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Nonrenewable Energy Sources in Poland

1. Introduction

Since ever, the development of civilization on Earth has been intrinsically related to the exploitation of mineral sources (including the fossil type). The latter type of sources has also become the sort of basis for the global energy production; initially it was used in the form of warmth, then it became mainly used as electric energy. What is more, the phenomenon of 18th. I century industrial revolution was predominantly founded upon the coal-based energy. Similarly, the discovery of petroleum contributed directly to the striking development of motorization being especially visible at the turn of 19th and 20th centuries and, which may be easily observed at present. Moreover, the multitude of natural gas features discovered soon after the World War II made its usage highly universal not only in the field of power industry, but in the chemical as well.

Mineral sources are defined as this specific part of the natural resources of the planet Earth that determines both human existence and the development of civilization. In order to obtain the most useful mineral sources, the previously tapped fossil sources frequently undergo a rarefaction process and a variety of other treatments as well. In spite of the fact that the vast majority of natural sources is renewable, the mineral type presents itself simply nonrenewable especially in the time scale of human civilization existence. Its renewability might be, however, perfectly exposed in the geological time scale.

2. Petroleum/Oil

According to the geological records collected in Poland in 2010, oil was struck in 82 different places in our country, including the Carpathian Mountains – 29 oil

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deposits in its foreland, 40 in the area of Polish Lowlands and two deposits found in the Polish Economic Zone of the Baltic Sea. What is more, oil extracted in the are of the Carpathian Mountains and its foreland is described as the oldest deposits owing to be discovered in the region of the oldest oil drilling in the world. Nevertheless, these particular resources are currently found at the verge of severe depletion. Taking into consideration Polish economy, the sources of paramount importance are certainly the deposits discovered in the Polish Lowland. In 2010 the recoverable resources of that area constituted approximately 74.5% of all deposits in the country, whereas oil struck in the Polish Economic Zone of the Baltic Sea powers it merely in 20.5%. Pondering the oil resources drilled in the Carpathian Mountains and its foreland, these are definitely a matter of lesser importance (0.3% and 0.2% of the Polish resources in total).

Oil deposits of the Polish Lowlands are to be found in the Permian, Carbon and Cambrian formations. The common feature of oil struck in this area is a moderate amount of paraffin (4.3–7.4%); the amount of sulphur oscillating around 1% and density between 0.857 and 0.870 g/cm³. The majority of reserves in question belongs to the massive type with the passive water layer and the gas-expansive condition of the production. The biggest deposit is located in the area called BMB (derived from the names of the following towns: Barnówko, Mostno and Buszewo) situated nearby Gorzów Wielkopolski. The oil reserves of that particular deposit were reported to have been twice as big as the whole petroleum deposits of Poland in times when it had not been yet discovered. However, the Lowlands abounds also with other oils deposits such as Lubiatów, Grotów or Czychry, the importance of which should not be definitely considered lesser that the one of BMB [5].

The oil struck in the Carpathian area appears in diverse tectonic units, most of them, however, appear in the Silesian kind. The deposits are predominantly of a structural type (the structural-lithological type occurs definitely rarer in this area); mainly of a stratified type with the encompassing waters. Initially, oil extraction is caused by the gas solution, then, as a result of gravity.

The Carpathian oil is of a methane type with the density between 0.750 and 0.943 g/cm³. It belongs to the non-sulphur type. The amount of paraffin oscillates between 3.5% and 7.0%. The Carpathian resources of oil deposits are certainly not large due to its dependency of the quantity and structural type [2].

As a result of the long-term exploitation the severe depletion of these deposits has been noticed. The oil reserves occurring in the hollow of the Carpathian foreland are found mainly in the quaternary substratum; the platform type of sedimentary Mesozoic formations (often the Jurassic carbonate and less frequently of the sandstone cretaceous formation type), mostly lying under the draughtproofing loamy formations of the Miocene. The majority of those reserves is of a stratified type; monitored stratigraphically, litologically or tectonically. The petroleum struck in this area is of a light and medium-light type (with the density 0.811–0.846 g/cm³). The paraffin amount oscillates between 2.32–9.37%, whereas the average percentage

of sulphur does not exceed 0.85%. Nearly 96% of the Polish oil deposits is being currently used. Some of the oil deposits struck in the area discussed include certain gas components being dissolved in the petroleum so that they form an oil condensate. Taking Polish Lowlands into account, oil condensate appear mainly in the deposits of Cychry, but it has been also noticed in the areas of: Babimost, Jastrzębsko or Antonin 1. Pondering the area of Carpathian Foreland, the oil condensate may be found in Łąka, while taking into account the Carpathian Mountains some tiny petroleum amounts are to be found in the deposits of Słopnice area.

In 2010 the total number of oil and oil condensate output extracted from both Polish overland area and Polish Economy Zone of the Baltic Sea (off shore) equaled 667.46 tonnes. Consequently, with reference to the previous year the petroleum extraction in Poland has been increased for approximately 5.5 tonnes. This perfectly illustrated the comparison of Figure 1.

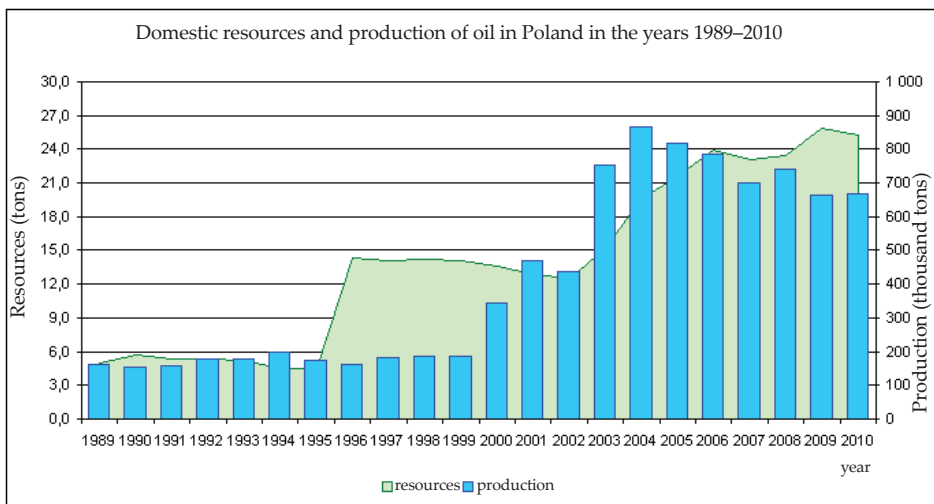


Fig. 1. Domestic resources and production of oil in Poland in the years 1989–2010

Source: [5]

3. Natural Gas

The main areas of natural gas extraction in Poland are the Polish Lowlands. Other places in our country, where the natural gas is frequently found are the Carpathian Forelands, the whole Carpathian Mountains (in which, however, the deposits are comparatively smaller) and the area of Polish Economy Zone of the Baltic Sea. Nearly three-quarters of all natural gas reserves are found in the formations of the Miocene

and in Rotliegendes; whereas the rest occurs mainly in the formations of the Cambrian, the Devonian, the Carboniferous period, in the Zechstein, Jurassic and Cretaceous formations. Taking the Polish Lowland into account, the main area where the natural gas resources appear is the area of the Sudety Mountains foreland as well as the Greater Poland region. In both these places natural gas is predominantly found in the Permian formations. In the Western Pomerania, however, the natural gas frequently occurs in the formations of Permian and Carboniferous periods. It is mostly of a massive or block type, with hydrostatic or gas pressure conditions of exploitation. In the area described there are only few natural gas reserves that contain large amounts of methane – the dominant type there is nitrified containing between 30–80% of methane. Consequently, the gas mixture received is either of methane/nitro or nitro-methane type. The natural gas reserves extracted from the area of the Carpathian Foreland appear mainly in the formations of Jurassic, Cretaceous and Miocene period. This type of gas is characterized most of all by the high amounts of methane and comparatively lower quantity of nitro at the same time, whereas the nitrified type is rather scarcely found in this area. The reserves usually belong to the structural-lithological, stratified type (the massive type occurs definitely rarer there), producing gas in the gas pressure conditions [2].

The natural gas extracted from the Carpathian Mountains is found in the Cretaceous and Quaternary formations and occurs either independently or in the company of oil and oil condensate. The natural gas extraction of that area is received mainly due to the gas pressure process. Thus, the gas type received contains a large quantity of methane (usually 85% or more) with a comparatively smaller amount of nitrogen.

The reserves located in the area of Polish Lowlands contain nearly 70% (69.5%) of the total natural gas amount in Poland, where one-fourth of all these reserves is being constantly extracted from the Carpathian Forelands. Pondering the natural gas explored from the Carpathian Mountains and the Offshore Baltic zone, it becomes clear that these reserves are of far lesser importance (not much than 4% of the natural gas comes from the Offshore Baltic Zone, whereas the reserves of the Carpathian Mountains does not exceed 1%). In comparison to 2009, the natural gas reserves has been decreased by 1,664 billion m³ during just the following year (the natural gas reserves measured in 2010 equaled 147,393 billion m³). Such an astonishing shortage was mainly caused due to the exploration process. However, 2010 was also the year in which some new natural gas reserves have been found, namely: Kowale (10,029 million m³), Markowice (7,400 million m³) and Winna Góra (20,387 million m³). Nevertheless, the largest accretion of the natural gas resources (by 2,520 billion m³) on the grounds of the most effective gas recognition has been taken in Żuchłów.

The recoverable resources of the natural gas reserves equal 12,158 billion m³, which constitutes 2.5% of the general amount of natural gas resources. The industrial reserves of the natural gas in 2010 equaled 6498 mld m³. Domestic resources and production of natural gas well is presented in Figure 2.

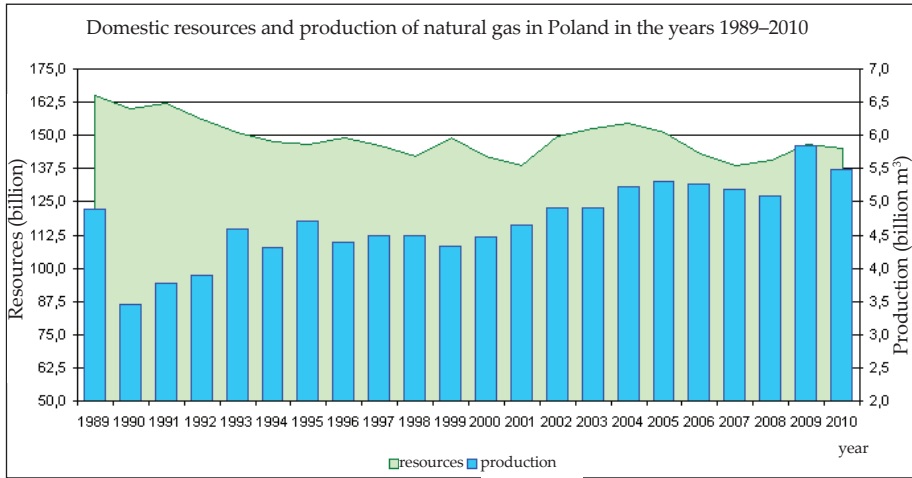


Fig. 2. Domestic resources and production of natural gas in Poland in the years 1989–2010.

Source: [5]

4. Hard Coal

Hard coal is a type of mineral raw materials the quantity of which is considered to be the largest in Poland. Moreover, it plays definitely the greatest role on the Polish raw materials market and, in comparison to other materials in our country, it certainly has the cardinal importance. There are three main coalfields in Poland: Upper Silesian Coalfield, Lublin Coalfield and Lower Silesian Coalfield. The hard coal mining, however, is being currently carried out only in the two of the previously mentioned places: in the Upper Silesian and Lublin Coalfield. As far as the Lower Silesian Coalfield is concerned, it has only the historical meaning.

4.1. The Lublin Coalfield

The area of Lublin Coalfield has been divided into two parts: The NE part situated on Łuków-Hrubieszów Hill and the SW part in Lublin. The borderline between these two parts is marked by the Kock structure. The NE part is characterized by its block structure. The Carboniferous formations are put there either horizontally or nearly horizontally, whereas the structure of the Carboniferous formations of the second part (SW) being definitely less explored, is slightly folded.

The industrial reserves of natural gas occur only in the layers of the Lublin area. Its diversified coal bearing capacity is strongly reliant upon the thickness of particular tectonic blocks. Formally, the part of Lublin Coalfield recognized predominantly by drillings, has been divided into several areas out of which only one is being currently exploited by the Bogdanka Coal mine. The hard coal mined in the

Lublin Coalfield is of a various type: the Northern area abounds in steaming type (gas-flame and gas coal), whereas the gas-coking coal dominates in the South. The steaming coal reserves constitutes nearly 84% while the gas coking type only 16%. The percentage of balance coal resources mined in the area of the Lublin Coalfields equals 21.5 of all balance coal resources in Poland [4]

4.2. The Upper Silesian Coalfield

The Upper Silesian Coalfield is situated in the area of the Cracow-Silesian Upland and covers nearly 6,100 km². It has a shape of triangular basin filled with the Upper Carboniferous coal measures. Its western borderline goes from the southwest to the northern-east (from the Nový Jičín to the Tarnów Mountains) whereas in the Eastern part the Upper Silesian Coalfield borders on the line stretching from the Tarnów Mountains to the town of Myslenice. The overthrust line of the Carpathian Mountains marks the Southern borderline of the Coalfield [3].

The vast majority (90%) of the anthracite in Poland is extracted from the area of Upper Silesian Coalfield. On the basis of drillings and mine workings it has been acclaimed that the USC abounds with all of the possible technological types of hard coal (the most frequently occurring types there are flame and gas flame coal). One of the main disadvantages of hard coal exploitation in that area is the severe environmental degradation. As a consequence, all of the present mining activities are carried out taking into serious consideration a number of radical ecological restrictions imposing the rational economy of the raw materials and its preservation; protecting the surface from the damaging effects of mine workings; waste and water management; coal desulphurization and reclamation of the areas degraded.

4.3. The Lower Silesian Coalfield

The substratum of the basin consists mainly of the Caledonian or even older formations. It has an elliptical shape with the longer part (60 m) going north-westwards and the shorter long for about 50 m. The northern and eastern parts of the Coalfields are included within the territory of Poland, whereas the western area belongs to the Czech Republic. The total area of Lower Silesian Coalfield covers approximately 1,200 km² out of which 500–600 km² contains the hard coal reserves that can be mined up to a depth of 1,500 m [4].

In 1994, the estimated quantity of hard coal mining equaled 500 million tons, out of which nearly 365 million had been recorded just up the year 1950. A high amount of Carbon dioxide occurring in the whole area of the Coalfield combined with the significant brittleness of hard coal result in the rapid rock and gas eruption. What is more, due to the exploitation processes being impeded by a variety of geological conditions such as: eruptions or rock bursting, the exploitation costs have been dramatically raised. As a result, the costs turned out to be utterly unprofitable. Thus, in 1992 the decision about closing the mines had been made and consequently the hard coal exploitation in

the area of Lower Silesian Coalfield was soon (2000) ended. The year 2000 was also the year in which the Nowa Ruda mine also stopped mining the hard coal. Currently, the anthracite is being mined only in some moderate quantities (Fig. 3.)

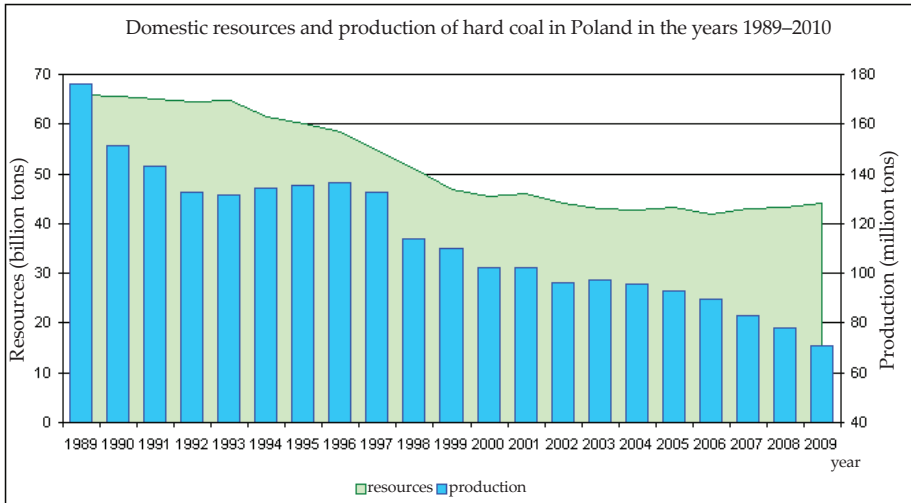


Fig. 3. Domestic resources and production of hard coal in Poland in the years 1989–2009

Source: [5]

5. Brown Coal Lignite

Soft brown coal occurs frequently in the areas of the Polish Lowland in both the Paleogenic and Neogenic formations, whereas the hard type is predominantly mined in the basin of Southern Sudety Mountains (the Cretaceous formations) as well as in the periphery of the Świętokrzyskie Mountains (the Jurassic formations). Currently, the only reserves of a practical matter are the Miocenic formations of soft lignite, the substantial reserves of which occur mainly in the area of Western Poland. What is more, these are the reserves that constitute presently the most important and highly valuable source of energy resources in Poland [1].

The 5th Oligocene brown coal Czempin seam is the only seam that has a considerable economic importance. It occurs among the Paleogenic formations on the area covering nearly 7,700 km² with a significant level of thickness of up to 45 m. There are three such seams, namely: Rogoźno, Łąnięta and Bąkowo, none of which, however, is being currently exploited. Another seam of a lesser importance is definitely the oldest Miocenic seam – the 4th Dąbrowa seam covering the area of 7,000 km². It has been observed that these are the youngest seams that are a matter of greater economic importance, namely: occurring within the formations of Miocene period such as: the 3rd Ścinawa seam extending for about 30,000 km² with the thickness oscillating around 35 m (the seams of

Mosty and Ścinawa); the 2nd Łużyce seam spreading over an area of 61,000 km² with a thickness up to 40 m (the seams of Czempin, Gostyń, Krzywiń, Lubstów, Mosina, Naramowice, Radomierzyce, Szamotuły) or even reaching 250 m in tectonic subsidences such as the Belchatów seam; as well as the 1st seam of Central Poland covering an area of 70,000 km² with 20 m of thickness (seams of the Konin region).

A number of diverse opinions concerning the brown coal exploitation and its application in the professional energetics have been stated; not to mention the one describing the its exploration as far unprofitable. Nevertheless, the most serious accusations against the source discussed were brought by the environment preservation activists.

Despite certain plans being made in order to increase the natural gas exploitation in the Polish power industry and the estimated growth in energy produced by the recoverable sources, it is anticipated that in 2030 over 60% of all electric power in Poland will be received from the power stations heated either by hard or brown coal. Nevertheless, it is lignite that is currently considered the least expensive source of energy (approximately 19 USD/MWh, which equals nearly 65% of the costs of energy received from hard coal).

The energy produced by four out of five great power stations heated by brown coal in Poland is still less expensive than the Polish most inexpensive power station using the hard coal – “Opole.” The propitious geological conditions combined with the advanced mining technology (with emphasis put on lower costs of conveyor transport of considerable loads) result in the fact that having converted it into the heating value (caloricity), lignite has been considered the least expensive source of energy in Poland. What is more, according to the latest surveys, it will certainly hold this position within the following years.

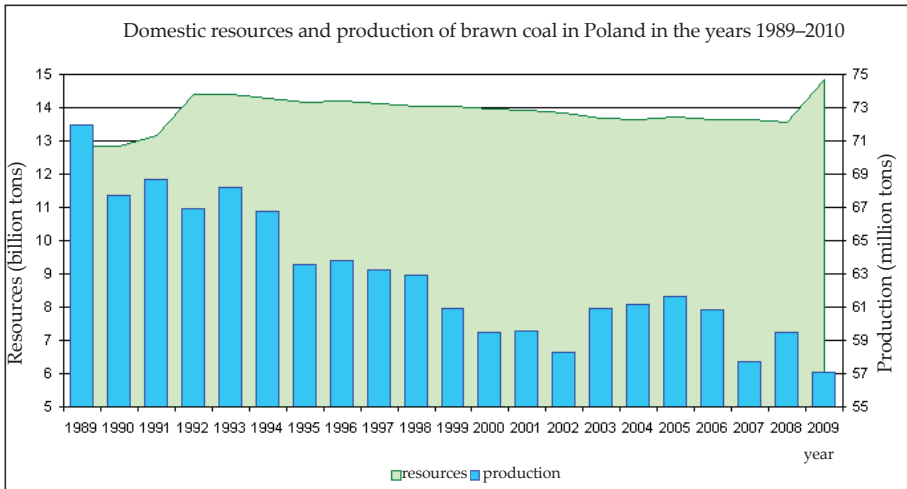


Fig. 4. Domestic resources and production of brown coal in Poland in the years 1989–2009

Source: [5]

In Poland, the resources of this material are very significant and the update data amounts to 29,814.7 million tons, including deposits identified initially – 15,963.5 million tons (Fig. 4) [5].

References

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