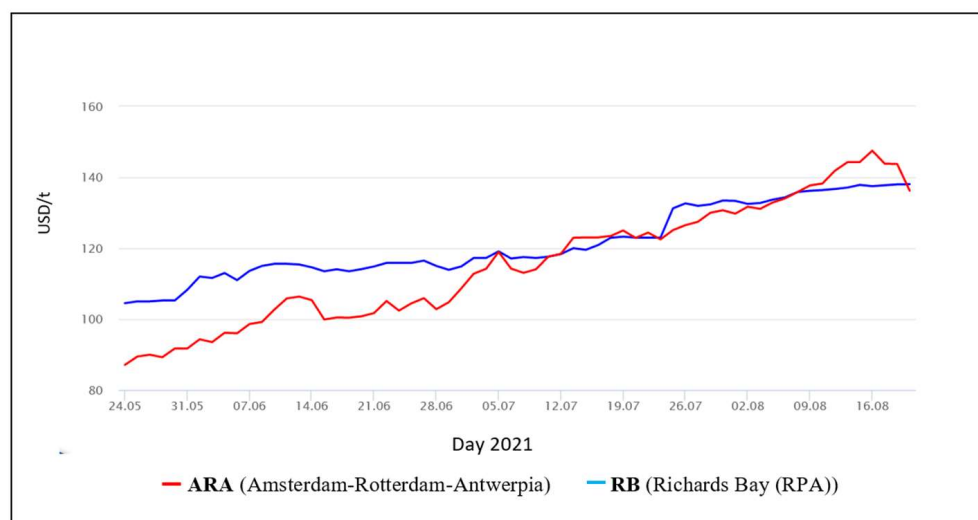


Figure 6. The evolution of coal prices in May–August 2021, source: own study based on [23].

One of the solutions enabling Poland to meet the requirements of the EU Climate Package is more effective use of biomass. Due to its natural conditions, Poland is unable to make full use of renewable solar, wind, or water energy. Strengthening Poland's energy security ought to commence with the use of RES locally, in every household, and especially in the regions of the country marked with electricity shortages. This would have an impact on the development of the regions, on maintaining energy independence, and, in the years to come, would bring effects in the form of lower cost energy together with new jobs [3].

A huge potential in the biomass sector, which should be used for the production of wood pellets and energy willow, is created by Poland's high forestation rate (almost 30% of the country's territory) and the possibility to use large agricultural areas for growing energy crops.

Wood pellets are mainly used for heating family houses. Its high efficiency as a source of renewable energy is due to its energy properties and its convenience for the user. It is considered an ecological fuel, as it balances the amount of carbon dioxide emitted during combustion with the amount of carbon dioxide absorbed by the tree during its growth. Additionally, its advantage is the small amount of ash that remains after its combustion [26]. Pellet production in Poland exceeds domestic consumption and a significant part of this raw material is exported to European countries (mainly Germany). It should be believed that its role in the structure of the energy consumption balance will increase once the coal boiler ban in 2022 enters into force and it will remain a sought-after product.

Besides pellets, another renewable energy source with high production potential is energy willow. Based on scientific research, the basket willow is qualified as a very good perennial renewable energy source. It is an ecological raw material easy to produce, has no special soil requirements, and is available throughout the country [27]. It is perfectly suitable for both energy and industrial applications. The possibility to use it already in the first year of cultivation makes the cultivation of basket willow highly profitable. According

to the estimates made by the Institute of Crops in Poland, as much as 900 thousand hectares can be allocated for energy crops, mainly for energy willow. Both arable and idle agricultural land should be used, for the cultivation of agricultural biomass is a better solution than forest biomass. The latter is limited in Poland.

However, increasing the use of biomass from both sources would enable Poland to increase the proportion of energy from renewable sources to 20% of total consumption and thus to meet EU requirements.

Another solution that would allow Poland to meet the requirements of the EU climate policy to reduce carbon dioxide emissions by the required 20 percent is to increase the acreage of our forests by about 3.4 percent [25], if only through the afforestation of idle agricultural land. It is conceivable that using biomass and increasing the forest acreage would have even greater effects, including improving climate conditions.

The EU's CAFE (Clean Air for Europe) directive, which sets limit values for concentrations of the so-called PM10 particulate matter (smoke), bans the use of coal-fired boilers after 2022. From the point of view of air quality protection, this policy is obviously the right one. It will definitely help to improve air quality in urban and industrial agglomerations. From the economic point of view, however, it is unfavourable for Poland, particularly for a large part of the population. First, it would require a transition to increased use of natural gas for heating purposes, the current domestic demand for which is practically met by imports. Increased gas imports entail increased costs of its acquisition and less use of coal, thus the necessity to reduce its extraction (this would entail additional losses in the coal industry). For some citizens who heat their homes with coal, changing their energy source is a considerable expense. It is true that there are government programmes to subsidise the replacement of heating boilers, but their effectiveness is unsatisfactory. A proposal to solve this problem is to increase the subsidy, in view of the fact that there are financial "penalties" for not meeting the requirements of the directive and for paying for CO₂ emission allowance packets. It is better to allocate the money to beneficial heat source replacements. Certainly, the LNG terminal built in Świnoujście and the Baltic Pipe gas pipeline, which is under construction, create a unique opportunity to increase energy security, not only for Poland, but also for this part of Europe. Owing to increased gas supplies resulting from diversification, it has been possible to reduce gas prices for individual consumers.

It is not, however, necessary to give up coal and incur huge costs for doing so. First, individual coal combustion in households must be eliminated in favour of commercial power generation only. This will make it possible to control CO₂ emissions. Poland is not in a position to give up coal-fired power generation in the short term; this takes time. The current net efficiency of the Polish coal-fired power industry is 33–34%. The construction of modern hard coal and lignite power units with an efficiency of 46% or more is another solution that will enable the generation of cheaper energy from domestic resources, will strengthen the country's energy security and in the future may constitute a reserve source of energy in emergency situations. This solution has been used for years in Germany (Moorburg, Lünen, and others). Each 10% increase in the efficiency of a power unit reduces CO₂ emissions by more than 20%. The change in the national coal-based power industry from the current one to a low-emission power industry (net efficiency of power units currently 46%, and 50% in the future) is also a strategic action in defence of the national coal and lignite mining industry [28].

In addition, new Polish technologies should be put forward and linked to this proposal. Powdered activators for the combustion of solid fuels can be used for applications in the power and heating industries. An example of such an activator is AnLen[®]. From a chemical point of view, AnLen[®] is a mixture of mineral substances of natural origin, mainly oxides and carbonates. It is a product based on natural ingredients and does not affect the environment in any way, including all living organisms. Owing to this technology, it is possible to reach complete incineration of fuel in the form of hard coal and brown coal, coke, firewood, and biomass (pellet, briquette, chips, etc.) and, above all, it is possible to make full use of the fuel's energy potential. More heat is produced from a fuel unit mass,

as the fuel is burnt over longer time and at a higher temperature, and, most important, smokeless combustion is carried out [29]. The cost of using solid fuel combustion activators is comparable to the cost of operation (maintenance and cleaning) for heating devices fired with traditional fuel, and which can be practically eliminated due to “clean” combustion.

Another solution may include the use of low-emission coal fuels, such as the so-called Blue Coal. On average, it emits at least several times less dust or volatile organic compounds than pea coal, while having a higher calorific value [30]. Initial estimates by the specialists from the Institute for Chemical Processing of Coal in Zabrze (the initiator and implementer of the project) determine the price of the new fuel to be 10–20 percent higher than the price of eco pea coal. One of the solutions to sell Blue Coal at the price of traditional coal could be to subsidise its production, for example, from the state budget. The cost of such a subsidy would be significantly less than the costs that have already been mentioned: restrictions on coal extraction, increased purchases of natural gas, and the purchase of CO₂ emission allowances. At present, only small quantities of Blue Coal are produced, which is why its price reaches high levels. An increase in production would make it possible to exploit economies of scale phenomenon and significantly reduce the cost of producing it.

A gradual departure from coal towards low-emission energy does not necessarily mean a reduction in coal mining, or abandonment of coal mining altogether. There is currently a decline in demand for coal in Poland and the EU, while the world demonstrates the opposite tendency. It is likely that the decline in coal use worldwide will be much slower than the transition to RES. The observed increase in the unit cost of coal mining in Poland is primarily the result of a decline in mining. Domestic demand for coal remains practically stable, and the output of Polish coal is falling because it is losing out to competing cheap foreign coal (South Africa, Australia), which is supplementing it. In other words, higher imports mean lower domestic output and, consequently, a higher unit cost for a tonne of coal. The policy of restructuring the Polish mining industry, which has been pursued since 1990 by Polish governments (and indeed by the World Bank), is aimed at winding down the industry. From being the fourth largest exporter of hard coal worldwide in 1984 (Poland’s share at that time was 14% of world exports), Poland has become an importer. Added to this is the social programme signed between the government and the trade unions, the aim of which is the liquidation of Polish mines by 2049.

Restructuring programmes for the Polish mining industry should be linked to energy policy, in strategic terms. The majority of industrialised countries in the world have long-term energy policies and the resulting fuel and energy balances with a time horizon of several decades. Adjustments are made to these long-term fuel and energy balances on an ongoing basis as a result of changing economic conditions on the domestic and global markets. Such measures should be introduced in our country. It is believed that without a long-term determination of demand for fuels and energy, evaluation of investment, exploitation, and social costs of their acquisition, along with internal and external conditions, it is impossible to undertake proper solutions guaranteeing energy security of the country on the one hand and optimal solutions from the economic point of view on the other [3].

The successive closure of mines will bring the potential into line with the demand, and thus may even lead to the profitability of the Polish coal industry. It is proposed that coal production should be increased by the amount of imported coal, which would have to be abandoned. This would reduce the cost of coal extraction. As a result, at a lower unit cost, the mines would be able to achieve profitability, and in some cases reduce the price of coal. The process of liquidating the Polish coal industry should be halted. The closure of mines is an abandonment of Poland’s wealth and constitutes an irreversible process. Coal is mainly perceived as a product to be burned only. This image needs to be altered, and instead of wasting it by closing the mines, it should be processed into expensive and sought-after products. After all, any product of modern organic chemistry can be obtained from hard coal. Processing some types of coal into coke yields coal products such as gas, tar, ammonia, and benzol. From these products, as a result of complex technological processes, many

different chemical products are obtained, such as aniline dyes, explosives, medicinal agents, aromatic agents, plastic compounds, artificial fertilisers, varnishes, cleaner fuels (synthetic petrol), synthetic fibres, and many other products of the chemical industry. Lignite is also of great economic importance and remains as valuable a chemical raw material as hard coal. Apart from fuel, it is also a precious raw material for electrode manufacturing, for the production of petrol, industrial oils, and plastic masses.

Under current market conditions, Poland should focus on processing relatively cheap coal into expensive semiproducts and products—specialised organic molecules that can be sold at high prices. Owing to them, Poland could be associated in the world with advanced chemistry. On the other hand, burning “clean” coal should take place only in power plants and combined heat and power plants, where apart from electricity, heat can also be obtained.

4. Discussion

According to the assumptions of Poland’s energy policy, coal will be gradually phased out as a source of energy production. This is mainly related to the EU’s climate and energy policy—decarbonisation of Europe. The decisions made regarding the closure of Polish mines by 2049 do not mean that coal-fired power plants will be decommissioned. The solution is to build a power plant with an efficiency of at least 45%, as is the case in Germany. The complete resignation from Poland’s coal will result in the necessity to import it in the future, because it is not possible to reorganise the energy sector in such a short time. On the other hand, instead of liquidating Polish mines, coal should be processed into products of modern organic chemistry. Such actions, as already mentioned, would allow for the reduction of the cost of coal exploitation, and thus increasing the profitability of the mining industry. Native coal would become competitive with imported coal. Wealth cannot be wasted. Although for the most part it is equated with combustion, unfortunately it is more than that. Gradual departure from coal as an energy carrier should be accompanied by all activities aimed at eliminating individual users in favour of commercial power engineering and the use of new coal technologies (Blue Coal, Anlen). However, from the economic point of view, it is unfavourable for Poland, especially for a large group of society. The transition of a large group of individual recipients to increased use of natural gas for heating (instead of coal) should be supported by government subsidies. Part of the funding would come from the reduced cost of fees for bundles of CO₂ emission allowances.

Emphasis should be placed on more effective use of biomass (wood pellets, energy willow), taking advantage of the large forestation of Poland and large areas of agricultural wasteland. It is, *inter alia*, an alternative to gas for individual consumers.

Natural gas is an alternative to coal. Unfortunately, the barrier to replacing coal with gas is the price of this gas compared to other energy carriers and the price of CO₂ emission allowances. The diversification of its supplies should also be taken care of, partly owing to the LNG terminal in Świnoujście and, in the future, the construction of the Baltic Pipe.

The use of renewable energy sources in Poland’s energy balance will undoubtedly increase. In the case of wind energy, problems can be observed in Poland with the restrictions on the location of wind farms [31] and the limitation of subsidies for energy production [32].

Photovoltaic installations are currently experiencing their prime. As a result of government subsidies, the prosumer sector is developing, but there are also large energy entities. A significant development of photovoltaics is expected to exceed 20 GW of installed capacity in 2040, which gives an 8.6% share in the electricity generation structure [13]. The construction of nuclear power plants remains in the government’s plans. The first nuclear unit with a capacity of approximately 1.5 GW is to be commissioned in 2033. Due to the fact that the Polish power industry is largely based on coal, it should be expected that electricity production will be based on coal for the next two decades. New energy technologies are to be characterised by a high technical level, efficiency, reliability, and minimal environmental impact [13]. Each increase in the unit’s efficiency by 10% reduces

CO₂ emissions by over 20%. The change of the domestic coal-fired energy from the current one to the low-emission energy is also a strategic action to defend the domestic coal mining industry.

5. Conclusions

It is in the interest of the state to have an effectively prosperous power industry, to make optimum use of the natural resources, and to ensure national energy security. For this reason, there should be no internal competition among economic entities in this strategic sector of the country, despite the fact that such conditions exist in the free market economy. Competition between mines or between their formalised groups (companies, holding, group) seems illogical, as they are state-owned enterprises—they belong to one owner. Coal (mines) cannot compete with itself. In other words, you cannot compete within your own assets. Competition only makes sense in relation to foreign coal (mines). This leads to a conclusion regarding the organisational model for the functioning of the mining industry. Managing the entire mining industry as a single enterprise creates greater opportunities for its profitability, and above all, for the profitability of individual mines. The independent operation of an unprofitable mine, or the one operating in a small group, will, under current market conditions, result in its liquidation. The closure of a company which is the main employer in a municipality or region is, in turn, associated with long-term social costs. Therefore, any decommissioning decision should be based on a criterion which includes the difference between the sum of the social and technical costs of a mine decommissioning and the losses incurred by unprofitable coal mining. Striving to meet the conditions of the EU climate package—replacing indigenous sources of energy (primarily coal) with costly renewable sources—takes time. The country's energy security, now and in the long term perspective, will be secured by Polish coal deposits. All measures should focus on its more effective exploitation and more environmentally friendly usage.

The abandonment of coal in Western European countries resulted from the replacement of this fuel with other indigenous energy carriers. For example, in Great Britain, coal was replaced by discovered oil and gas deposits, while in France, by uranium deposits and nuclear power plants.

Poland possesses mainly coal; therefore, it is absurd and enormously expensive to deliberately give up energy resources and base the country's energy security largely on imported fuels.

A country's concept of energy generation is determined not only by its economic development, but also by its geographical location and its abundance of energy resources. In the long term, coal will continue to be the basic raw material for power generation in Poland. It should not be abandoned, but Polish interests, including the maintenance of coal's dominant position, should be defended due to energy security and the welfare of the Polish economy. The solutions presented on the use of coal allow Poland not only to meet the requirements of the EU Climate Package but to achieve economic benefits as well.

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