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BROWN COAL - THE FUTURE OR PAST? POLISH ENERGETIC SECURITY IN CASE OF MATERIAL MINING

Abstract. Points of the article are: summarizing the seventy years of lignite presence on the national energetic market, describing current share of raw material in electricity production in Poland, analyzing possible effects of reduction of its output and proposing an alternative in case of burn-out of deposits. As a part of writing article, research methods that were used: analyze of texts, documents, directives and assess the current situation regarding climatic and energetic policy.
Keywords: lignite, brown coal, energy, energy security, Polish energy policy, climate policy, lignite mining history, lignite future.

WĘGIEL BRUNATNY – PRZYSZŁOŚĆ CZY PRZESZŁOŚĆ? BEZPIECZEŃSTWO ENERGETYCZNE POLSKI W KONTEKŚCIE WYDOBYCIA SUROWCA

Streszczenie. Celem artykułu jest podsumowanie siedemdziesięciu lat obecności węgla brunatnego na krajowym rynku energetycznym, opisanie aktualnego udziału tytułowego surowca w produkcji energii elektrycznej w Polsce, dokonanie analizy możliwych skutków zmniejszenia jego wydobycia i zaproponowanie alternatywy w przypadku wyeksploatowania złóż. Podczas przygotowania artykułu posłużono się następującymi metodami badawczymi: analiza tekstów, dokumentów, dyrektyw oraz ocena bieżącej sytuacji politycznej dotyczącej polityki klimatyczno-energetycznej.
Słowa kluczowe: węgiel brunatny, energetyka, bezpieczeństwo energetyczne, polityka energetyczna Polski, polityka klimatyczna, historia wydobycia węgla brunatnego, przyszłość węgla brunatnego, eksploatacja złóż.

Introduction

In the age of ever-increasing numbers of conventional and non-conventional methods of production and consumption, societies and decision-makers in developing energy security strategies can analyze the advantages and disadvantages of using a particular fuel or element. A number of factors may influence the opinion, and the interpretation of each one is dependent on the material and resource situation of the country, but also on the mentality and the worldview of society.

Energy is present in human life since the dawn of time. The oldest traces of the use of fire, that is, heat energy, derive from two million years ago. About three hundred thousand years ago, the primitive man began to sustain the burning flame and commonly use it, taking from it immeasurable benefits that we – common society also cannot give up, despite the advances in technology and the passing of time. Human, and almost every living entity will be always accompanied by primary needs - warmth, safety, hunger and this will not change in the near future. But as time goes by, more raw materials are beginning to play a key role in the economy: wood has replaced coals and oil, which are used on a large scale, and in turn are starting to be displaced by radioactive elements. Unconventional energy that can satisfy most of the energy needs, regardless of latitude and climate, can be named as utopia. It is possible that humanity will begin to use water and its hydrogen and geothermal energy in the context of commonly used fuels in the future. In addition to the development and dissemination of technology enabling such a process, changes in the economic and climatic policies of fuel and energy states and consortia may be necessary.

The main factor, including the presence of raw material in a given area or its possible import, is cost-effectiveness. Almost all members of the European Union (except Denmark) are more or less dependent on foreign sources of electricity, so in most countries processing of raw materials is available on the domestic market. In the first place (26%) among the most used energy sources is coal-fired [2]. Gas (23%) is on the next position, mostly imported from outside of the European Union [3]. Third place is reserved for the processing of radioactive elements (14%), which are also imported from other continents.

Recalling the topic of nuclear energy, one should analyze the next factor that determines the energy policy of the country - the social mentality and possible unwillingness of the given sources of energy, we can show Lithuania as an example. As a result of the closure of the Ignalina Nuclear Power Plant, which covered 90% of the country's needs, Lithuania became dependent on imports of electricity from abroad. The reason for ending the operation of this power plant was the commitment of the Lithuanian government in the framework of EU accession to the exclusion of the plant, and a referendum held in 2012, in which Lithuanian public opposed the construction of a new reactor in Ignalina.

As another example of social prejudice to nuclear power we can show Poland. In our country, unlike Lithuania, no nuclear power plant was ever built, although in 1982 its construction was started in Żarnowiec. As a result of the Chernobyl disaster in 1986 and growing social aversion, the construction of the Pomeranian Power Plant in 1989 was halted.

Ecology, directives and other elements of the legislative power are the next determinants of the use of fuels in the context of energy security. Awareness of the need for environmental protection on a broader scale is a relatively new initiative in Poland, which at the time of the emergence most power plants and growing demand for electricity played a marginal role. Only with the passage of time, systemic transformation and generational exchanges, this issue has returned to the popular debate. Ecological environment may influence the construction, possibly abandoning it directly through protests and social actions. However, the earlier, indirect factor is the laws, standards and directives without which the project will stop at the conceptual stage.

History of lignite mining in Poland

In Poland the oldest pre-partition coal mine was established in 1766 in Szczakowo (today's Jaworzno) [4]. Since then, with the inauguration of the next mines, the extraction of raw materials has grown steadily, mainly in Upper Silesia. Over a century later, in 1882, Thomas Edison's design and implementation of the world's first power plant logically uncovered the next use of coal - the production of electricity. Another device which used this sedimentary rock as fuel was the steam engine used in the manufactures (mechanical energy production). Soon, in 1900, technological progress also appeared in the territory of present-day Poland - then Russian Empire - in the form of the first municipal power plant, located in Radom. The subsequent years, including the periods of the two world wars, were related to the further development of the industry and increasing demand for raw materials. After the end of the World War II in 1945, it was necessary to develop a plan to rebuild destroyed economy and energy infrastructure. The first step was the adoption of a law under which the Polish state took control of all industrial enterprises, including among others the mining industry [5]. The determinant of this policy was the necessity of restoring stability, energy security and increasing electrification of cities, and later also villages. In 1947 Poland, by virtue of a decision [6], took control of the first lignite mines in the area of Turów near Bogatynia [7] (before the war under German jurisdiction) from the Soviet Union. At that point, a period of control of a previously unavailable type of mining began, culminating in 1988, when Poland was in the top five world lignite mining. In 1947, only 4.3 million tons of raw material was harvested [8], seven and a half times less than hard coal in the

same period (62 million tons [9]). Disproportion later reached the most similar value in 1993 - 68 million tons of lignite mined to 131 million tons of hard coal (less than twice). This ratio, however, did not translate into a disproportion in electricity production in that year (only about 10% was produced from hard coal).

One of the advantages of lignite is the location of the deposit on much higher lots than hard coal. This is due to the much later development of the former (at least 8 million years - lignite, 28 million years - hard coal). Due to the small depth of the deck, the cost of mining is lower by engaging fewer employees and by using more machines. In addition, the number of accidents in open pit mines is low. The disadvantages are: low calorific value - an average of 6 MJ to 11 MJ / kg, limited transport capacity (therefore the power stations are always close to the lignite mine), negative impact on the environment (therefore the raw material is referred to as the "dirtiest").

There are two important factors that have contributed to the increase in lignite mining after 1947. The first of these was the launch of two large mines in 1955-1963: KWB[1] Konin and KWB Adamów. As of 1969, almost half of the mentioned fossil fuel in the country came from mining operations. An another factor was the discovery of the largest known lignite deposits in the world, estimated at 2 billion tonnes in the village of Piaski (municipality of Kleszczów, Bełchatów district) in 1960. Due to the scale of investments, conceptual planning took up as much as 12 years, and as a result, it was not until the 1980s that brown coal was first acquired. As a result of these events, the country achieved a maximum domestic production of 73.3 million tons in 1988.

In the years when the next five-year plans were being developed (an important element of the plans was the construction of the mines and the power plants), there was a boom in the industry that resulted in increased demand for electricity. Between 1980 and 2008, the average annual demand in Poland was about 30% [10], not to mention the earlier postwar years. Another factor contributing to this demand was also the demographic rise (an increase from 24 million in 1946 to almost 38 million in 1988 [11]). For these reasons, the development of the analyzed industry and exploitation of the title fossil fuel in Poland can be considered as justified and necessary to achieve the assumed economic goals and to ensure energy security.

[1] KWB – pol. Kopalnia Węgla Brunatnego – eng. Brown Coal Mine

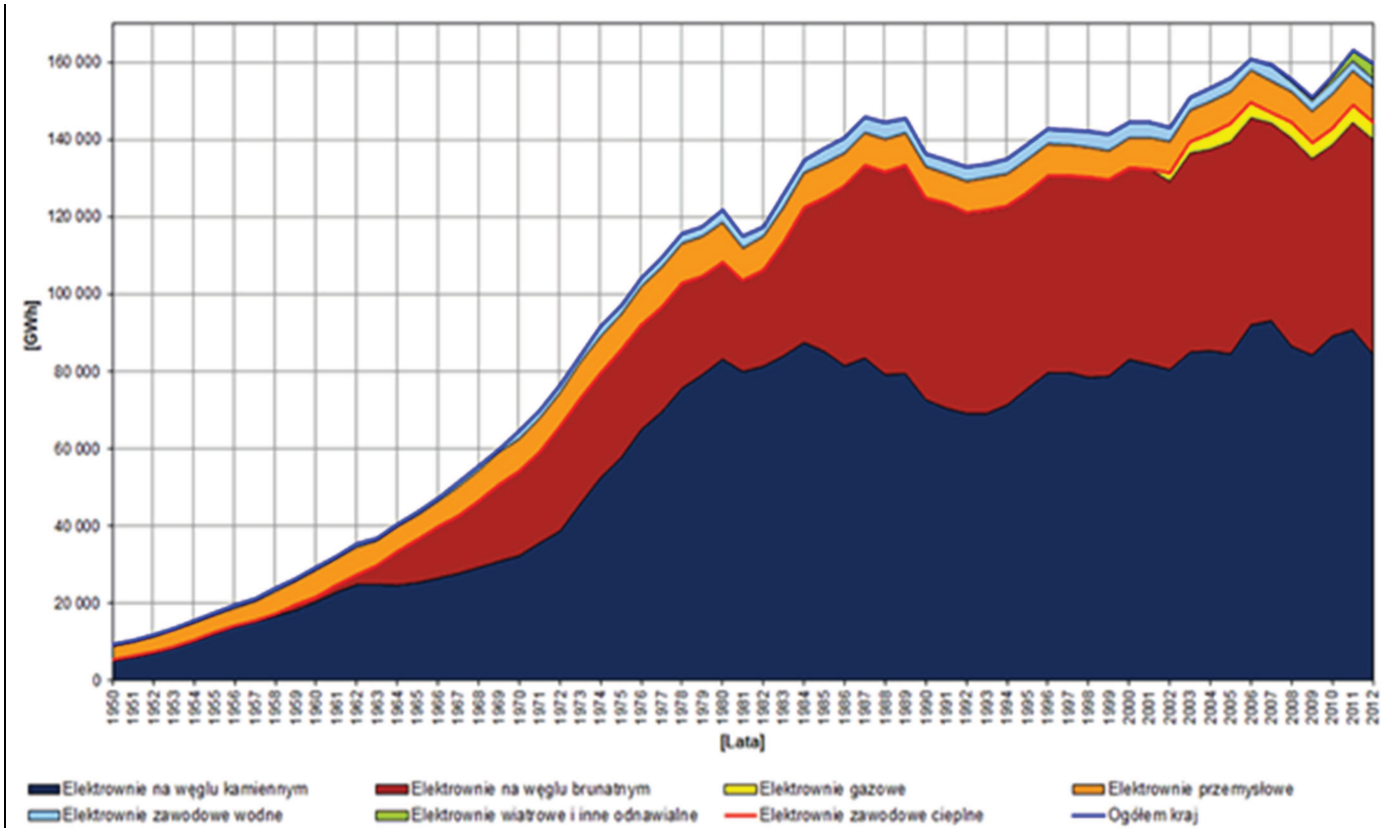

Fig. 1. Electric production in Poland in the years 1950-2012 [source: www.wysokienapiecie.pl]

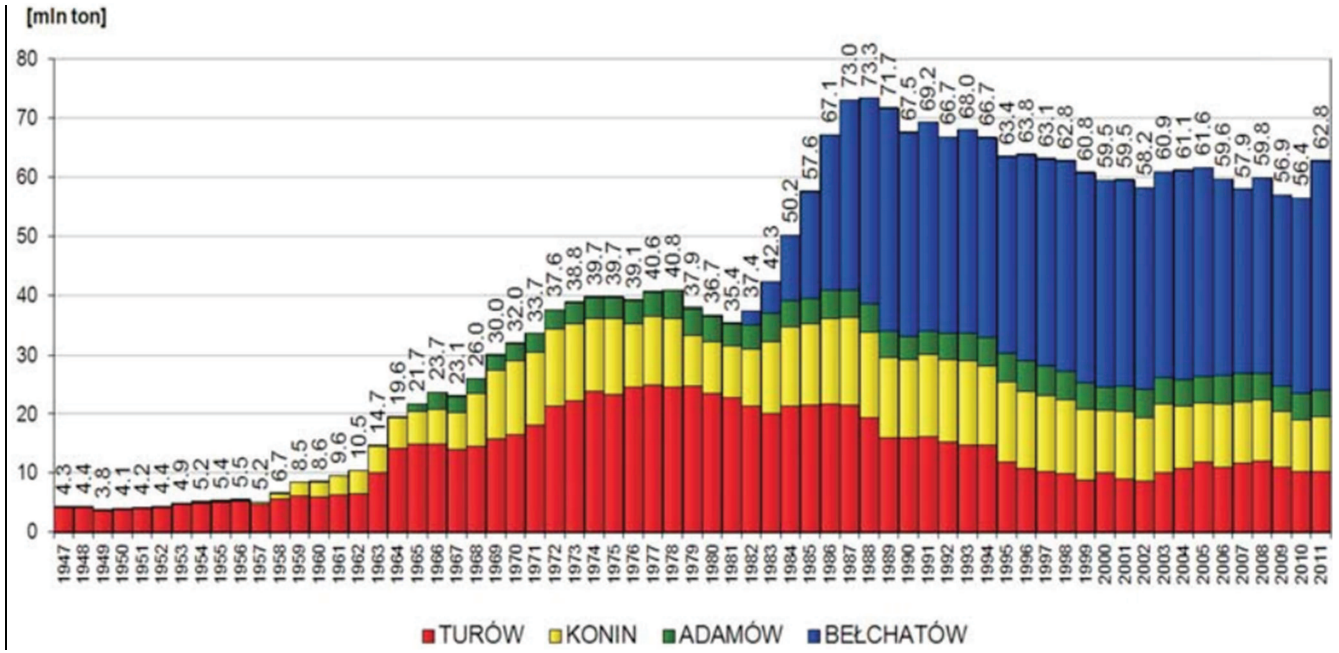

Fig. 2. Lignite mining in Poland in the years 1947-2011 [source: Kasztalewicz 2012]

Contemporary participation of lignite in electricity production in Poland

Over 60 million tons of lignite has been mined in Poland in 2016 (downward trend, with a maximum of 77.3 million tons in 1988). In 2015, 53.5 TWh (terawatt hours) was generated on this fossil fuel, which accounted for 33.11% of electricity produced in Poland [13]. Operation of the raw material on a similar level should be maintained until 2023, when the work in the Adamów KWB is going to be complete. Up to 2030, there will be an end of mining in Konin which is near Adamów (they are in one association of power plants - PAK). Adamów Power Plant, the first of the PAK group, may end its operation in 2018 [14]. The reason is that it's not compliant with the EU directive from the energy and climate package on greenhouse gas emissions (the plant was not included in the Transitional National Plan[2]). Modernization and adaptation to new standards in nearby mines seems unprofitable due to high costs and short lignite mining time.

The exploitation of new excavations in this region, which would give hope to prolong the existence of the power plant does not indicate much - the efforts to invest in the Dęby Szlacheckie (Babiak municipality) and a 40 km away Ościsłów will be unsuccessful. In the referendum, the inhabitants of the first commune expressed a negative opinion on the establishment of the mine. In Ościsłów, the local population expresses a similar opinion, and is supported by the ecological movement. The General Directorate for Environmental Protection is also not approving. On March 10, 2017, the company refused to specify the environmental conditions for the Ościsłów uplift. This is related to the possibility of violating protected areas under the Natura 2000 program and the redevelopment of 225 hectares of high-class agricultural land. Due to the appeal lodged by the KWB Konin authorities, the reissue of the decision was to take place on September 22, 2017, but it did not come to an end. Operation of the new deposit could extend the electricity production in this part of the Great Poland until around 2045. In summary, within thirteen years from now, two power plants supplying fuel for power stations which generate about 8% of Polish electricity will be shut down. In addition, according to climate policy, every member of the European Union is obligated to reduce greenhouse gas emissions by 20% by 2020, compared to 1990 levels (EU Directive, Article 28, paragraph 1).

[2] The plan, which aims to adjust the infrastructure of industrial plants with a minimum burning capacity of 50 MW to the standards set out in the Industry Emmisions Directive by 30 June 2020.

Plans for exploitation of new lignite deposits

According to current predictions, in the years 2040-2044, brown coal deposits will be depleted in the Bełchatów and KWB Turów. They are the only power plants that will be able to extract the raw material in Poland after 2030. If no new lignite deposits are to be exploited, this will mean the need for new fuels for the Bełchatów Power Plant and the Turów Power Plant, which are currently producing up to a quarter of Polish electricity [16] [17]. The modernization of the blocks 3-12 in 2016-2017, and the construction of the new thirteenth block in the Bełchatów Power Plant took a total of about 14 billion PLN [18] [19]. In turn, in Turów in 2019, a 450 MW unit will be put into operation, costing 4 billion PLN [20]. The costs incurred are determined by the need to find alternatives to operate these plants after 2040, especially in the era of ever-increasing electricity demand. We cannot forget that after 2020, every ten years there will be an increase in EU greenhouse gas emission limits, which in 2030 will be only 60% of 1990 emissions.

The most realistic for this moment is the operation of the Złoczew field (containing about 500 million tons of lignite [21]), from which the raw material would be transported by conveyors or trains to a distant 50 km straight line of the Bełchatów Power Plant. Brown coal, which also consists of water, would lose quality during transport, so this variant is still being analyzed. At present, the Polish Energy Group is applying for a concession for mining in the area of Złoczew. The presentation of the "Winter Package" by the European Commission, or, in fact, the commitment to fulfill it, is a threat to the development of the investment mentioned by the Ministry of Energy [22]. It may be added that, unlike Ościsłów and Szlacheckie Dęby, the inhabitants of Złoczew mostly contribute positively to the construction of the mine. Its creation would provide fuel for the Bełchatów Power Plant until at least 2055 (if a positive decision will be made for a long-distance coal transport).

The second deposit, which is the most considered in terms of exploitation, is located in Gubin-Brody municipalities, in the Lubuskie province, near the border with the Germany. Its content is estimated at 1.6 billion tonnes of lignite [23]. However, there are the same contraindications as in Ościsłów and Szlacheckie Dęby - the reluctance of the local population and the protests of ecological movement. In addition, in 2016 The Regional Directorate for Environmental Protection in Gorzów Wielkopolski has suspended the procedure for issuing a decision on environmental conditions for the planned mine [24]. Polish Energy Group manager admitted on November 3, 2017 that the administrative procedure for the construction of the Gubin power plant and mine is much more complicated than in the Złoczew area. In Poland there are some of the world's largest lignite deposits, which are located north of Legnica.

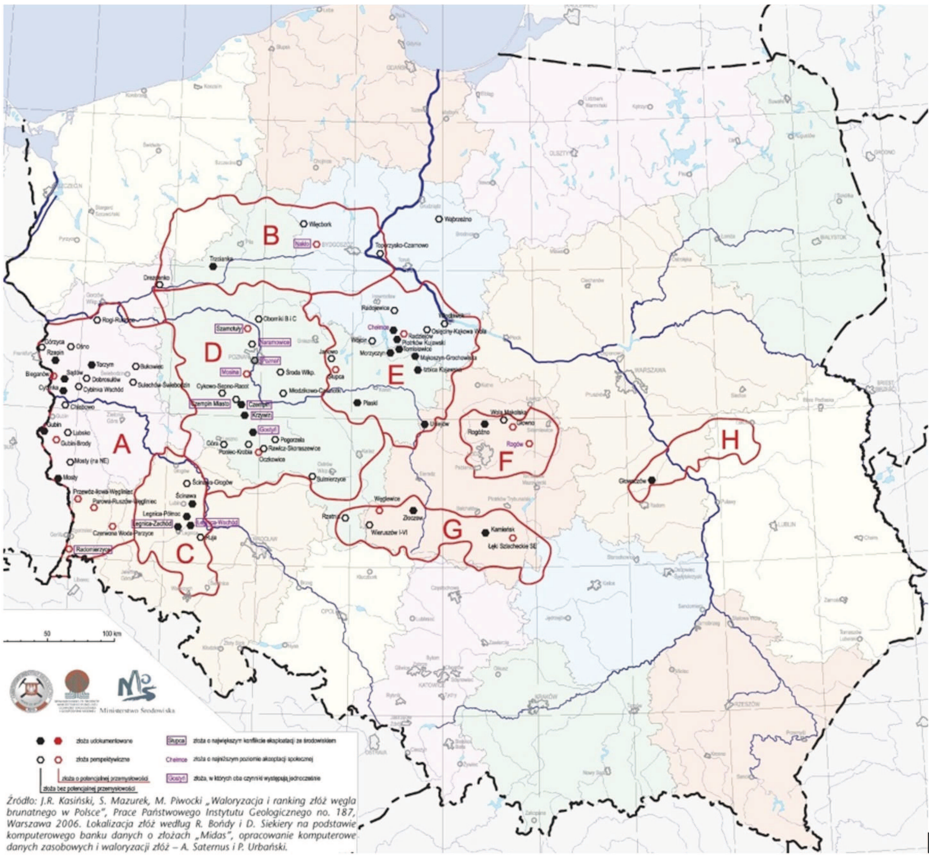

Fig. 3. Distribution of lignite deposits in Poland [source: National Geological Institute]

There are more than 15 billion tons of this sedimentary rock [25], five times as much as in Poland since 1947, and seven and a half times more than in Bełchatów Basin (the raw material is more caloric). The deposit is not considered in the operational context in the years to come due to lack of public support, conflict with the ecological movement, and planned location of the S3 expressway which will be over the deposit [26].

Of the six locations indicated at the parliamentary meeting on July 5, 2017, currently only in one is a chance to implement plans for the establishment of a lignite mine (Złoczew). All others have encountered difficulties in the form of: lack of social acceptance (including three negative references to the construction of local referendums), protests of ecological groups, and two refusals to define environmental conditions for mining operations by the Environmental Protection Directorate. This means that after 2040 the only lignite-fired power

station can be the Bełchatów Power Plant (generating 20% of the 33% generated by power plants fired with the title material).

By virtue of the Act of 28 November 2003 (Article 125) [27], it was restated to the owner of a property if his lignite mines were owned by the country. Theoretically, it can issue a decision for 12 months, but in reality it can be repeatedly extended. The same law describes the need to pay compensation for losses (it is possible to appeal to the governor [28]). In practice, this means that if the company decides on the environmental conditions of the project and receives a concession for lignite mining, it may start with the support of the district office and without approval of the local population, which may be a decision taken only centrally.

Conclusions

According to government assumptions, the core of the national energy sector is to remain hard coal and lignite by 2050 (with increasing share of renewable energy, biomass and biofuels). This policy with growing electricity demand will interfere with the "Winter Package" and the commonly-known IED (Industry Emissions Directive - Directive 2010/75 / EU of the European Parliament and of the Council). In the case of persistent greenhouse gas emissions and as a result of EU pressure, it may be necessary to close several power plants. The consequence will be the increasing import of electricity from abroad (which has recently reached a maximum of about 0.8 GW), which would have a negative impact on its price. Another variant (in the case of overruns after 2020), whose cost-effectiveness is a matter of debate, is to pay the contribution while shutting down power plants (if the cost of electricity is higher than the contribution).

In order to adapt the infrastructure to European restrictions, modernizations should be carried out throughout the country, at least on a scale such as those of Bełchatów and Turów, which absorbed a total of over 18 billion PLN. By investing 48 billion PLN [29], we are able to build a nuclear power plant with installed capacity of over 3,000 MW, which would meet more than 11% of domestic demand, thus filling the gap left over from lignite mining and power plant operations in Adamów and Konin. Such share of nuclear power in electricity production would coincide with the plans of the Polish Energy Group for the year 2025 [30] whose implementation by the need to acquire technology and land development is delayed. In addition, this would reduce greenhouse gas emissions and increase the likelihood of adapting to growing EU standards. According to the executives of the Ministry of Energy, Poland can afford to invest in nuclear power [31]. In a variant that uses alternative sources of electricity, the share of lignite in the industry could be around 20%. Considering the

growing demand for electricity and its growing import, finding new solutions in the Polish energy sector is necessary [32]. In addition, in the perspective of 2030 and the growing threshold for reducing greenhouse gas emissions, action is needed in the near future.

The following alternatives exist for traditional coal power plants that could be used in Poland:

1. development of geothermal energy (mainly in the context of thermal energy), especially in the area of Polish lowland [33];
2. increasing imports of natural gas and crude oil;
3. investment in nuclear power, including uranium and thorium recovery (e.g. coal in Bełchatów has an average of 3.3 g / Mg of thorium and 3.3 g / Mg of uranium.) At 52 million tons of coal ash deposited at the Power Plant Bełchatów is hypothetically able to raise more than 100 thousand kg of uranium and 80 thousand kg of thorium (no information on the occurring isotopes);
4. development of clean coal technology, i.e. carbon sequestration (CSS), coal gasification.

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