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ENERGY POLICY OF POLAND UNTIL 2040

THE CHALLENGES AND THREATS TO ENERGY SECURITY IN THE NEXT TWO DECADES

ABSTRACT Poland's energy transformation will be carried out over the next two decades, and its main objective is decarbonization. Specific goals are included in the energy policy of Poland until 2040. In this context, it should be emphasized that the Polish energy sector requires a complete modernization, especially in terms of electricity supply. The current state of affairs is a consequence of the still too high use of coal in the energy mix. The planned investments are to lead to a deep transition in the Polish energy sector, which will ensure the energy security of the state. The Polish energy policy proposes several methods that are to be used for modernization, i.e., gasification of the electricity sector, implementation of nuclear energy, or the development of renewable energy sources. In this context, it is necessary to identify the challenges and threats to Poland's energy security. The article presents the current state of the Polish energy sector, the main goals of the EPP 2040 and the resulting threats to energy security.

Keywords: Poland, energy policy, energy security, energy transformation, decarbonization

INTRODUCTION

The Energy Policy of Poland until 2040 (EPP 2040) was announced in 2021. Its main aim is to define the transformation of the energy of the country. It is clear that one of the main setbacks is connected with the re-development of the Polish energy sector. Dynamic decarbonization is planned as a result of the zero-emission policy which the European Union aims to achieve.¹ What seems to be a challenge is not only the transformation of the energy sector into a more environment-friendly one, but also the time frames within which this transformation is supposed to be realized. Two or maximum three decades pose a significant challenge for the carbon-dominated countries, therefore Poland's energy policy must be correlated with both internal factors, such as energy resources or power engineering infrastructure, and international opportunities. This paper aims to analyze EPP 2040 with regard to challenges and threats to Poland's energy security.

The following research questions are considered: do the aims of energy policy of Poland until 2040 respond to the needs and expectations (political, economic, and social) of the energy transformation of the country? Are the chosen methods and measures suitable for Poland's capabilities? In this regard, the following hypotheses are presented: strategic goals of energy policy of Poland until 2040 are concurrent with political, economic, and social expectations, while quick decarbonization of the energy sector might threaten energy security of the country. The research applied the method of critical text analysis, the subject of which are the latest document on Polish energy policy (EPP 2040), as well as other documents and studies in the field of energy security.

The paper presents the current state of the energy sector, including EPP 2040 in the context of the planned energy transformation. First, the concept of energy security is explained. The paper then describes a specific structure of electric energy production in Poland, including access to strategic energy sources. Subsequently, the paper refers to the key concepts and goals of EPP 2040. The above-mentioned aspects are combined with the analysis of EPP 2040 from the perspective of challenges and threats to Poland's energy security. The paper does not refer to energy policy updates which were made after Russia's attack on Ukraine in 2022.

1. ENERGY SECURITY OF THE STATE – A THEORETICAL OUTLINE

Academic literature offers many definitions of energy security. Differences between them usually refer to various aspects of this concept. Definitions vary when we think in a short-term perspective. What is taken into consideration then is, for instance, the

¹ D. Yergin terms the EU's proposed forced march towards 'net zero' carbon emissions in 2050 *breath-taking: nothing less than reshaping economic activity, directing investment, and rebuilding Europe's economy* in a way that will aggregate power to the European Commission by regulating businesses and allocating capital. See more: D. Yergin, *The New Map: Energy, Climate, And the Clash of Nations*, New York 2020, p. 389.

risk of suspension of energy supplies by the main producers. A long-term perspective involves other aspects, such as the depletion of resources or the increase of their prices.² Therefore, it should be clearly stated that there is no universal and commonly accepted definition of energy security. This term is so generic that it would be not only difficult but also pointless to limit it to a synthetic, universal concept. However, as mentioned above, both the Polish and international literature present plenty of valuable explanations of what energy security is. According to Roman Ney, energy security is the provision of energy in sufficient amount and quality at economically justified prices.³ A similar definition is given in the Polish literature by the following: P. Czerpak,⁴ J. Soliński,⁵ A. Gardziuk, W. Lach, E. Posel-Częścik, K. Sochacka,⁶ K. Żukrowska.⁷ Regarding the international scholarship, one should mention: D. Yergin,⁸ S.S. Haghighi,⁹ A. Yorkan,¹⁰ J.H. Kalicki,¹¹ D.L. Goldwyn, J. Bordoff and others.¹²

The Energy Policy of Poland until 2040 defines energy security as a current and future fulfillment of a recipient's demand for fuel and energy which is technically and economically justified considering environmental protection regulations.¹³ It focuses on guaranteeing the security of the supply, production, transmission, and distribution of raw materials, which forms a complete energy chain.¹⁴ The document

² J. Braun, "Bezpieczeństwo energetyczne jako dobro publiczne – miary i czynniki wpływające na jego poziom", *Studia Ekonomiczne. Zeszyty Naukowe Uniwersytetu Ekonomicznego w Katowicach*, vol. 358 (2018), p. 25.

³ R. Ney, "Perspektywy energetyczne Polski w świetle tendencji światowych", *Polityka Energetyczna*, vol. 3, no. 1 (2000), p. 21.

⁴ P. Czerpak, "Bezpieczeństwo energetyczne", in K. Żukrowska, M. Grącik (eds), *Bezpieczeństwo międzynarodowe. Teoria i praktyka*, Warszawa 2006, p. 122.

⁵ J. Soliński, "Główne tezy raportu Organizacji Narodów Zjednoczonych i Światowej Rady Energetycznej pt. »Światowa ocena energetyczna – energia i wyzwania szans rozwojowych«", *Polityka Energetyczna*, vol. 4, no. 1 (2001), p. 15.

⁶ A. Gradziuk et al., "Co to jest bezpieczeństwo energetyczne państwa", in S. Dębski, B. Górka-Winter (eds), *Kryteria bezpieczeństwa międzynarodowego państwa*, Warszawa 2003, p. 80.

⁷ K. Żukrowska (ed.), *Bezpieczeństwo międzynarodowe. Przegląd aktualnego stanu*, Warszawa 2011, p. 397.

⁸ D. Yergin, "Energy Security in the 1990s", *Foreign Affairs*, vol. 67, no. 1 (1988), p. 111.

⁹ S.S. Haghighi, *Energy Security: The External Legal Relations of the European Union with Major Oil and Gas Supplying Countries*, Oxford 2007, p. 14.

¹⁰ A. Yorkan, "Energy Security of European Union", in L. Jesień (ed.), *The Future of European Energy Security. Interdisciplinary Conference*, Kraków 2006, p. 65.

¹¹ J.H. Kalicki, D.L. Goldwyn, *Energy and Security: Towards a New Foreign Policy Strategy*, Washington 2005, p. 9.

¹² J. Bordoff, M. Deshpande, P. Noel, "Understanding the Interaction between Energy Security and Climate Change Policy", in C. Pascual, J. Elkind (eds), *Energy Security: Economics, Politics, Strategies, and Implications*, Washington 2009, p. 214.

¹³ This definition was already proposed in the Polish Energy Law from 1997. See: Art. 3, pt. 16, *Ustawa z dnia 10 kwietnia 1997 r. – Prawo energetyczne*, Dz.U. 1997, no. 54, item 348.

¹⁴ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski do 2040 r.*, Warszawa 2021, p. 14. It should be pointed out that energy security is one of the goals of the energy policy.

mentions the protection of the environment, which reflects European trends in defining energy security from the perspective of ecology.¹⁵ This view correlates with the position of the German government and the European Commission according to which energy security is understood as a possibility of production and consumption of relatively inexpensive, solid and eco-friendly energy.¹⁶ This concept is not universal because there are many countries which pay more attention to the cost-efficiency factor of their energy sector, while ignoring threats to the natural environment. Recently, the technical/technological dimension of energy security has also been of particular importance (for example: critical infrastructure, transmission infrastructure, technological advancement, energy efficiency).¹⁷

It should be noted that, in some cases, the concept of energy security is limited to ensuring the continuity of the supply of energy resources.¹⁸ This means that the shortage of energy is a sign of uncertainty and some steps should be taken to act against such a threat. Importantly enough, fluctuations in the prices of raw materials or energy do not imply that a given situation is unstable or poses a threat to the security of the state. Reliable energy supplies are the most important element of energy security. Fluctuations in prices are a natural economic phenomenon that has to be taken into consideration in the energy policy. With all this in mind, it seems relevant to define energy security not only as a way of ensuring energy supplies or raw materials at a reasonable price, but also considering the quality of energy and its impact on human life as well as natural environment.¹⁹ Taking into account technological development, it is likely that in the future the definition of energy security will be extended.²⁰

¹⁵ See more: T. Młynarski, *Bezpieczeństwo energetyczne i ochrona klimatu w drugiej dekadzie XXI wieku. Energia – środowisko – klimat*, Kraków 2017, pp. 19-85.

¹⁶ S. Müller-Kraenner, *Bezpieczeństwo energetyczne. Nowy pomiar świata*, transl. by K. Jankowska, Szczecin 2009, p. 7. See more: R. Hillebrand, "Climate Protection, Energy Security, and Germany's Policy of Ecological Modernization", *Environmental Politics*, vol. 22, no. 4 (2013), pp. 664-678.

¹⁷ M. De Rosa et al., "Diversification, Concentration and Renewability of the Energy Supply in the European Union", *Energy*, vol. 253 (2022), 124097, p. 2; J. Trubalska, "W kierunku unii energetycznej. Nowa koncepcja bezpieczeństwa energetycznego w Unii Europejskiej", *Zeszyty Naukowe Instytutu Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk*, no. 97 (2017), p. 24.

¹⁸ E. Lieb-Dóczy, A.R. Börner, G. MacKerron, "Who Secures the Security of Supply? European Perspectives on Security, Competition, and Liability", *The Electricity Journal*, vol. 16, no. 10 (2003); S. Ölç, R. Sims, N. Kirchner, *Contribution of Renewables to Energy Security. IEA Information Paper*, International Energy Agency, 2007, at https://iea.blob.core.windows.net/assets/682ee8e1-a423-4775-bcd1-38bf4c18717f/so_contribution.pdf, 12 February 2022; P. Wright, "Liberalisation and the Security Gas Supply in the UK", *Energy Policy*, vol. 33, no. 17 (2005); F. Hoogeveen, W. Perlot, "The EU's Policies of Security of Energy Supply Towards the Middle East and Caspian Region: Major Power Politics?", *Perspectives on Global Development and Technology*, vol. 6, no. 1-3 (2007).

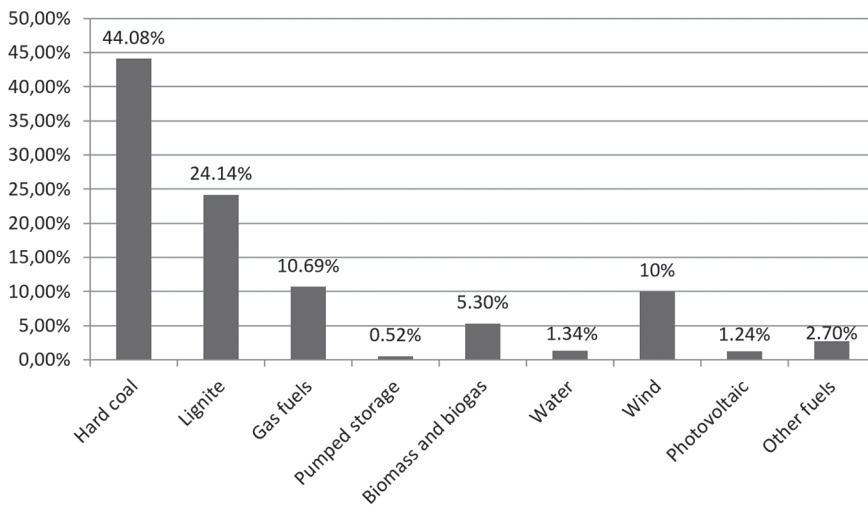
¹⁹ T. Młynarski, *Bezpieczeństwo energetyczne w pierwszej dekadzie XXI wieku. Mozaika interesów i geostrategii*, Kraków 2011, p. 33-34.

²⁰ See more: W. Hebda, *Polityka oraz sektor energetyczny w wybranych państwach Europy Południowo-Wschodniej (Serbia, Chorwacja, Bułgaria, Grecja, Rumunia)*, Kraków 2019, p. 21-24.

2. CURRENT CONDITION OF THE POLISH ENERGY MIX – AN OUTLINE

The Polish energy sector calls for an urgent and dynamic redevelopment that results from technological backwardness and international obligations in terms of decarbonization. In 2014, the European Council approved four objectives for the whole EU to be achieved by 2030. Reviewed in 2018 and 2020, these objectives now focus on the reduction of greenhouse gas emission by at least 55% (in relation to 1990), increases in the use of renewable resources in the gross final consumption (by at 32%), increase of energy efficiency by 32.5%, and creation of an internal energy market in the EU. The objectives are related to the Paris Agreement, signed in December 2015 during the 21st session of the Conference of the Parties of the UN Framework Convention on Climate Change (COP21). Its goal was to limit global warming to well below 2°C compared to pre-industrial levels. Another important element is the statement of the European Commission related to the European Green Deal in 2019, a strategy which aims to achieve no net emissions of greenhouse gases by 2050.²¹

Figure 1. Energy mix of Poland in 2020



Source: Own elaboration based on: Główny Urząd Statystyczny, *Gospodarka paliwowo-energetyczna w latach 2019-2020*, Warszawa 2021, p. 29.

Based on the data from Figure 1, the Polish energy mix in 2020 looked rather unfavorable, as hard coal and lignite accounted for 68.2%. A significant fraction of coal

²¹ Idem, "The North-South Gas Corridor in the Context of Poland's Gas Transmission System – A Perfect Opportunity to Diversify Gas Resources", *Energies*, vol. 14, no. 21 (2021), 7188, p. 2.

consumption is the effect of rich deposits and a well-developed coal industry in Poland.²² It shall be emphasized that Polish carbon deposits are among the largest in Europe. However in the light of data in Table 1, the use of coal in the production of electricity has gradually decreased (in 2014 – 81.4%, 2016 – 78.2%, 2018 – 76.8%).²³ The opposite trend is visible in the natural gas sector, which met the need for electricity in 2020 in almost 11%. Its role is definitely becoming more and more important – during the last five years, its consumption has risen almost three times (in 2015 it accounted for only 3.8% in the energy mix). Unfortunately, Poland does not have significant natural gas resources, so most of the raw material is imported.²⁴ Production has been steady for many years and it allows one to satisfy about 20% of national needs. The rest is imported, mostly from Russia (about 55% in 2020). In this context, it is worth mentioning that the heavy reliance on Russian energy resources has disappeared visibly (from about 89% in 2016), mostly due to the launch of the LNG terminal in Świnoujście. At the same time, the finalization of the investment in the gas sector, namely the Baltic Pipe, North-South Gas Corridor will allow the import of natural gas from basically any direction and to eliminate completely gas import from Russia.²⁵ Dynamic changes are occurring not only in the area of fossil fuels but also in renewable energy resources, where one can witness a rising trend in electric energy production. In 2012, green energy represented a little more than 10% while in 2020 it was almost 18% in the energy mix. The highest increase in generative power was observed in the wind and solar energy sectors. In 2020, wind power plants generated ca. 10% of electric energy, biomass and biogas – ca. 5%, while hydroelectric plants and photovoltaics ca. 1.3%.²⁶ In the years 2010-2020, the production of electricity coming from renewable sources was doubled. What contributed the most was definitely investments in the wind power sector, which resulted not only from technological progress, but also from a significant potential located in Poland.²⁷

²² H. Brauers, P.-Y. Oei, “The Political Economy of Coal in Poland: Drivers and Barriers for a Shift away from Fossil Fuels”, *Energy Policy*, vol. 144 (2020), 111621, pp. 3-5.

²³ Główny Urząd Statystyczny, *Gospodarka paliwowo-energetyczna w latach 2019-2020*, Warszawa 2021, p. 29.

²⁴ It is worth noting that Poland has considerable opportunities in the shale gas sector. See more: C. Baranzelli et al., “Scenarios for Shale Gas Development and Their Related Land Use Impacts in the Baltic Basin, Northern Poland”, *Energy Policy*, vol. 84 (2015), p. 92.

²⁵ W. Hebda, “The North-South Gas...”, pp. 4-5.

²⁶ Główny Urząd Statystyczny, *Gospodarka paliwowo-energetyczna...*, p. 29.

²⁷ B. Igliński et al., “Wind Energy in Poland – History, Current State, Surveys, Renewable Energy Sources Act, SWOT Analysis”, *Renewable and Sustainable Energy Reviews*, no. 64 (2016), pp. 23-24.

Table 1. Electricity generation by energy carrier (GWh)

Specification	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hard coal	80528 (49.66%)	81568 (49.56%)	76162 (47.88%)	77693 (47.10%)	79400 (47.65%)	79022 (46.36%)	81257 (47.79%)	76538 (46.67%)	69668 (44.08%)
Lignite	54054 (33.33%)	56150 (34.12%)	53365 (33.55%)	52825 (32.02%)	50920 (30.57%)	52166 (30.60%)	49331 (29.01%)	41639 (25.39%)	38148 (24.14%)
Gas fuels	6259 (3.86%)	5247 (3.18%)	5329 (3.35%)	6405 (3.88%)	7831 (4.71%)	10141 (5.95%)	12709 (7.47%)	15131 (9.24%)	16891 (10.69%)
Pumped storage	428 (0.26%)	558 (0.34%)	551 (0.35%)	603 (0.37%)	482 (0.29%)	474 (0.28%)	417 (0.25%)	706 (0.43%)	819 (0.52%)
RES (all)	16879 (10.42%)	17066 (10.38%)	19841 (12.47%)	22679 (13.76%)	22808 (13.69%)	24050 (14.11%)	21580 (12.69%)	25378 (15.47%)	28248 (17.87%)
Biomass and biogas (RES)	10094 (6.22%)	8622 (5.24%)	9976 (6.27%)	9932 (6.02%)	7957 (4.76%)	6416 (3.76%)	6511 (3.83)	7602 (4.63%)	8371 (5.3%)
Water (RES)	2037 (1.25%)	2439 (1.48%)	2182 (1.37%)	1832 (1.11%)	2139 (1.28%)	2560 (1.50%)	1970 (1.16%)	1958 (1.19%)	2118 (1.34%)
Wind (RES)	4747 (2.92%)	6004 (3.65%)	7676 (4.82%)	10858 (6.58%)	12588 (7.55%)	14909 (8.75%)	12799 (7.53%)	15107 (9.21%)	15800 (10%)
Photovoltaic (RES)	1 (0%)	1 (0%)	7 (0%)	57 (0.03%)	124 (0.07%)	165 (0.1%)	300 (0.18%)	711 (0.43%)	1958 (1.24%)
Other fuels	3991 (2.47%)	3968 (2.42%)	3810 (2.40%)	4739 (2.87%)	5139 (3.09%)	4613 (2.70%)	4745 (2.79%)	4597 (2.8%)	4270 (2.7%)
Total	162139 (100%)	164557 (100%)	159058 (100%)	164944 (100%)	166634 (100%)	170465 (100%)	170039 (100%)	163989 (100%)	158043 (100%)

Source: Own elaboration based on: Główny Urząd Statystyczny, *Gospodarka paliwowo-energetyczna...*, p. 29.

3. EPP 2040 – THE CONCEPT AND ITS GOALS

The assumption is that the concept of Energy Policy of Poland until 2040 seeks to enable a dynamic transformation in the energy sector, mainly through decarbonization and investments in new technologies. There are three pillars in this aspect which lay the foundation for the changes expected within the next two decades. The first pillar is just a transition. It is supposed to ensure new development opportunities to regions and communities that were influenced by the negative effects of the low-emission energy transition process. This pillar is also supposed to provide new workplaces and build new branches of the industry which will participate in the transformation of the energy sector. It refers to coal-dominated regions, such as Upper and Lower Silesia, Greater Poland, and the areas surrounding Lublin. The second pillar is a zero-emission energy system. Its aim is to limit emission by building nuclear power plants and introducing wind power into the sea, and increase the role of distributed and community energy while guaranteeing energy security through temporary usage of energy technology based on gas fuels. The third pillar of the transformation concentrates on good air quality, which is supposed to be achieved through the transformation of the heating sector (both system and individual), transport electrification, and promoting passive and zero-emission houses which use local sources of the energy.²⁸

The realization of the above-mentioned assumptions needs some detailed goals. One of the most important is the optimal use of own energy resources, such as coal (both hard and brown), whose consumption is going to be slowly reduced.²⁹ Therefore, it will be necessary to ensure profitability of the coal sector as well as rational exploitation, consumption, and distribution of the raw material. It is worth mentioning that EPP 2040 emphasized how important research and development are. Innovations would reduce the stress put on the environment through coal mining and, at the same time, would provide new solutions that contribute to low-emission as well as effective and flexible use of energy resources. Meanwhile, natural gas and crude oil will remain the imported raw material.³⁰ Therefore, it is highly important to diversify the delivery directions and sources, since Poland still relies significantly on Russia. Partially, the demand for crude oil and natural gas will be replaced with biofuels and alternative fuels (such as LNG, CNG, biomethane, and hydrogen). When it comes to diversification of delivery directions and sources, it is planned to launch Baltic Pipe (Norway-Denmark-Poland gas pipeline, transportation capacity of 10 billion m³ annually), to develop LNG terminal in Świnoujście (capacity of 7.5 billion m³ per annum), to put into service floating terminal FSRU in Gdańsk Bay (capacity of 6 billion m³, ultimately 12 billion m³ per annum) and finally to increase the capacity of gas interconnectors

²⁸ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 6.

²⁹ A. Tajduś, S. Tokarski, "Risk Related to Energy Policy of Poland until 2040 (EPP 2040)", *Archives of Mining Sciences*, vol. 65, no. 4 (2020), pp. 890-893.

³⁰ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 8.

with neighboring countries and increase their storage capacity. Natural gas is supposed to play a major role since it will be used as a transition fuel in the transformation process. Consequently, the demand for gas will increase considerably and therefore it is crucial to secure its deliveries.³¹ When it comes to crude oil, EPP 2040 stated that there is a need to increase the delivery by sea, for instance, through extending the Pomeranian pipeline. It is also important to enlarge the storage capacities of oil and liquid fuels.³²

The next goal is to expand the transmission infrastructure and the electricity grid. In this matter, Poland will aim to cover its energy needs with own resources. The national coal deposits will remain important for Poland's energy security, but the increase in energy demand will be covered by resources different from conventional coal power. Coal consumption will account for no more than 56% in 2030 in general energy consumption. It can even drop to the level of 37.5% if the prices of CO₂ emission go up.³³ Decarbonization will be achieved through the development of renewable energy resources, paying special attention to photovoltaics and wind power. In 2030 renewable energy resources are supposed to account for at least 32% of national energy consumption. However, to succeed, this plan must be correlated with the development of the grid infrastructure and energy storage technology, as well as the expansion of gas units. Undoubtedly, the implementation of nuclear power in the 2030s will play a major role. Investments in transmission and grid infrastructure will result in building a power engineering system that will be based on low- and zero-emission sources.³⁴

Among the EPP 2040 goals, one can also notice the development of the energy markets, dividing them into the following sectors: electricity, natural gas, crude oil, and hydrogen. First, there is a plan for a gradual increase of the cross-border transfer capacities of electric energy. This aim will be realized through expanding the transmission network, especially with the neighboring countries which are members of the EU. It is definitely more challenging to develop the natural gas market. The plan includes creating a regional hub for gas transmission and trade (gas hub), gasification of the country, and increase of gas consumption in industry, heat engineering, power engineering, as well as in households.³⁵ When it comes to the oil products market, it will be necessary to systematize the ownership structure of the fuel market segments so that refinery companies will be concentrated on production and distribution of the fuels, while the state will control the infrastructure key for fuel security. Additionally, demand for oil products will be covered by the increased usage of biocomponents and alternative fuels (LNG, CNG, biomethane, hydrogen, and synthetic fuels) and the development of the electromobility. The novelty in Polish energy policy is the development of a hydrogen

³¹ W. Hebda, "The North-South Gas...", p. 6.

³² Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 9.

³³ It should be noted, however, that the EU ETS carbon prices have increased significantly in 2021 and are currently record-breaking. See more: The World Bank, *State and Trends of Carbon Pricing 2022*, Washington 2022, p. 21.

³⁴ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 8.

³⁵ T. Olkusi et al., "The Polish Natural Gas Market – Resources, Extraction, Import and Consumption", *Inżynieria Mineralna – Journal of the Polish Mineral Engineering Society*, vol. 20, no. 2 (2018), p. 308.

market, which comes as a consequence of the research into new technologies based on hydrogen. It was noticed that all investments in that matter should be compliant with the EU policy, that is, the European Green Deal. The development of hydrogen technologies will contribute to effective decarbonization of transport and industry.³⁶

As mentioned above, when it comes to generative infrastructure, the introduction of nuclear energy is planned. In this way, this issue reappeared among the aims of Poland's energy policy (previously in EPP 2030).³⁷ This time the nuclear plan assumes that six nuclear units will be ready until 2043 (the first one is supposed to be launched in 2033). The increase in the power capacity of nuclear power plants will allow filling up power deficiencies after the shutdown of coal power plants. This, in turn, will stabilize electric energy production guaranteeing zero-emission air pollution. A considerable part of the nuclear program will be realized with the assistance of Polish companies. Therefore, it will be necessary to guarantee a sufficient amount of qualified staff. EPP 2040 also aims to launch nuclear power plants along with a repository of radioactive waste.³⁸

The next specific goal of EPP 2040 is the development of renewable energy sources; therefore, it is of exceptional value in the context of zero-emission plan. The Polish government states that in 2030 at least 23% of gross energy consumption will be generated by renewable energy sources (ultimately 32% in 2040). From a technological perspective, the major role in increasing the value of green energy is supposed to play offshore wind farms³⁹ and photovoltaics.⁴⁰ The emphasis on these two sources is correlated with Poland's potential, which is much more promising in terms of wind and solar energy than other renewable energy sources, such as geothermal ones. Thanks to renewable energy sources, it will be possible to achieve a higher level of distributed energy (through the development of local infrastructure) which will relieve the current centralized energy sector and will influence its higher efficiency.

Among the detailed goals of EPP 2040, there is also the development of heat engineering, especially at the local level. In order to cover heating needs in an individual way (households), low-emission sources are going to be used, e.g. heat pumps, electric heating, or natural gas. It is also necessary to step back from coal used for heating – in cities until 2030, in the countryside – until 2040.⁴¹

³⁶ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 10.

³⁷ J. Gierszewski et al., "Nuclear Power in Poland's Energy Transition", *Energies*, vol. 14, no. 12 (2020), 3626, p. 19.

³⁸ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 10.

³⁹ K. Pronińska, K. Książkowski, "Baltic Offshore Wind Energy Development – Poland's Public Policy Tools Analysis and the Geostrategic Implications", *Energies*, vol. 14, no. 16 (2021), 4883, p. 12; P. Ziemia, "Uncertain Multi-Criteria Analysis of Offshore Wind Farms Projects Investments – Case Study of the Polish Economic Zone of the Baltic Sea", *Applied Energy*, vol. 309 (2022), 118232, p. 19.

⁴⁰ R. Gnatowska, E. Moryń-Kucharczyk, "The Place of Photovoltaics in Poland's Energy Mix", *Energies*, vol. 14, no. 5 (2021), 1471, pp. 4-6.

⁴¹ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 11.

4. EPP 2040 – CHALLENGES AND THREATS TO ENERGY SECURITY

Taking into consideration the current condition of the Polish energy sector and the geopolitical situation, the implementation of EPP 2040 goals will definitely pose a series of challenges and threats to Poland's energy security. One of the priorities for the next two decades is to undergo the decarbonization process and reevaluate the energy mix. In fact, currently 60% of electricity comes from coal power plants and for this reason its production and consumption will gradually decrease. Recent years have witnessed an increase in the dependence of Poland on imported coal, which is a consequence of its gradual decrease in production.⁴² This issue becomes even more problematic when we realize that the most dominant direction of import remains Russia (75% in 2020).⁴³ There is no doubt that the reduction in the coal industry and energy poses some threats to the stability of power engineering. Lowering the production and shutting down coal units may lead to a growing import of electric energy (which is visible for instance in Greece⁴⁴). One should not forget that Poland has rich coal deposits and long traditions in the coal industry.⁴⁵ In fact, if coal stops being used in the production of energy, this will result in closing many mines, since this energy resource is mostly exploited to satisfy the needs of local power plants. This, in turn, will create the need to requalify workers and reclaim exploitation hollows, which will generate serious economic and social costs. EPP 2040 points out that there is a necessity to sign a social agreement which will include, i.e. the mechanism of financing hard coal companies, including a new program of public support for the mining sector, investments into low- and zero-emission energy sources using clean coal technologies (such as IGCC, CCS, CCU) as well as those which use coal to produce methanol, hydrogen, or smokeless fuel. Deadlines for hard coal production in particular mines will be established by 2049. Regions that will likely suffer from the negative consequences of the transformation will receive financial support from the EU Just Transition Fund with a total sum of 60 billion PLN.⁴⁶ Unfortunately, it cannot be excluded that the redevelopment and further closing of the coal sector might encounter economic, social, or political obstacles.

Maintaining security and stability in the oil and gas sector will be an undoubtedly larger challenge. This issue is even more problematic, since Poland is heavily dependent on imported energy resources, mainly from Russia. In 2020, this dependency was

⁴² It should be emphasized that the use of coal in 2021 has not been reduced, and the war in Ukraine will lead to its greater consumption in 2022 not only in Poland.

⁴³ P. Kleinschmidt, J. Maćkowiak-Pandera, "Ponad bilion złotych na import surowców energetycznych do Polski", *Forum Energii*, 18 January 2022, at <https://www.forum-energii.eu/pl/blog/import-paliw-kopalnych>, 12 February 2022.

⁴⁴ W. Hebda, "Decarbonization of the Energy Sector in Greece – is Greek Coal Mining over?", *Polityka Energetyczna – Energy Policy Journal*, vol. 24, no. 1 (2021), p. 54.

⁴⁵ G. Rentier, H. Lelieveldt, G.J. Kramer, "Varieties of Coal-Fired Power Phase-out across Europe", *Energy Policy*, vol. 132 (2019), pp. 628-629.

⁴⁶ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 17.

65% for crude oil and 55% for natural gas.⁴⁷ Therefore, it is necessary to diversify directions and sources of delivery. The natural gas sector has witnessed many investments, especially in recent years, e.g. LNG Terminal in Świnoujście was opened, gas interconnectors with Germany and the Czech Republic were launched, and storage capacities were increased. However, for the sake of a more effective diversification, it is necessary to finalize the remaining projects specified in EPP 2040: Baltic Pipe, North-South Gas Corridor as well as gas interconnectors with Lithuania and Slovakia. In light of what the Polish government announced, the agreement with Gazprom will not be prolonged (it expires on 31 December 2022). The issue is even more obvious after the Russian invasion of Ukraine. In this situation Poland has only a few months to find alternative delivery source and resign from the eastern import. Therefore, it seems crucial to open the Baltic Pipe within the next months and to speed up the realization of remaining gas projects. It is also worth mentioning that natural gas delivery is closely related to the goals of Poland's energy transformation. In the coming years, gas consumption will increase significantly because decarbonization will be based on a transition fuel – natural gas.⁴⁸ In the future, and against current geopolitical reality, stability in the gas sector in the Central Europe and the Balkans is and will be a real challenge for energy security.⁴⁹ It will be crucial not only to secure natural gas supply but also to maintain the independence of the Polish crude oil sector from the Russian one. In recent years, Poland has increased oil import from Saudi Arabia, Norway or the United States.⁵⁰ However, it will be necessary to raise the level of storage and import by sea. To facilitate the diversification of crude oil supplies, it is advisable to redevelop the ground-based storage infrastructure. In 2020 PERN S.A realized two important investments such as enlarge storage capacity of the unit in Górkki Zachodnie (near Gdańsk, from 0.6 million m³ to the level of ca. 1.9 million m³) and the extension of Gdańsk Oil Terminal (transshipment capacity – ca. 40 million tons per year). It is also crucial to rebuild the transmission infrastructure and open the second line of the Pomeranian pipeline. The crude oil transmission infrastructure is currently limited to the Druzhba and Pomeranian pipelines. The first enables the import of oil from the eastern direction (56 million t/year) to the refinery in Płock. The second pipeline distributes the raw material to Gdańsk refinery (27 million t/year). The Pomeranian pipeline is reversible and it is possible to transfer crude oil to Płock by sea (30 million t/year). Despite that, this pipeline is definitely the weakest link in the oil transmission chain. The artery consists of only one line, which

⁴⁷ P. Kleinschmidt, J. Maćkowiak-Pandera, "Ponad bilion złotych...".

⁴⁸ W. Hebda, "The North-South Gas...", p. 16.

⁴⁹ More on that: idem, "Projekty energetyczne na Bałkanach – szansa wzmocnienia bezpieczeństwa energetycznego Europy", *Przegląd Geopolityczny*, no. 9 (2014), pp. 64-67, at http://przeglad.org/wp-content/uploads/2014/10/Hebda_Wiktor_PG_tom_9.pdf, 12 February 2022; idem, "Strategia energetyczna Republiki Bułgarii do 2020 roku", *Polityka Energetyczna – Energy Policy Journal*, vol. 18, no. 2 (2015), pp. 120-122; M. Tutak, J. Brodny, "Analysis of the Level of Energy Security in the Three Seas Initiative Countries", *Applied Energy*, vol. 311 (2022), 118649.

⁵⁰ T. Olkusi et al., "Polish Energy Security in the Oil Sector", *E3S Web of Conferences*, vol. 108 (2019), 02015, p. 4.

means that in case of any malfunction there is no alternative way of transport in this strategic section.⁵¹ Extension of infrastructure and storage capacities will exploit the potential of Gdańsk Naftoport and consequently will increase Polish independence from Russian supplies. According to a two-year agreement signed in 2021 between Orlen and Rosneft, crude oil deliveries were reduced to the level of 3.6 million tons a year and this trend is expected to proceed in the years to come.⁵² To compare – in the years 2016-2019 the volume of crude oil deliveries was 6-8.4 million t/year, while between 2019 and 2021 – 5.4-6.6 million t/year.⁵³ Progress in oil sector is therefore clearly noticeable; however, there is still a need for further investments.

Poland can strengthen its energy security not only by diversifying the sources of supply and directions of crucial raw materials, such as natural gas and crude oil, but also by introducing nuclear power. Decarbonization entails far-reaching changes in the Polish energy sector and is mainly related to the gradual shutdown of coal power plants. Therefore, it will be necessary to compensate for the loss of generative power of the electric energy. The experience of other countries shows that nuclear power is an effective method of balancing and diversifying the energy mix in a relatively short time. Furthermore, the energy generated by nuclear power plants does not contribute to air pollution. According to EPP 2040, construction works of a first nuclear unit in Poland are supposed to start in 2026. It is planned that by 2043 this source will account for 6-9 GW of power (total number of six nuclear units). The first nuclear power plant is expected to open in 2033, however, taking into account the experience of the last decades in nuclear power investments in Poland, one should be somewhat cautious about this deadline.⁵⁴ In order to introduce nuclear power, it is necessary to develop the required infrastructure (legal, organizational, institutional, research and development system, staff training, and protection against cyberterrorism). Polish experience in the field of nuclear power makes it possible for Polish companies to realize 70% of projects; however, it is of great importance to accelerate the actions taken towards further development.⁵⁵ The greatest challenges in this aspect will not be the choice of technology or general contractor for the project but rather the agreement on where the investment should be located and social approval. The best place for the first power plant seems to be Gdańsk Pomerania (Żarnowiec or Lubiatowo-Kopalino) or the central part of

⁵¹ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 41.

⁵² B. Supernak, "PKN Orlen podpisał nowy, dwuletni kontrakt z Rosnieftem na dostawy ropy", *Inwestycje.pl*, 16 March 2021, at <https://inwestycje.pl/biznes/pkn-orken-podpisał-nowy-dwuletni-kontrakt-z-rosnieftem-na-dostawy-ropy/>, 12 February 2022.

⁵³ "PKN Orlen podpisał z Rosnieft nowy kontrakt, zmniejsza zakupy ropy do 5,4-6,6 mln ton rocznie", *Centrum Informacji o Rynku Energii*, 31 January 2019, at <https://www.cire.pl/artykuly/serwis-informacyjny-cire-24/143486-pkn-orken-podpisał-z-rosnieft-nowy-kontrakt,-zmniejsza-zakupy-ropy-do-5,4-6,6-mln-ton-rocznie>, 12 February 2022.

⁵⁴ K. Szulecki, "Securitization and State Encroachment on the Energy Sector: Politics of Exception in Poland's Energy Governance", *Energy Policy*, vol. 136 (2020), 111066, p. 4-5; P. Majewski, "Polish Potential Nuclear Power Based on PEP2040", *The Copernicus Journal of Political Studies*, no. 2 (2018), p. 85-87.

⁵⁵ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 58.

Poland (near Bełchatów or Pątnów). Although social support for the construction of a nuclear power plant in Poland has increased in recent years (currently 74%), some resistance is still visible, especially when discussing the construction of a nuclear power plant in the proximity of one's residence (39%).⁵⁶ In such situations, local communities usually object to the construction. It will also be vital to deliver fuel to power Polish nuclear units. Fuel must be imported since Poland does not have uranium deposits. This will, in turn, require the creation of stable and safe import directions.

EPP 2040 also addresses the importance of renewable energy sources, which is supposed to reduce the emissivity of the energy sector and diversify the structure of generating power. Compared to other EU countries, Poland does not use as much green energy in the energy sector. Therefore, within the next few years, this process will accelerate. Taking into consideration national potential of renewable sources, competitiveness of green energy technologies, or technical potential, Poland declares that in 2030 renewable energy sources will account for 23% of total gross energy consumption (measured as a total consumption in power engineering, heat and cooling engineering, as well as transport) and in 2040 it should account for at least 28.5%. Technological progress will definitely facilitate the use of renewable energy sources. It will influence both currently known ways of generating energy (e.g. increasing the capacity of wind or solar power plants) and cutting-edge technologies, also in the field of energy storage.⁵⁷ When it comes to transport, it will be necessary to use biocomponents added to liquid fuels. It will also be crucial to develop electromobility by promoting electric engines in cars.⁵⁸ In heat and cooling engineering, the usage of biomass⁵⁹ will play a vital role, however, it is expected that heat pumps and photovoltaic panels will become more common in households. Renewable energy sources will be key in power engineering – it will allow one to re-evaluate the mix of energy sources and will push it towards zero-emission system. In this regard, EPP 2040 addresses the importance of the development of all types of renewable energy sources, in particular wind power.⁶⁰ One of the most strategic projects is the development of offshore wind power farms, which will become the core and the most important renewable energy source in Poland in the next two decades. The first offshore wind power farm is predicted to be included in the power balance around 2024/2025. Extension of the transmission grid in the northern part of the country will be necessary along with the construction of a port that will facilitate

⁵⁶ D. Ciepela, "Większość Polaków zgadza się na sąsiedztwo elektrowni atomowej", Wnp.pl, 15 December 2021, at <https://www.wnp.pl/energetyka/wiekszosc-polakow-zgadza-sie-na-sasiedztwo-elektrowni-atomowej,517379.html>, 12 February 2022.

⁵⁷ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 63.

⁵⁸ W. Drożdż, P. Szczerba, D. Kruszyński, "Issues Related to the Development of Electromobility from the Point of View of Polish Utilities", *Polityka Energetyczna – Energy Policy Journal*, vol. 23, no. 1 (2020), pp. 51-52.

⁵⁹ A. Beldycka-Bórawska et al., "Development of Solid Biomass Production in Poland, Especially Pellet, in the Context of the World's and the European Union's Climate and Energy Policies", *Energies*, vol. 14, no. 12 (2021), 3587, p. 18.

⁶⁰ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 64.

the chain of supply of the components necessary for the development of offshore wind power energy and will also provide logistics for offshore wind energy in the Baltic Sea.⁶¹ The potential of wind power will also be used in the mainland through the redevelopment of wind power plants in the northern and central part of Poland.⁶² Photovoltaics will, in turn, focus on microinstallations (households, offices), which might also lead to overloading of the energy grid and problems with the energy distribution. The further development of photovoltaic microinstallations requires redevelopment of the energy distribution grid.⁶³ Among the EPP 2040 goals, there is also hydropower. However, considering the rather limited potential of Poland, all that is planned is the increase of storage reservoirs or barrages (redevelopment and construction of new constructions). Pumped storage hydroelectricity can be of local importance.⁶⁴ The development of renewable energy sources is undoubtedly expensive and difficult to realize without EU funds. Additionally, the dynamic boost of the generative power from green energy is still unlikely to replace conventional sources of energy within the next two decades. Renewable energy sources can significantly support the Polish power engineering system, but without the development of the remaining energy sectors, that is, nuclear power, the aims of the energy transformation will be difficult to achieve.

A visible weakness of EPP 2040 is its lack of reference to hydrogen technologies when it comes to the energy transformation of the country.⁶⁵ Hydrogen is mentioned in the context of transport (hydrogen mobility). Due to its zero-emission character, hydrogen is considered to be useful, especially for individual vehicles and public transport. Hydrogen implementation in transport, both in its pure form (fuel cells) and zero-emission synthetic fuels (fuel derivatives, including N-fuels which use ammonia synthesis with green hydrogen), will be used in fleet vehicles, in public transport, utility services, and industrial logistics. One of the advantages of hydrogen-driven vehicles over electric ones is that they do not need charging of several hours.⁶⁶ Clearly, hydrogen technology will be used in the future not only in transport but also in power engineering. Technological progress as well as intensive research point out that hydrogen energy will become an essential element of modern economies.

Finally, it is also necessary to mention the costs of Poland's energy transformation. It was estimated that the realization of the EPP 2040 goals, carried out in a socially acceptable way that guarantees energy security, maintains competitiveness of the economy and limits negative influence on the environment, will call for enormous financial input, which could reach even 1,600 billion PLN in the years 2021-2040. In the entire

⁶¹ Ibid.

⁶² B. Igliński et al., "Wind Energy in Poland...", p. 23.

⁶³ P. Rapacka, "Słoneczna rewolucja na dachach wymaga inwestycji w sieci", *BiznesAlert*, 16 July 2020, at <https://biznesalert.pl/fotowoltaika-rapacka-slonce-dachy-inwestycje-sieci-dystrybucja-pse-ozee-energetyka/>, 12 February 2022.

⁶⁴ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 66.

⁶⁵ L. Gawlik, E. Mokrzycki, "Analysis of the Polish Hydrogen Strategy in the Context of the EU's Strategic Documents on Hydrogen", *Energies*, vol. 14, no. 19 (2021), 6382, p. 13.

⁶⁶ Ministerstwo Klimatu i Środowiska, *Polityka energetyczna Polski...*, p. 54.

fuel and energy sector, the costs might reach around 867-890 billion PLN, while in the non-energy sectors (industry, households, services, transport, and agriculture) the total amount can get to around 745 billion PLN.⁶⁷ This raises some reasonable doubts whether Poland can actually afford such expenses, even with a significant financial support from the EU.

CONCLUSIONS

Energy security is a key element for the functioning of society and that is why it is so important for the state to get its highest level and maintain it for the longest possible time span. Dynamic changes in the international environment mean that the approach towards methods and measures taken to guarantee energy security has to be flexible. This obviously applies to Poland, which faces a huge challenge in ensuring energy security since the power engineering system is rather obsolete and highly dependent on the Russian raw materials. That is why the solutions presented in EPP 2040 are supposed to boost the transformation of the energy sector. Within the next two decades, Poland will achieve a balanced energy mix through the process of decarbonization. Coal will still be used, but its amount will definitely be reduced in favor of natural gas and renewable energy sources. Natural gas will function as a transition fuel necessary to balance the need for energy and after 2040 its role will decrease. Green energy will experience the opposite trend – its importance will increase year by year. Nuclear energy will play a special role in the transformation process and significantly compensate for the energy losses caused by the shutdown of coal power plants. Realization of goals related to nuclear power will have an impact on the balance of the Polish energy mix in the 2030s. The cutting-edge technologies will emerge aiming to utilize other sources of energy, such as hydrogen. It may appear that the technological progress will facilitate more dynamic and effective redevelopment of the energy sector, not only on the national level, but also on the global level.

EPP 2040 should be evaluated positively. The strategic goals are relevant to the needs and expectations for the energy transformation of the country. Methods and measures taken to realize the aims match the potential of the Polish state. The biggest challenge in this aspect will be to achieve the goals in accordance with the time frame set in EPP 2040 and to reduce the dangers of decarbonization. One of them will be providing deliveries of energy raw materials on a sufficient level, especially natural gas. The other key challenge will be to secure sufficient investment funding. Undoubtedly, the energy transformation is well beyond the financial reach of Poland, therefore EU funding will be necessary. Unfortunately, the redevelopment of the Polish energy sector could also be influenced by the geopolitical situation. Certainly, the war between Russia and Ukraine will have an impact on the energy sectors of many countries, including Poland, and will force EPP 2040 to adapt to the changing political and economic reality.

⁶⁷ Ibid., p. 90.

Unquestionably, strategic goals of EPP 2040 are concurrent with political, economic, and social expectations. Quick decarbonization of the energy sector might threaten energy security of the country.

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