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Poland's energy transformation in the context of the challenges of the European green deal

Transformacja energetyczna Polski w kontekście wyzwań Europejskiego Zielonego Ładu

Summary: One of the most important socio-economic challenges is the skilful transformation of the economy towards low and zero-emission energy sources. This transformation is ongoing, and Poland, due to its high dependence on coal and high emissions has a challenging task to perform. Hence, the article aims to indicate the activities undertaken by Poland as part of the energy transformation related to the European Green Deal and the impact of energy transformation on the Polish economy. Therefore, the issues discussed include: explaining the principles characterizing the European Green Deal programme, describing the current state of the Polish energy sector, indicating activities that will make Poland a zero-emissions nation, and highlighting the economic implications of this energy transformation at the national level.

The analysis shows that the transformation of the domestic energy sector is a long-term, ongoing process. The share of green energy in the national mix is systematically, albeit slowly, growing, and energy sector emissions show a downward trend, although in the current difficult energy situation in Europe, this trend may slow down. Moreover, for systemic and financial reasons it is not possible to quickly replace energy production from coal with other low or zero-emission energy carriers.

The study used a critical analysis of the literature and strategic documents on the energy sector, the institutional and legal method, the prognostic method, and inductive inference.

Keywords: energy security, energy transition, European Green Deal, climate and energy policy, Poland's energy strategy (PEP2040)

Streszczenie: Jednym z najważniejszych wyzwań społeczno-gospodarczych jest umiejętne przedstawienie gospodarki na źródła nisko- i zeroemisyjne. Transformacja energetyczna trwa, a Polska z uwagi na dużą zależność gos-

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podarki od węgla oraz wysoką emisyjność ma bardzo trudne zadanie do wykonania. Z tego też powodu celem artykułu jest wskazanie działań podejmowanych przez Polskę w ramach prowadzonej transformacji energetycznej związanej z Europejskim Zielonym Ładem oraz wpływu transformacji energetycznej na polską gospodarkę. W związku z tym do poruszanych zagadnień należą: wyjaśnienie zasad charakteryzujących strategię Europejski Zielony Ład, opisanie obecnego stanu polskiego sektora energetycznego, wskazanie działań, dzięki którym Polska osiągnie zeroemisyjność oraz wypunktowanie implikacji gospodarczych na płaszczyźnie krajowej, jakie niesie transformacja energetyczna.

Z analizy wynika, że transformacja krajowej energetyki jest procesem długotrwałym, lecz postępującym. Udział zielonej energii w krajowym miksie rośnie systematycznie, choć powoli; emisyjność sektora energetycznego wykazuje tendencje spadkowe, chociaż w obecnej trudnej sytuacji energetycznej w Europie niewykłuczone jest wyhamowanie tego trendu. Ponadto ze względów systemowych i finansowych nie jest możliwe szybkie zastąpienie produkcji energii z węgla innymi nisko- lub zeroemisyjnymi nośnikami energii. W badaniu posłużono się krytyczną analizą literatury i strategicznych dokumentów sektora energetycznego, metodą instytucjonalno-prawną, prognostyczną oraz wnioskowaniem indukcyjnym.

Słowa kluczowe: bezpieczeństwo energetyczne, transformacja energetyczna, Europejski Zielony Ład, polityka klimatyczno-energetyczna, strategia energetyczna Polski (PEP2040)

Introduction

Fundamental changes are taking place in the global energy system that will affect virtually all countries and have widespread geopolitical implications. Climate change is one of the greatest threats today and entails enormous social and economic risks. Climate warming is an undeniable fact. Scientific observations show an increase in global average air and ocean temperatures, melting snow and ice, and rising sea levels. Over the past 150 years there has been an increase in air temperature of 0.8°C globally and as much as 1°C in Europe alone, and recent years have been among the warmest on record according to global temperature measurements since 1850¹. Renewable energy sources (RES), as a result of technological progress and the decreasing costs of production of green energy devices, have become the centre of the global energy landscape.

The article aims to indicate the actions taken by Poland as part of the energy transformation related to the European Green Deal and

1 European Environment Agency, *Climate Change*, <https://www.eea.europa.eu/pl/themes/climate/about-climate-change> [22.04.2022].

the impact of this energy transformation on the Polish economy. In order to achieve this objective, it will be necessary to answer the following research questions:

- What is the essence of the strategy called the European Green Deal?
- What measures will Poland take to achieve zero emissions?
- What are the economic implications of this energy transition for Poland?

Answering the research questions required the application of several research methods. The analysis and critique of literature made it possible to deepen the knowledge in the area of the assumed research problem. The formulation of research problems was possible thanks to synthesis. The institutional-legal method was used to present the existing legal regulations related to the analysed phenomenon. The forecasting method was used to determine changes in the Polish economy which are taking place or will take place as a result of the energy transformation. Inductive reasoning was used to specify general conclusions.

Poland is the only country out of all members of the European Community that, at the June 2019 European Union summit, spoke negatively on achieving climate neutrality by 2050. After six months of negotiations, Poland withdrew its veto, but in the conclusions of the December 2019 EU summit, the principle was written that Poland will reach a zero-carbon economy at its own pace². Therefore, an in-depth analysis seems necessary to understand the background to this decision.

1. Europe's path from the Kyoto Protocol to the European Green Deal

The formation of an international agreement to combat climate change began with the entry into force of the treaty commonly referred to as the Kyoto Protocol in 2005. The treaty negotiated at the UN conference in Kyoto, Japan, in December 1997 obliged the signatories

2 T. Bielecki, *Poland agrees to EU climate acceleration*, Deutsche Welle, 11 December 2020, <https://www.dw.com/pl/klimat-polska-szczyt-ue-55proc/a-55909122> [25.04.2022].

(ca. 83 countries) to reduce greenhouse gas emissions by 5.2% annually between 2008 and 2012 in relation to 1990 levels. According to the assumption developed countries were obliged to reduce emissions through actions at the national level³. The protocol did not foresee any financial consequences for countries that do not meet their obligations after 2012, and the lack of serious economic sanctions resulted in some countries not complying with the provisions of the treaty. It should be noted that the treaty expired at the end of 2012, and the United States, China and India – the largest emitters of greenhouse gases – did not sign or ratified the document. In addition, the following countries withdrew from it: Russia, Canada and Japan. The Protocol's biggest supporters were the European Union as well as Australia and other Pacific countries threatened by ocean flooding as a result of climate change⁴. The Kyoto Treaty initiated changes in the climate and energy policies of many countries around the world, but it played a special role in the policies of the European Union, an excellent example of which are the two climate and energy packages adopted by the European Community in 2009 and 2014. The Kyoto Protocol can therefore be regarded as the international community's first step towards formalized action on climate stabilization.

The long-lasting process of shaping an international agreement on responding to climate change was crowned in 2015 in Paris, where the Climate Conference was held, during which 195 countries, its participants, adopted the Climate Agreement. These countries, including Poland, expressed their willingness to participate in a global action plan to protect the world from the threat of climate change by limiting global warming to less than 2°C (the average temperature is already 1°C higher than in the preindustrial era). These measures are necessary to prevent long-term and irreversible changes, including the loss of important ecosystems.

In order to implement measures to help the European Community achieve climate neutrality by 2050, the European Union has proposed a new growth strategy called the European Green Deal. It was

3 Kyoto Protocol to the UN Framework Convention on Climate Change, OJ 2005, no. 203.

4 S. Tokarski, J. Janikowski, *Kyoto Protocol – Poland ahead of Scandinavia in reducing emissions*, "Polska Energia Tauron" 2010, no. 4, pp. 18-19.

adopted by the European Commission in December 2019. Its goal is for the European Community to achieve net-zero greenhouse gas emissions over the next 30 years. It is worth adding that by 2030, gas emissions are to be reduced by 40% compared to 1990. The main assumptions of the new programme revolve around actions which are to bring the Union closer to the aforementioned climate neutrality. These include:

- Broad promotion of renewable technologies with simultaneous reduction of coal power plants, leading to the complete elimination of coal from the energy sector;
- Promoting thermo-modernization of buildings, and electric and gas heating, while reducing coal and oil heating;
- Supporting industrial innovation;
- Reductions in emissions of the energy sector;
- An electric offensive in the automotive industry, aiming at the complete elimination of fossil fuel cars.

The above-mentioned plan will lead to a profound social and economic transformation. As its creators assure us, it is to become a new strategy for economic growth for the EU through investments in green technologies, sustainable solutions, and new businesses. The success of the entire initiative requires the involvement of all EU Members States, hence it is important for the rich countries of the Community, which promote the process of energy transformation in Europe, to win over to their side the countries resisting transformation, such as Poland. The “Brussels Plan” envisages the mitigation of economic, financial, and social consequences of the departure from coal thanks to funding of EUR 100 billion, which is to come from the Fair Transformation Fund (FST)⁵. The Fair Transition Financial Mechanism consists of three pillars: the Just Transition Fund; a scheme under the Invest-EU programme; and a loan facility implemented by the European Investment Bank (EIB). The mechanism focuses on regions and sectors which will be most affected by the transition due to their dependence

5 The European Council, The Council of the Economic and Social Committee and the Committee of the Regions, *Announcement from the Commission to the European Parliament*, Brussels 2019, pp. 5-12.

on fossil fuels, mainly coal, but also where other hydrocarbons are extracted, e.g. peat in Ireland or oil from bituminous shale in Romania⁶.

The most reliable source of funding for energy transition in Europe is revenue from the sale of CO₂ mission allowances, which should be used for “green investments”. It is worth adding that, as a result of the post-2020 reform of the emissions trading system, two new instruments have been introduced to support poorer Member States. The first of these is the Modernisation Fund, which is intended to support a wide range of activities using RES, from investment in generation, use of energy from non-conventional sources, improvement of energy efficiency, energy storage, and modernization of energy networks, to support change in regions which are dependent on coal, so as to make it easier for workers to change jobs. The second instrument in the Emissions Trading System (ETS), the Solidarity Fund, is made up of 10% of all CO₂ emissions allowances monetized by the EIB. Money from this Fund can be used for energy transition in a broad sense⁷.

2. Characteristics of the energy sector in Poland

The Polish energy sector is one of the largest in the European Union and ranks in the top 10, taking into account the main macro-energy indicators. For this reason, it constitutes an important backbone of the Polish economy, generating over 8% of GDP, of which 4.1% comes from the energy sector alone and 4.2% from related sectors. Thus, it provides employment for almost 600 thousand people⁸.

The Polish energy sector entered the new decade mainly with regulatory challenges and expectations resulting from the energy and climate policy. For many years, Poland has been taking action to protect the climate by ratifying, among others, the UN Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, the Doha Amendment, and the Paris Agreement. The tangible result of Polish

6 M. Kołodziejcki, *Fundusz na rzecz Sprawiedliwej Transformacji*, March 2022, <https://www.europarl.europa.eu/factsheets/pl/sheet/214/fundusz-na-rzecz-sprawiedliwej-transformacji-fst> [25.04.2022].

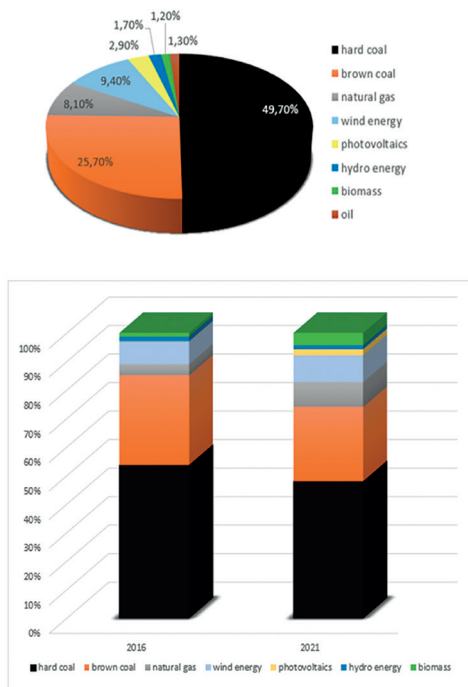
7 *Energy transformation: the Polish way to a low-carbon economy*, Biznes Alert, 21 November 2019, <https://biznesalert.pl/transformacja-energetyczna-energetyka-polska> [5.05.2022].

8 The Ministry of Energy, *National Energy and Climate Plan for 2021-2030*, 2019, p. 4.

actions in the field of climate protection is the reduction of greenhouse gas (GHG) emissions over the last 30 years by approximately 30%, and in the energy sector by 38%. It is worth noting that the emission reductions were made in a period of high economic growth, and the decrease in GHG emissions was one of the highest in the EU⁹. For the Polish power sector, ambitious targets for the reduction of harmful gases and dust are a significant challenge. This is mainly due to the dominant share of domestic energy resources in the energy mix, which include hard coal and lignite.

These fuels have ensured Poland's energy security for decades due to their available and, until recently, cheap and uninterrupted supply (Figure 1).

Figure 1. Structure of electricity generation sources in Poland in 2016 and 2021



Source: Own study based on: ARE S.A, *W 2021 udział mocy węglowych w krajowym miksie spadł do 58,5%*, are.waw.pl, 23 February 2022, <https://www.are.waw.pl/o-are/aktualnosci/w-2021-udzial-mocy-weglowych-w-krajowym-miksie-spadl-do-58-5> [15.09.2022].

9 Ibidem, p. 51.

The energy resources mining sector in Poland plays an important role both economically and socially, ensuring energy security and stability of production, and generating jobs. In 2019, hard coal mining employed 83.5 thousand people, which includes the staff of industrial plants and headquarters supporting the operations of coal companies¹⁰. In contrast, the lignite industry employed around 23.5 thousand people¹¹. Due to the large share of indigenous energy carriers in the national energy mix, Poland has an optimal energy import dependency ratio, which in 2020 amounted to 42.8%, compared to an EU average equal to 57.5%¹².

Decarbonization of the Polish economy is a huge challenge. The country does not have many rivers on which hydroelectric power stations could be built, and the number of hours of sunshine is 1,300-1,900 per year, which is half as much as in southern Europe¹³. Natural gas deposits are small and geopolitical factors make importing it on a sufficient scale a challenge. The Baltic Sea allows the development of offshore wind energy in the north of the country, but it is in the south that the most energy-intensive intensive industrial areas are found. Poland also does not have any nuclear power plants, unlike other EU countries from the former Eastern bloc. Despite the difficult conditions for starting the energy transition, Poland has taken steps to achieve zero emissions.

An important element influencing the security of the power system is the number and capacity of cross-border connections. As evidenced by the forecasts of Polskie Sieci Energetyczne (the Polish Energy Network), the demand for electricity in Poland will grow. In 2021, the demand for energy amounted to 117.3 TWh¹⁴, and 20 years later it will reach a 204.2 TWh net¹⁵.

10 J. Frankowski et al., *Employment in hard coal mining in the Upper Silesian Basin*, "IBS Research" 2020, no. 1, pp. 12, 14.

11 Z. Kasztelanowicz, *Raport o stanie branży węgla brunatnego w Polsce i w Niemczech wraz z diagnozą działań dla rozwoju tej branży w I połowie XXI wieku*, Cracow 2018, p. 41.

12 M. Lu, *The European Union's Energy dependency*, Visual Capitalist, 22 March 2022, <https://www.visualcapitalist.com/visualizing-the-eus-energy-dependency/> [17.04.2022].

13 G. Jastrzębska, *Odnawialne źródła energii i pojazdy proekologiczne*, Warsaw 2007, p. 89.

14 B. Derski, *Najwyższa w historii produkcja i zużycie energii*, Wysokie Napięcie, 15 January 2022, <https://wysokienapiecie.pl/44288-najwyzsza-w-historii-produkcja-zuzycie-energii/> [26.04.2022].

15 Polskie Sieci Energetyczne S.A., *Plan rozwoju w zakresie zaspokojenia obecnego i przyszłego zapotrzebowania na energię elektryczną na lata 2021-2030*, Konstancin-Jeziorna 2020, p. 18.

The importance of RES in meeting electricity demand will also gradually increase. There are more installations harnessing green energy sources every year. Recently, there has been an upward trend in the development of solar panels. This market is the fastest growing of all renewable energy sectors, which gives Poland fifth place in the EU ranking according to the increase in installed capacity¹⁶. It is worth adding that the Polish solar panel market is dominated by micro-installations, thanks to the high activity of individual and business prosumers. Next, in terms of the dynamics of development of RES, are biomass and biogas. An increase of as much as 20% in the co-combustion of biomass with coal is the result of the high price of CO₂ emission rights. Hydroelectric power plants, especially pumped storage plants which serve as energy storage, are also increasingly used¹⁷.

Natural gas is also an important energy carrier in Poland. Although, as already mentioned, Poland does not have its own large resources of this raw material, an increase in its consumption has been noticeable for a decade (21.6 billion m³ in 2020)¹⁸. In recent years, many investments have been made that have improved the state's security in the gas sector. The basic tools of the energy policy of the Polish government in relation to the gas sector are those aimed at improving the operation of the gas market, including support for the wholesale gas market through diversification of supply directions and regionalization of the gas market through the development of cross-border connections.

3. Zero Climate emissions **– European theory and Polish practice**

In recent years, a new framework for European climate and energy policy has been created, including actions aimed at achieving zero emissions on the continent by the middle of the 21st century. In January 2021, the Polish government adopted Poland's Energy Policy

¹⁶ IE, *Photovoltaic market in Poland 2020*, 2020, p. 5.

¹⁷ B. Derski, *Źródła energii w Polsce w 2020: mniej węgla, więcej gazu i OZE*, Wysokie Napięcie, 12 February 2021, <https://wysokienapiecie.pl/35619-zrodla-energii-w-polsce-w-2020-mniej-węgla-wiecej-gazu-oze/> [5.05.2022].

¹⁸ BP, *BP Statistical Review of World Energy*, 2021, p. 40.

2040 (PEP 2040). It shows that energy transformation in Poland will be implemented based on eight specific objectives:

1. Optimal use of national energy resources;
2. Development of production infrastructure;
3. Diversification of supplies and expansion of the network infrastructure of natural gas, crude oil, and liquid fuels;
4. Development of energy markets;
5. Implementation of nuclear energy;
6. RES development;
7. Development of heating and cogeneration;
8. Improving energy efficiency¹⁹.

At the beginning of the energy transformation process, Poland had one of the most difficult starting points from which to begin this process. The traditional dependence on fossil fuels and strong political support for the extraction sector put the country at odds with the standards and obligations generated by the EU political system.

A significant problem for Poland is to meet the projected increase in demand for electricity and power, which requires the development of new energy generation facilities. In accordance with the provisions of PEP 2040, the change in the current fuel structure will take place gradually. By 2040, a dozen or so generation units with a capacity of approximately 26.5 GW will be permanently withdrawn from service, mainly obsolete coal-fired power plants, which will be replaced by new units operating on hard coal (4.4 GW by 2025). According to forecasts, there will also be a development of green energy sources, a significant increase in the capacity of gas/steam power plants (approximately 2 GW of capacity by 2040), and in 2033, the implementation of nuclear energy is planned (three units with a total capacity of 4.5 GW). It is worth noting that the production of energy from hard coal will remain stable (decreasing by 2040 by approx. 11.5 TWh) and hard coal-fired generating units will remain a significant producer of electricity in the country. This will be largely due to the recently commissioned new power plants in Kozienice, Opole, and Jaworzno. In the case of lignite, existing power units are expected to be decommissioned. This is due to the fact that lignite-based power plants will

19 Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski 2040*, Warsaw 2021, p. 5.

have been replaced by nuclear energy, but there is a risk of a threat to the country's energy security if the nuclear project is delayed or withdrawn. In the heating subsector on the other hand, the role of coal-fired heat and power plants will diminish, as they will be replaced by new gas-fired cogeneration units²⁰.

Ensuring Poland's energy security in the coming years will not be possible without gas, as it is gas that will fill the gap left by the gradual withdrawal of coal from the energy mix. Thanks to intensive diversification efforts initiated over 15 years ago, Poland could have decided to end its long-standing cooperation with Russia and withdraw from a gas contract with Gazprom at the end of 2022, after the Yamal contract expires. However, the move away from Russian energy resources was accelerated by the war in Ukraine. Since the commissioning of the Swinoujście LNG terminal in 2015, imports from Russia have steadily declined and Poland has taken deliveries from new exporters, which include: Qatar, Norway, and the USA. In 2020, imports of liquefied gas already amounted to 3.76 bcm after regasification and are increasing every year²¹. Thanks to contracts for the purchase of LNG from the USA in the years 2024-2042, Polish networks will receive 9.3 bcm of gas after regasification (along with contracts for LNG supplies from three gasification terminals under construction in the USA). It is worth mentioning that the import plans are promising: apart from increased supplies from the USA, Poland is to receive 2.7 bcm from Qatar (contract with Qatargas valid until 2034), some 2.5 bcm is to come from PGNiG's own production on the Norwegian Continental Shelf, and the whole is to be supplemented by imports via the Baltic Pipe pipeline, which will enable the transmission of gas from Norway to Poland and Denmark, as well as to final customers in neighbouring countries. Deliveries will commence in October 2022. The expansion of the Polish gas portfolio will be made possible by increasing the capacity of the LNG terminal in Swinoujście from 5 to 7.5 bcm of gas per year and by the construction of a floating regasification terminal (FSRU) in the port of Gdansk with a capacity

20 The Ministry of Energy, *Draft Conclusions from forecast analyses for the fuel and energy sector – appendix 2. to PEP 2040*, 2019, pp. 19-20, 22.

21 PGNiG, *Sprawozdanie Zarządu z działalności PGNiG SA oraz GK PGNiG na 2020 rok*, 2020, p. 22.

of at least 4.5 bcm per year²². Due to the size constraints, such a terminal cannot handle the largest Q-Flex or Q-Max type gas carriers holding 200 thousand m³ of LNG. The unit is to commence operation in 2024 or 2025²³. The condition for closing the Polish gas balance in the above shape, which does not include deliveries from Russia, will be the timely commissioning of the Baltic Pipe, the launch of gasification terminals in the USA, and the launch of the first Polish FSRU.

RES will become an important energy source in the coming decades. According to Polish government forecasts, it will be possible to achieve a 21-23% share of RES in gross final energy consumption by 2030. This goal will be achieved by increasing the use of green sources in three subsectors (power engineering, heat engineering, and transport). The largest share of zero-emission technologies in energy generation will be in the electricity subsector, with 32% in 2030 and nearly 40% ten years later. Contributing to this growth will be the use of wind energy, which will continue to dominate all green energy sources. A positive impulse to support the development of wind energy in Poland will be provided by an act regulating the construction of offshore wind farms in the Baltic Sea (the so-called Offshore Act), whose draft was published in mid-January 2021. The solutions and support mechanisms, including the tasks of electricity system operators, are to constitute measures already applied in other RES. The act introduces new obligations on investors to stimulate the development of the local supply chain to activate the regions in which wind farms are built and to effectively utilize the Polish industry providing equipment and services for the construction of offshore wind farms. Such a solution has worked well in many Western countries, for example in France and in the UK. At present, almost 100 Polish companies have the know-how and technology to produce the structural and operational elements necessary for the construction of offshore wind farms, and Poland has a chance to become a hub for offshore technology development in the southern part of the Baltic Sea basin, according to the authors of the aforementioned act²⁴.

22 M. Ruszel, *The significance of the Baltic Sea Region for natural gas supplies to the V4 countries*, "Energy Policy" 2020, vol. 146, pp. 4,7.

23 R. Miętiewicz, *FSRU terminal on the Gdańsk coast – próba analizy*, "Analiza IPE" 2019, no. 1, p. 10.

24 K. Zalewska-Wojtuś, P. Kałek, *Amendment of the Energy Law*, "Energią Elektryczną" 2020, no. 1, p. 16.

In the near future, the Polish energy sector is to expand into yet another subsector: nuclear energy. For more than a decade, the governments have been discussing a return to the concept of building a nuclear power plant. Recently, the discourse of reviving the nuclear programme has been visible in official documents issued by the Polish government. According to the assumptions of the Polish Nuclear Power Programme of 2020, two power plants with three nuclear reactors of the III and III+ generations, each with a total capacity of 6 to 9 GWe, are to be built in Poland. In 2022, a final decision will be taken on the location of the first nuclear power plant, and four years later construction of the first power plant will begin, with commissioning scheduled for 2034. Ten years later, the second nuclear power plant is due to be commissioned. SMR (small modular reactor) technology has recently attracted increasing interest from both state and private enterprises. This innovative technology is the cure for the lack of power generation capacity. Its extraordinary advantage is that it takes less time to build and costs less than traditional nuclear units²⁵. Poland's government believes that if Poland is to remain competitive in the global market for goods and services, it must introduce the atom into its energy sector, especially in view of the withdrawal of coal from the energy mix.

All activities undertaken as part of the energy transformation are aimed at creating a circular economy. The biggest challenge in the transformation process is the decarbonization of the economy. In 2021, greenhouse gas emissions in Poland amounted to 145.68 million tonnes of CO₂ equivalent (without taking into account data on fuel consumption by cars and household emissions)²⁶. In Poland, emissions from the energy sector dominate the total figure and amounted to 35% in 2021 (fig. 2). A decrease in CO₂ emissions in the Polish energy sector is visible but too slow. The first decade of the 21st century was overslept in this respect. In recent years, there have been no decisive

25 R. Budnitsa, H. Rogner, A. Shihab-Eldinc, *Expansion of nuclear power technology to new countries – SMRs, safety culture issues, and the need for an improved international safety regime*, "Energy Policy" 2018, vol. 19, p. 536.

26 J. Frączyk, *Polska gospodarka ostro ściegła emisję CO₂. Osiem krajów za nami, w tym Niemcy i Czechy*, Business Insider, 20 June 2022, <https://businessinsider.com.pl/gospodarka/emisja-co2-ostro-w-dol-osiem-krajow-za-nami-w-tym-niemcy-i-czechy/djj4lcf> [19.09.2022].

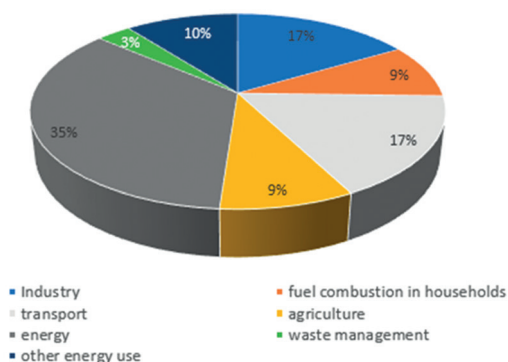
decisions to switch the energy sector to renewable sources. Poland has become the leader of the infamous ranking of the largest CO₂ emitters in Europe, even though the country has experienced a huge increase in solar panel capacity. The growing emissions in the power industry are the result of the increase in production of electricity from coal resulting from a growing demand for Polish electricity in the country and abroad; electricity produced from coal was competitive in terms of gas prices²⁷. To reduce emissions of pollutants from the energy sector, low-efficiency generating units will be gradually phased out and replaced with higher-efficiency power units (including cogeneration units). By 2040, an almost entirely new power system will be built, the strong foundation of which will be low and zero-emission sources.

In the heating subsector, the share of green energy will increase by 1.1%, mainly due to the use of biomass, which has the greatest potential here. The energetic use of biomass enables better waste management, while thanks to biogas energy, it is possible to manage particularly onerous waste (e.g. landfill or animal waste). In addition, buildings should be connected to heating networks where old coal-fired boilers are replaced with new ones fuelled by biomass and gas-fired cogeneration sources. Thanks to these measures, Poland has the opportunity to reduce greenhouse gas emissions in this sector by approximately 40% over the next 10 years and thus meet its European commitment to reduce emissions²⁸.

Transport is the next sector of the economy in terms of emissions. Currently, transport is responsible for 17% of emissions, and this figure has increased dramatically over recent years. The best solution is to use electromobility on a large scale. What is needed is not only the promotion of zero-emission vehicles, but above all the expansion of battery charging stations and the switch of urban transport to new propulsion technologies. At the same time, imports of high-emission second-hand cars should be reduced. All these measures will improve air quality, particularly in large conurbations, and give a boost

27 B. Sawicki, *Znaczący wzrost emisji CO₂ w Polsce. Winny eksport prądu*, energia.rp.pl, 18 May 2022, <https://energia.rp.pl/co2/art36322571-znaczący-wzrost-emisji-co2-w-polsce-winnny-eksport-pradu> [19.09.2022].

28 J. Rączka, *Transformation of district heating 2030: Small district heating systems*, Energy Forum, 2017, p. 29.

Figure 2. Greenhouse gas emissions by sector in Poland in 2021

Source: Own study based on: Forum Energii, *Transformacja energetyczna w Polsce*, 2022, p. 25.

to the domestic automotive sector through the production of electric or hydrogen buses. It can be provisionally estimated that in 8-10 years, the Polish transport sector will have reduced its dependence on oil prices and that Poland will therefore have a chance to reduce its transport emissions by 46% by 2030. So far, only a 13% reduction has been achieved, with 1990 as the base year²⁹.

Industry is an equally high-emission sector of the economy has emissions on a par with transport. Transformation of production processes must include digitization and the reduction of CO₂ emissions. The reduction of emissions in industry will be based primarily on changing production processes and replacing currently used technologies with zero-emission technologies (e.g. through electrification and decarbonized hydrogen), as well as increasing energy efficiency. For the competitiveness of production in Poland, it will be crucial to ensure an adequate amount of clean energy is available. This will allow industry to reduce its cost, but also reduce the emission intensity of production. The higher the share of RES in the production of electricity, the lower the emissions of industry. Thus, the emissions footprint of the energy sector has a significant impact on the emissions footprints of other sectors of the economy³⁰.

29 A. Gawlikowska-Fyk, M. Borkowski, *How Poland can achieve increased greenhouse gas emission reduction targets by 2030*, Energy Forum, 2020, p. 16.

30 K. Bocian, W. Lewandowski, P. Wróbel, *Zielone koło ratunkowe. Dostęp do czystej energii warunkiem konkurencyjności polskiego przemysłu*, Warsaw 2022, pp. 5,7.

The above-mentioned measures will make it possible to achieve the main goal of Poland's energy policy, which is to ensure energy security while ensuring the competitiveness of the economy and energy efficiency and reducing the impact of the energy sector on the natural environment, with the optimal use of the country's own energy resources³¹.

4. Consequences of energy transformation for the Polish economy

Energy transformation is the greatest challenge the Polish economy has faced in this century. The conditions of the energy transformation in Poland are very specific. Poland has the largest number of mining regions of all the EU Member States, which significantly hinders the process. Wages in the energy sector are above the national average and there is also the strong position of trade unions, which translates into a stronger bargaining position with the government than in other industries and ultimately influences the country's energy strategy. The unsuccessful restructuring of mines in Bytom and Wałbrzych in the 1990s is still deeply rooted in the memory of Silesian society³². The closure of coal mines and coal-fired power plants is linked to employment restructuring, which is why a balanced approach to this process is essential, as is the gradual closure of individual mining or manufacturing units. Without massive financial support from the European Union, the current energy transformation will share the fate of the unsuccessful actions of the period of political transition. U decision-makers see energy transition as a developmental stimulus, including for Poland. Over the next 20 years, investments related to changes in the fuel structure will amount to some PLN 400 billion, while the GDP growth resulting from these investments will be approximately 75-80% of that amount, i.e. PLN 280-300 billion³³. Moreover, Poland is to receive around EUR 4.4 billion from the Fair Transformation Fund (FTF) and the Cohesion Policy Fund, which will be al-

31 Ministerstwo Klimatu i Środowiska, op. cit., p. 10.

32 H. Brauers, P.-Y. Oei, *The political economy of coal in Poland: Drivers and barriers for a shift away from fossil fuels*, "Energy Policy" 2020, vol. 144, p. 1.

33 M. Lachowicz, M. Gacki, K. Moskwik, *Paliwa i motory wzrostu gospodarczego*, Warsaw 2020, p. 54.

located to three Polish regions (Silesian, Lower Silesia, and Greater Poland) requiring compensation for the social, economic, and environmental effects of energy transformation. It is worth noting that more than half of these funds will go to the Silesia region, where the local economy is heavily dependent on the mining sector, which directly employs 78,000 people, almost half of all miners in the EU. EU support will also go to three other regions which were not on the European Commission's list of areas approved for support under the FTF: Lublin Province, Lesser Poland, and Lodz Province³⁴. The money will be used for diversification of enterprises, job creation and raising or changing qualifications of the local population, counteracting depopulation of mining areas and spurring their revitalization³⁵.

In this context, an important social effect resulting from the transformation of the energy system is the depopulation of Silesia, the largest mining region in Poland. The departure from coal is already a foregone conclusion, hence the situation of the people living in this region, employed on a large scale in the mining and connected industries, will depend on the transformation of the region and the above-mentioned funds.

Poland is delayed in the process of energy transformation by several years compared to the countries of Western Europe. For example, in the field of RES development in relation to Germany, this delay is approximately 11 years (as of 2019), calculated according to the time delay method, taking into account the dynamics of phenomena and their variability over time³⁶. The consequences of the delay are already visible in Poland, their greatest manifestation is the rising electricity prices (Map 1). The increase in prices is due to increased EU climate action, the effect of which is higher prices of greenhouse gas emission allowances. The EU plans to deepen the reduction of CO₂ emissions by 2030 in relation to 1990 by 55%, instead of the previously

34 *Dowiedz się więcej o Funduszach Europejskich*, Portal Funduszy Europejskich, 4 June 2021, <https://www.funduszeuropejskie.gov.pl/strony/o-funduszach/fundusze-na-lata-2021-2027/dowiedz-sie-wiecej-o-funduszach-europejskich-na-lata-2021-2027/> [20.04.2022].

35 European Commission, *Commission Staff Working Document Country Report – Poland 2020*, Brussels 2020, p. 56.

36 K. Książopolski, G. Maśloch, *Time Delay Approach to Renewable Energy in the Visegrad Group*, "Energies" 2021, vol. 14, pp. 6, 9.

approved 40%³⁷. The increase in electricity prices is most noticeable in energy-intensive industries, i.e. in the cement, textile, food, and paper industries, as well as in metallurgy and rail transport. In the near future, this will reduce the competitiveness of these industries. On the other hand, at the level of enterprises or local governments, energy is an important component of the costs incurred, and an increase in its price may eliminate the competitiveness of certain industries. Ultimately, this can lead to instability in livelihoods and affect social and political stability³⁸.

The development of RES, as required by the EU's European Green Deal strategy, is necessary in the energy transition process, but it is not only due to support mechanisms offered by the government; its growth is correlated with the legal environment and the changes in electricity prices, which until recently discouraged investment rather than providing a significant incentive³⁹. It is worth adding that the wholesale price of energy in Poland is coupled to the price of hard coal, which accounts for 50% of energy produced in our country. Since 2019, coal mined from domestic deposits has become more expensive than imported coal, although for many years the reverse was true. The declining profitability of the coal sector in Poland does not bode well for a reduction in the price of domestic coal, so that it will be as attractively priced as imported coal, in the near future⁴⁰. For several years, Polish imports of electricity have also been on the rise, amounting to 10 TWh in 2021 and costing 3 billion PLN⁴¹. Electricity supplied to Poland as part of cross-border trade came from the Czech Republic, Germany, Sweden, Slovakia, and Ukraine⁴². Electricity imports are becoming necessary, as without them there would be problems with closing the national energy balance. Due to a higher demand for

37 M. Robaina, A. Neves, *Complete decomposition analysis of CO₂ emissions intensity in the transport sector in Europe*, "Research in Transportation Economics" 2021, vol. 90, p. 1.

38 E. Kochanek, *Evaluation of Energy Transition Scenarios in Poland*, "Energies" 2021, vol. 14(19), p. 11.

39 F. Landis, P. Heindl, *Renewable Energy Targets in the Context of the EU ETS: Whom do They Benefit Exactly*, "Discussion Paper" 2016, no. 16, p. 5.

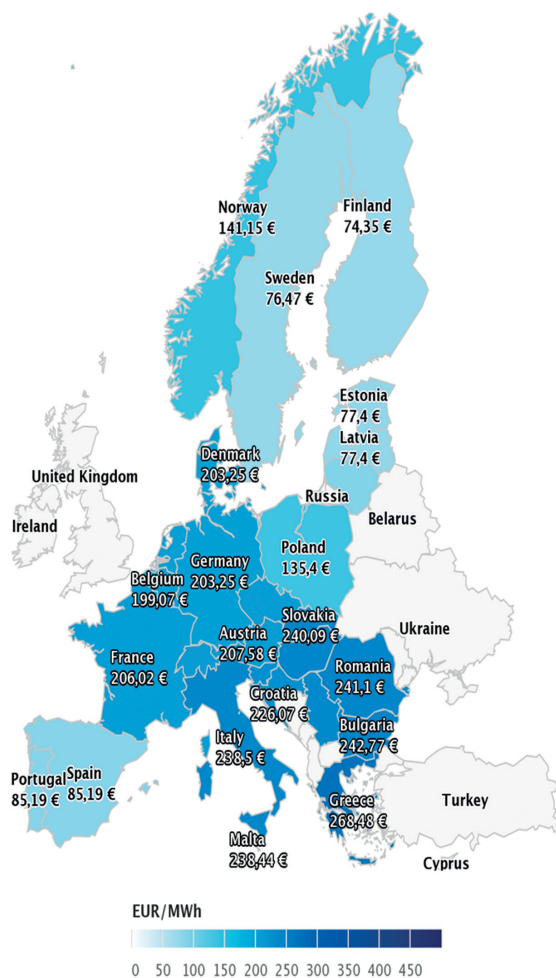
40 H. Gabryś, *Elektroenergetyka w Polsce 2020*, "Energetyka" 2020, no. 8, p. 367-368.

41 B. Derski, *Najwyższa w historii produkcja i zużycie energii*, Wysokie Napięcie, 15 January 2022, <https://wysokienapiecie.pl/44288-najwyzsza-w-historii-produkcja-zuzycie-energii/> [26.04.2022].

42 B. Derski, *Importujemy coraz więcej prądu i... ratujemy sąsiadów eksportem*, Wysokie Napięcie, 21 January 2021, <https://wysokienapiecie.pl/35185-importujemy-coraz-wiecej-pradu-ratujemy-sasiadow-eksportem/> [26.04.2022].

electricity and decreasing production capacities, Poland is an exporter of electricity to a smaller extent than in previous years, mainly under an intervention export⁴³.

Map 1. Average day-ahead electricity market price in the EU



service provided to the Hellenic Regulatory Authority for Energy (RAE); powered by DIEM; sources: ENTSOe, GME; last update: 2022-04-20 05:04

Source: S. Michalopoulos, *Greeks pay the highest electricity price in the EU*, Euractiv, 20 April 2022, https://www.euractiv.com/section/politics/short_news/greeks-pay-the-highest-electricity-price-in-the-eu/ [1.05.2022].

43 Urząd Regulacji Energetyki, *Raport Krajowy Prezesa Urzędu Regulacji Energetyki 2020*, 2020, p. 31.

Adaptation of the Polish energy balance to the requirements of the European Union by 2040 will require investments in new generation capacities and transmission networks. Moreover, investments in the energy sector (e.g. the offshore wind energy subsector, the gas subsector) should primarily benefit domestic companies, while the transfer of foreign technologies should only take place where it is necessary⁴⁴. The permanent setting-aside of coal-fired generation capacity will not take place until after 2030. The closure of Poland's coal-fired power stations over the next five to six years would result in an economic catastrophe as a result of the need to import electricity, which in turn would affect the competitiveness of the Polish economy and impede its development. Therefore, it can be assumed that after 2035, the dependence of the Polish economy on fossil fuel prices will decrease due to the implementation of the nuclear energy sector, development of electromobility, and increasing the share of RES in the national energy mix⁴⁵.

These ambitious measures, although difficult, are necessary because they will enable the development of a modern and clean Polish economy and will also have a health-promoting effect on Polish society, which is suffocating in the smog that lingers over large conurbations. Moreover, without implementing these changes, Poland stands little chance of achieving the level of greenhouse gas emission reductions set by the EU.

Conclusions

The shift in EU energy policy towards zero emissions began well over a decade ago, but many Member States have not taken the appropriate steps to facilitate this process. Poland is an example of such a country. Poland's problems with energy transition are complex. On the one hand, they result from the heavy dependence of the economy on the production of electricity from fossil fuels, mainly coal, old-generation infrastructure, and the lack of nuclear power plants. On the other hand, their origin lies in the lack of continuity in the im-

44 M. Lachowicz, M. Gacki, K. Moskwik, *op. cit.*, p. 55.

45 E. Kochanek, *op. cit.*, p. 7.

plementation of energy sector development strategy. And here their cause is the weakness of each government's administration, which after taking power does not continue the activities of its predecessors within the framework of the previously adopted national energy strategy. Moreover, the delay in updating the Polish Energy Policy and in introducing various legal regulations prevent companies from creating their operating strategy and defining the direction of development research. As a result, RES development is delayed by approximately 11 years⁴⁶. The departure from coal is already a foregone conclusion, so efforts must be stepped up to implement an energy strategy based on RES, gas, and nuclear energy so as not to lose the financial and development opportunities currently offered to Poland by the European Union. The energy transition will affect the Polish economy, and its effects will be felt by society as a whole. At present, in an uncertain and turbulent environment, it is very difficult to predict what the scale of these implications will be. Certainly, some regions, due to their geological or geographical specificity, are more exposed to risks resulting from the transformation (e.g. mining areas), while others will benefit from the European change of course towards zero emissions (e.g. coastal or sparsely populated areas).

References

- Bielecki T., *Poland agrees to EU climate acceleration*, Deutsche Welle, 11 December 2020, <https://www.dw.com/pl/klimat-polska-szczyt-ue-55proc/a-55909122> [25.04.2022].
- Bocian K., Lewandowski W., Wróbel P., *Zielone koło ratunkowe. Dostęp do czystej energii warunkiem konkurencyjności polskiego przemysłu*, Warsaw 2022.
- BP, *BP Statistical Review of World Energy*, 2021.
- Brauers H., Oei P.-Y., *The political economy of coal in Poland: Drivers and barriers for a shift away from fossil fuels*, "Energy Policy" 2020, vol. 144.
- Budnitza R., Rogner H., Shihab-Eldinc A., *Expansion of nuclear power technology to new countries – SMRs, safety culture issues, and the need for an improved international safety regime*, "Energy Policy" 2018, vol. 19.
- European Environment Agency, *Climate Change*, <https://www.eea.europa.eu/pl/themes/climate/about-climate-change>.

46 K. Księżopolski, G. Maśloch, op. cit., pp. 6, 9.

- Derski B., *Importujemy coraz więcej prądu i... ratujemy sąsiadów eksportem*, Wysokie Napięcie, 21 January 2021, <https://wysokienapiecie.pl/35185-importujemy-coraz-wiecej-pradu-ratujemy-sasiadow-eksportem/>.
- Derski B., *Najwyższa w historii produkcja i zużycie energii*, Wysokie Napięcie, 15 January 2022, <https://wysokienapiecie.pl/44288-najwyzsza-w-historii-produkcja-zuzycie-energii/>.
- Derski B., *Źródła energii w Polsce w 2020: mniej węgla, więcej gazu i OZE*, Wysokie Napięcie, 12 February 2021, <https://wysokienapiecie.pl/35619-zrodla-energii-w-polsce-w-2020-mniej-wegla-wiecej-gazu-oze/>.
- Dowiedz się więcej o Funduszach Europejskich*, Portal Funduszy Europejskich, 4 June 2021, <https://www.funduszeuropejskie.gov.pl/strony/o-funduszach/fundusze-na-lata-2021-2027/dowiedz-sie-wiecej-o-funduszach-europejskich-na-lata-2021-2027/>.
- Energy transformation: the Polish way to a low-carbon economy*, Biznes Alert, 21 November 2019, <https://biznesalert.pl/transformacja-energetyczna-energetyka-polska>.
- European Commission, Commission Staff Working Document Country Report – Poland 2020, Brussels 2020.
- Frączyk J., *Polska gospodarka ostro ścięła emisję CO₂. Osiem krajów za nami, w tym Niemcy i Czechy*, Business Insider, 20 June 2022, <https://businessinsider.com.pl/gospodarka/emisja-co2-ostro-w-dol-osiem-krajow-za-nami-w-tym-niemcy-i-czechy/djj4lcf>.
- Frankowski J. et al., *Employment in hard coal mining in the Upper Silesian Basin*, “IBS Research” 2020, no. 1.
- Gabryś H., *Elektroenergetyka w Polsce 2020*, “Energetyka” 2020, no. 8.
- Gawlikowska-Fyk A., Borkowski M., *How Poland can achieve increased greenhouse gas emission reduction targets by 2030*, Energy Forum, 2020.
- IEO, *Photovoltaic market in Poland 2020*, 2020.
- Jastrzębska G., *Odnawialne źródła energii i pojazdy proekologiczne*, Warsaw 2007.
- Kasztelanowicz Z., *Raport o stanie branży węgla brunatnego w Polsce i w Niemczech wraz z diagnozą działań dla rozwoju tej branży w I połowie XXI wieku*, Cracow 2018.
- Kochanek E., *Evaluation of Energy Transition Scenarios in Poland*, “Energies” 2021, vol. 14(19).
- Kołodziejwski M., *Fundusz na rzecz Sprawiedliwej Transformacji*, March 2022, <https://www.europarl.europa.eu/factsheets/pl/sheet/214/fundusz-na-rzecz-sprawiedliwej-transformacji-fst->
- Książopolski K., Maśloch G., *Time Delay Approach to Renewable Energy in the Visegrad Group*, “Energies” 2021, vol. 14.
- Kyoto Protocol to the UN Framework Convention on Climate Change, OJ 2005, no. 203.
- Lachowicz M., Gacki M., Moskwik K., *Paliwa i motory wzrostu gospodarczego*, Warsaw 2020.

- Landis F., Heindl P., *Renewable Energy Targets in the Context of the EU ETS: Whom do They Benefit Exactly*, "Discussion Paper" 2016, no. 16.
- Lu M., *The European Union's Energy dependency*, Visual Capitalist, 22 March 2022, <https://www.visualcapitalist.com/visualizing-the-eus-energy-dependency/>.
- Miętkiewicz R., *FSRU terminal on the Gdańsk coast – próba analizy*, "Anali-za IPE", nr 1, 2019.
- Ministerstwo Klimatu i Środowiska, *Polityka Energetyczna Polski 2040*, War-saw 2021.
- PGNiG, *Sprawozdanie Zarządu z działalności PGNiG SA oraz GK PGNiG na 2020 rok*, 2020.
- Polskie Sieci Energetyczne S.A., *Plan rozwoju w zakresie zaspokojenia obec-nego i przyszłego zapotrzebowania na energię elektryczną na lata 2021-2030*, Konstancin-Jeziorna 2020.
- Rączka J., *Transformation of district heating 2030: Small district heating sys-tems*, Energy Forum, 2017.
- Robaina M., Neves A., *Complete decomposition analysis of CO₂ emissions intensity in the transport sector in Europe*, "Research in Transportation Economics" 2021, vol. 90.
- Ruszel M., *The significance of the Baltic Sea Region for natural gas supplies to the V4 countries*, "Energy Policy" 2020, vol. 146.
- Sawicki B., *Znaczący wzrost emisji CO₂ w Polsce. Winny eksport prądu*, en-ergia.rp.pl, 18 May 2022, <https://energia.rp.pl/co2/art36322571-znaczący-wzrost-emisji-co2-w-polsce-winnny-eksport-pradu>.
- The European Council, the Council of the Economic and Social Committee and the Committee of the Regions, *Announcement from the Commission to the European Parliament, European Green Deal*, Brussels 2019.
- The Ministry of Energy, *Draft Conclusions from forecast analyses for the fuel and energy sector – appendix 2. to PEP 2040*, 2019.
- The Ministry of Energy, *National Energy and Climate Plan for 2021-2030*, 2019.
- Tokarski S., Janikowski J., *Kyoto Protocol – Poland ahead of Scandinavia in reducing emissions*, "Polska Energia Tauron" 2010, no. 4.
- United Nations, *Paris Agreement*, 2015.
- Urząd Regulacji Energetyki, *Raport Krajowy Prezesa Urzędu Regulacji En-ergetyki 2020*, 2020.
- Zalewska-Wojtuś K., Kałek P., *Amendment of the Energy Law*, "Energia Ele-ktryczna" 2020, no. 1.