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**THE STATE AND CONDITIONS OF THE FUTURE FUNCTIONING
OF HARD COAL MINING IN POLAND****STAN I WARUNKI PRZYSZŁEGO FUNKCJONOWANIA GÓRNICTW
WĘGLA KAMIENNEGO W POLSCE**

The role of the hard coal mining sector in ensuring energy security of the country has been presented in the paper. An analysis of its current status was made based on the results obtained by the sector in 2017. Moreover, the determinants which are the precondition for further sustainable and efficient operation in the years to come have been defined.

Keywords: hard coal mining, technical and economic results, operational efficiency

Zaprezentowano rolę sektora górnictwa węgla kamiennego w zapewnieniu bezpieczeństwa energetycznego państwa. W oparciu o wyniki uzyskane przez sektor w 2017 roku dokonano analizy jego obecnego stanu oraz określono determinanty warunkujące dalsze trwałe efektywne funkcjonowanie w następnych latach.

Słowa kluczowe: górnictwo węgla kamiennego, wyniki techniczno-ekonomiczne, rentowność działania

1. Introduction

Hard coal and lignite mining sectors, supplying the largest amounts of raw materials for the power industry, play a special role in our country – they are the basis for energy security. This concept is defined as *‘current and future satisfaction of the needs of customers for fuels and energy in a technically and economically justified manner, while maintaining the requirements of environmental protection’* (Polityka, 2018). Particularly important in this respect is hard coal, which has by far the largest share among primary energy carriers, which are used in Poland for

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the production of electricity and heat. It should be noted that this situation will continue for many years to come. This is due to three main reasons:

- the existing structure of the energy-producing enterprises, of which coal power plants are by far the most numerous,
- abundance of exploited coal deposits and the possibility of opening out new deposits,
- lack of an appropriate amount of other primary energy carriers – natural gas and crude oil.

Moreover, it is also very important that hard coal mining by providing numerous workplaces (especially in the Upper Silesian region) and substantial revenues to the state budget, also has a significant socio-economic importance (Bijańska et al., 2018).

For this reason, it is important for the entire economy that this sector functions effectively, producing coal with high quality parameters in a safe manner and at possibly the lowest costs, which will find buyers both on the domestic and foreign markets.

This paper aims to provide, based on the results obtained by the end of 2017, information on the current sector of the hard coal mining industry, along with determining the prospects for its operation in the coming years.

2. Coal resources, functioning mines

Hard coal deposits in Poland are found in three basins: the Upper Silesian Coal Basin (USCB), the Lublin Coal Basin (LCB) and the Lower Silesian Coal Basin (LSCB). Currently, its extraction is carried out in two of them – the Upper Silesian and in the Lublin Coal Basin (since 2000 exploitation was abandoned in the Lower Silesian Coal Basin and it has only historical significance). Figure 1 shows a map with marked areas on which coal deposits are located.



Fig. 1. Location of coal basins in Poland

The state of hard coal resources, according to the data of the Polish Geological Institute, as at 31.12.2017 is presented in Table 1 and Figure 2.

TABLE 1

Hard coal resources in Poland as at 31.12.2017, [mln Mg]

Specification	No. of deposits	Geological resources					Industrial resources
		Recoverable				Non-recoverable	
		in total	A + B	C1	C2 + D	group a group b	
Total resources, including coal:	158	60,495.60	6,344.02	21,045.06	33,106.52	13,726.59 1,040.66	3,200.87
type 31-33		42,749.01	4,110.96	13,841.27	24,796.78	10,576.53 817.78	1,904.80
type 34-37		16,959.15	2,225.23	7,158.24	7,575.68	3,113.33 222.88	1,296.08
others		787.44	7.83	45.55	734.06	36.84 —	—
including developed resources							
In total	50	22,497.49	4,367.70	10,377.82	7,751.97	4,396.14 793.16	2,832.38
including undeveloped resources							
In total	61	33,493.50	610.36	8,972.03	23,911.11	8,259.98 246.41	250.77
including resources the exploitation of which was abandoned							
In total	47	4,504.62	1,365.97	1,695.21	1,443.44	1,070.58 1.09	117.72

Source: (Szuflicki et al., 2018)

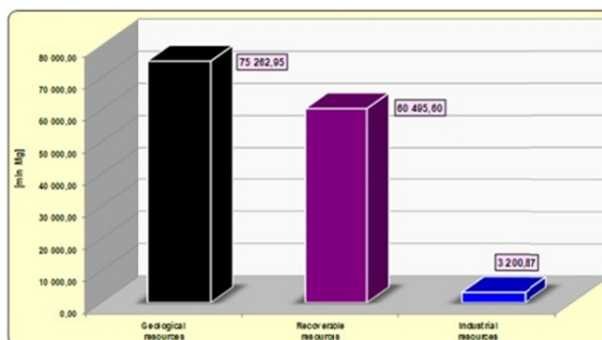


Fig. 2. Geological, recoverable and industrial resources of hard coal – as at 31.12.2017

Source: (Szuflicki et al., 2018)

As can be seen from the overview included in Table 1, most of the hard coal resources are found in undeveloped deposits (33.49 billion tons – 55.4%). In addition, from almost 22.5 billion tons of coal from developed deposits only a part of them is explored in detail, in terms of A, B and C1 exploration categories – 14.75 billion tons, which is about 65.6% of these deposits. In turn, out of this only 2.83 billion tons (about 12.5% of the developed resources) constitute industrial resources that may have economic significance. Assuming that about 30-40% may

be operating and non-operating losses, only about 2.0-1.7 billion tons of the total amount are recoverable resources.

The main area of exploitation of hard coal seams is the USCB – apart from one mine, LW ‘Bogdanka’ SA located in LCB – all other mines operate within the USCB. In 2017, they jointly produced about 56.4 million tons of coal, which accounted for 86.1% of domestic production. A summary of coal companies existing at that time is shown in Figure 3.



Fig. 3. Coal enterprises operating in Poland in 2017

Source: own study

In 2017, there were 21 hard coal mines (20 of them have been active since April 2018), extracting annually from over 9 million tons to less than 200 thousand tons of coal. The changes in the number of mines in the period since 1990 are illustrated by the chart in Figure 4.

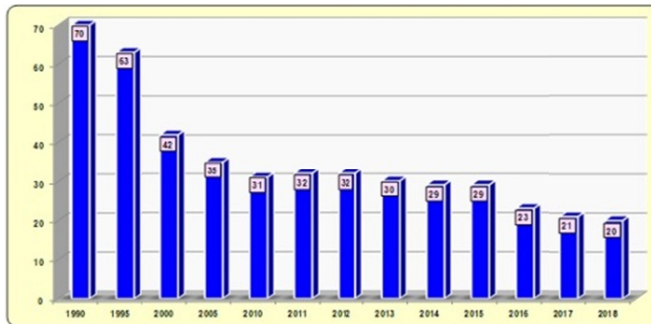


Fig. 4. The number of active hard coal mines in the years from 1990-2018

Source: data of ARP SA Branch in Katowice

3. Operating conditions in Polish hard coal mines, results and indicators obtained in the year 2017

In 2017, the net output of hard coal amounted to 65.48 million tons and it was the fifth consecutive year in which it decreased in relation to the previous year (Fig. 5).

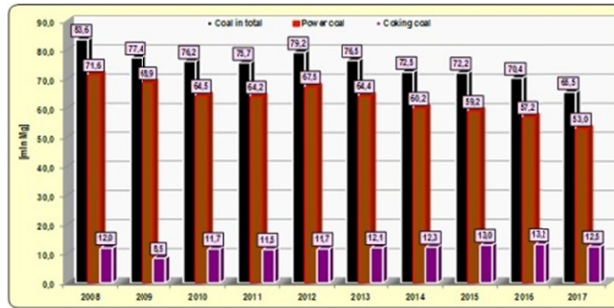


Fig. 5. Hard coal output (total and broken down into power and coking coal) from 2008-2017
 Source: data of ARP SA Branch in Katowice

The decrease in the volume of extraction related mainly to power coal – since 2012 it has decreased from 67.5 to 53.0 million tons (21.5%), while this figure in relation to coking coal in the last five years, depending on the year, has ranged from 11.7 to 13.2 million tons.

In all the mines, the exploitation of the seams was carried out by a longwall system with caving of roof rocks. On average, there were 85 active longwalls a year with a total length of the exploitation front of 17.2 km (Fig. 6).

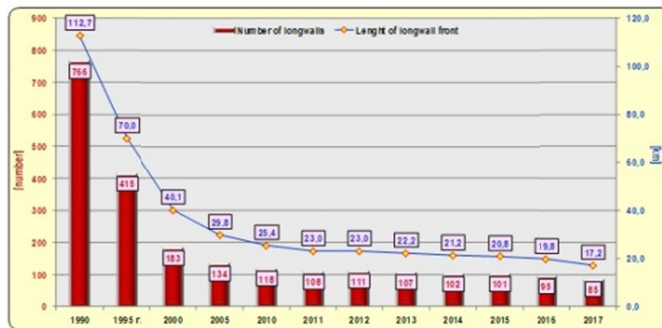


Fig. 6. Average number of active longwalls and the length of the longwall front from 1990-2017
 Source: data of ARP SA Branch in Katowice

The average output from one longwall in 2017 amounted to 3,047 Mg/d – it was the largest volume obtained in the Polish hard coal mining to this day (Fig. 7).

The average depth of exploitation was 780 m, and in the ‘Budryk’ mine it reached even 1290 m. Mining works were conducted in the conditions of natural hazards: methane, fire, rock-bursts, water, dust, climate, radiation, as well as gas and rock outbursts. The constantly increasing depth of exploitation together with the intensification of the existing natural hazards has been and continues to be one of the reasons for the decrease in the volume of coal output (Tajduś et al., 2018; Krause & Dziurzyński, 2015).

Out of the total output of 65.48 million tons of coal, 52.08 million tons (79.54%) were extracted from methane deposits. In thirteen mines methane drainage was used in deposits, in

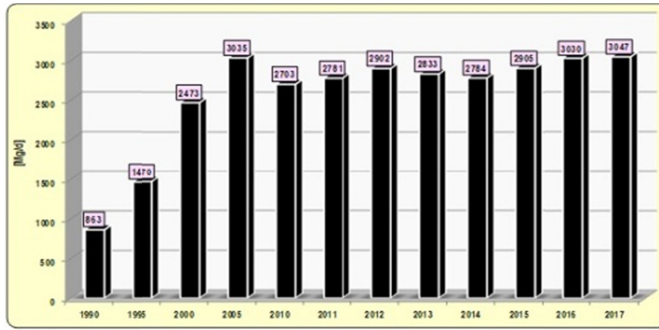


Fig. 7. The sizes of the average extraction from one longwall in the period from 1990-2017
 Source: data of ARP SA Branch in Katowice

total 337.01 million m³ of methane was captured. In total 34.80 million tons of coal (53.3%) was extracted from the rockburst – threatened seams. Eleven fires occurred in underground excavations – the W_p fire index reached the value of 0.168 fire/1 million tons of coal – it was the highest since 2009. Although eleven fires also took place then, yet the volume of extraction was 77.8 million tons ($W_p = 0.141$ fires/1 million tons of coal) (Kabiesz, 2018).

At the end of 2017, hard coal mines employed 79.4 thousands of people, of which 63.0 thousand in underground excavations and 16.4 thousand on the surface (Fig. 8). Analysing changes in employment in recent years, it can be seen that its decline has significantly increased since 2015. This is related to the adoption by the Sejm of the Republic of Poland in January 2015 of an Act introducing the possibility of financing the so-called mining holidays or one-off severance pays for employees of liquidated mines from a budget subsidy (Act, 2015). In connection with the termination of employment relationship related to retirement, in the period from 2015 to 2018 this caused over 20% drop in the number of employees compared to the state of 2014 (over 16 thousand people employed in underground workings and almost 4.5 thousand employees on the surface).

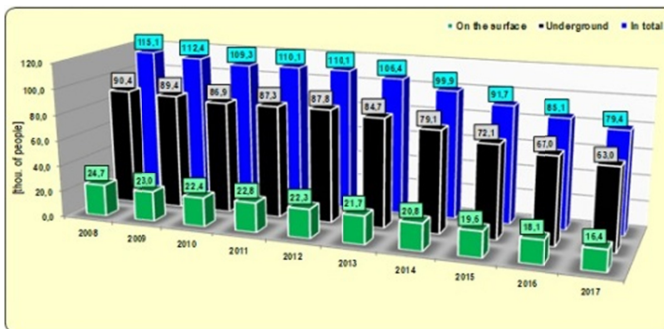


Fig. 8. Employment volumes in hard coal mining (in total, underground and surface) from 2008-2017
 Source: data of ARP SA Branch in Katowice

Such a significant reduction in the number of people employed in mines caused that despite the annual decrease in the volume of extraction, the values of performance indicators increased, including the two most important measured with (Fig. 9):

- an annual number of tons of commercial coal produced divided by the number of employees (so-called annual productivity),
- an annual number of kilos of commercial coal produced divided by the number of all working days (so-called general productivity).

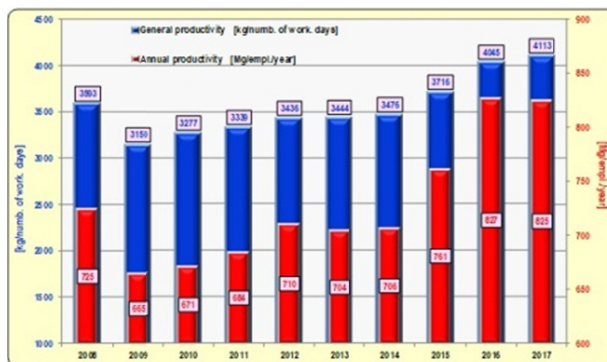


Fig. 9. The size of labour productivity indicators in hard coal mining in the period from 2008-2017
 Source: data of ARP SA Branch in Katowice

In the year 2017, 66.3 million tons of coal were sold (9.3% decrease compared to 2016) – 60 million tons in the domestic market (6.5% decrease) and 6.3 million tons in the export and dispatch (significant drop by 29.2%), which in this case was the lowest value obtained in the last six years (Fig. 10). The overall volume of sales comprised 65.5 million tons of commercial coal produced in 2017 and 0.8 million tons of coal from dumping grounds. It should be added that 13.4 million tons of imported coal, mainly from Russia, found buyers on the domestic market.

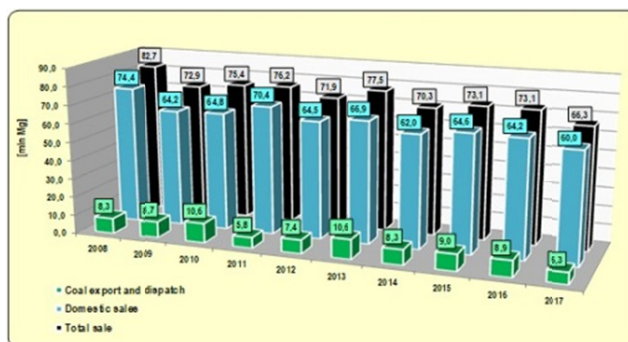


Fig. 10. The volume of hard coal sales (in total, on the domestic and foreign markets) in the period from 2008-2017
 Source: data of ARP SA Branch in Katowice

The average price of coal sold was 310.8 PLN/Mg (increase by 26.0% compared to 2016) – in the case of power coal it was 239.3 PLN/Mg (increase by 11.1%) and coking coal 628.0 PLN/Mg (significant increase by 62.8%) (Fig. 11).

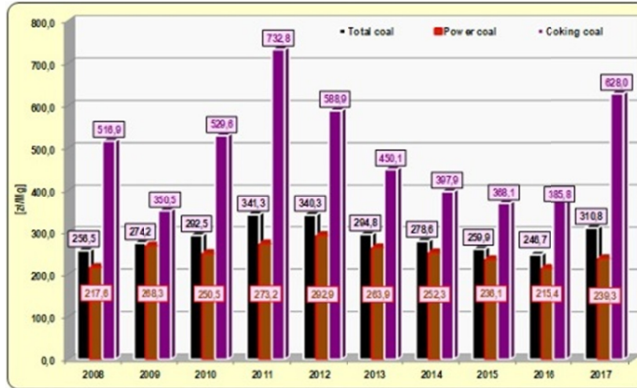


Fig. 11. Average sales prices of hard coal (total, power and coking) in the period from 2008-2017

Source: data of ARP SA Branch in Katowice

Intensive restructuring activities, which have been carried out since 2015, are aimed to reduce the operating costs of mining enterprises and the increase in coal prices. They have contributed to the fact that for the first time since 2012, the industry has achieved positive coal sales and net financial sales (Fig. 12 and 13). The sale of commercial coal in 2017 brought a profit of PLN 2,718.6 million (the loss in 2016 amounted to PLN –561.4 million). The obtained net financial result was also positive – it amounted to PLN 2,999.6 million (in 2016 it was only PLN 254.9 million).

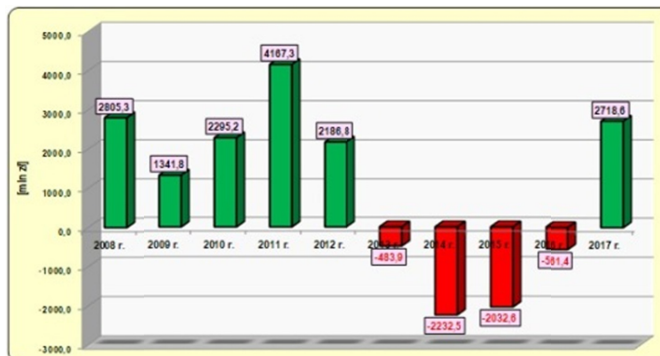


Fig. 12. The results of coal sales obtained from 2008-2017

Source: data of ARP SA Branch in Katowice



Fig. 13. Net financial results of hard coal mining obtained from 2008-2017
 Source: data of ARP SA Branch in Katowice

4. Determinants of the future functioning of the hard coal mining sector

As mentioned in the introduction, hard coal and lignite play the most important role in ensuring the country's energy security – generation of electricity and heat is based mainly on these two solid fossil fuels. In 2017, their total share in the structure of electricity production amounted to 80%. However, this is a large drop compared to 2010, when it reached the level of 89.2% (Fig. 14).

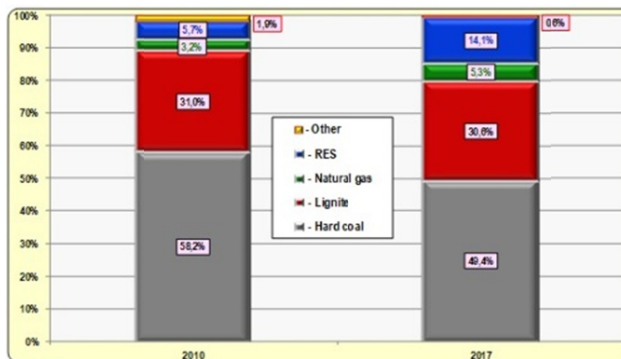


Fig. 14. The structure of electricity production in 2010 and 2017
 Source: (<https://wysokienapiecie.pl>)

It can be noticed that while from 2010 the share of lignite in this structure fluctuated within 30%, it decreased significantly in the case of hard coal. In 2010, in which about 158 TWh of electricity was produced, the share of hard coal in its production was over 58%, while in 2017,

with production of over 170 TWh (the highest volume so far) it decreased to less than 50% (the lowest volume so far).

Analysing the results obtained by the hard coal mining sector in 2017, it should be noted that despite the drop in the volume of extraction and sales, it achieved satisfactory financial results. After dramatically high losses, especially incurred in the years 2014-2015, the results of both coal sales and, above all, net financial sales, approached three billion in profits. A similar situation probably occurred in 2018 – however, in order to confirm it, one must wait until the annual balance sheets have been prepared and verified.

Undoubtedly, the reason for such a big improvement are the effects of decisive restructuring measures undertaken from 2015-2017 – the number of mines was reduced (by merger or liquidation of permanently unprofitable mines). Financial programs were implemented to encourage voluntary resignation from further work in mining. In addition, measures to reduce the operating costs of mining enterprises are rigorously enforced. However, in order for the existing situation to be sustainable, further coordinated actions in this area are necessary, both on the part of state institutions, as well as research and scientific facilities and mining enterprises themselves.

In January 2018, the Council of Ministers adopted a government *Program for the hard coal mining sector in Poland*, covering the period up to 2030 (Program, 2018). It sets out the detailed objectives along with the actions necessary to achieve them. However, the provisions of the document are quite general in nature, and at the same time many issues concerning the future are considered in a variant manner. In its final part it was indicated that only until 2020, a new, comprehensive act on the functioning of hard coal mining is to be developed. In addition to presenting the target model of the future functioning of hard coal mining, it will also determine the possibilities of financing the implementation of many activities designed as part of individual sub-objectives included in the (Program, 2018). In order to determine the scope of activities ensuring stabilization in the functioning of the sector, it is very important that the program is developed and adopted as soon as possible.

The second, extremely important document being developed at the state level is the already prepared and undergoing consultations document entitled: *The state's energy policy until 2040* (Polityka, 2018). It was clearly stated in it that *'domestic coal resources will remain the main element of Poland's energy security and the basis of the country's energy balance'*. It was pointed out there that hard coal mining will still have a special significance in shaping the generation potential of the national power industry. It was assumed that by 2030, the total share of hard coal and lignite in the generation of electricity will be around 60%. However, due to the tightening requirements regarding adverse environmental impact, including primarily carbon dioxide emission standards, greater importance in this respect will be attributed to hard coal, which is characterized by more favourable emission parameters. Apart from that, thanks to technological progress, newly built and modernized coal blocks are to have greater efficiency and better technical parameters, which will affect the rationality and efficiency of consumption of this raw material and reduce adverse environmental impact of energy.

Another extremely important activity that has been highlighted in the document is the obligatory implementation of innovative solutions in the extraction and use of coal. In this respect, special role will be given to research and scientific institutions – newly developed solutions should contribute to greater efficiency in the consumption of coal (e.g. in gas form) and to reduce the amount of pollutants emitted. This is extremely important, first of all in the light of Poland's commitments to the European Union's requirements regarding the need to adapt coal-based en-

ergy to the tightened environmental protection requirements by coal producers. The other reason are high and constantly rising costs resulting from the prices of CO₂ emission allowances in the European Emissions Trading System, achieving even more than 25 euros per ton.

The implementation of the above-described assumptions of the project (Polityka, 2018) is determined by the fulfilment of a number of conditions, also recorded in this document. The most important of them, indicated in the first place, is the need to ensure the profitability of the hard coal mining sector. It must be clearly stated that in this respect a special role belongs to mining enterprises and their management. So far, for a number of years, they have been mainly subjected to restructuring processes related to the transformation of the organizational structure of their functioning. In the coming years, they should be of a vanishing nature, and the emphasis must be placed on the processes of strategic reorientation – focusing on key issues that they should become (Fig. 15):

- adjusting the production capacity and production volume to the balanced energy needs of the state and the possibilities of their implementation,
- reducing the costs of broadly understood functioning.

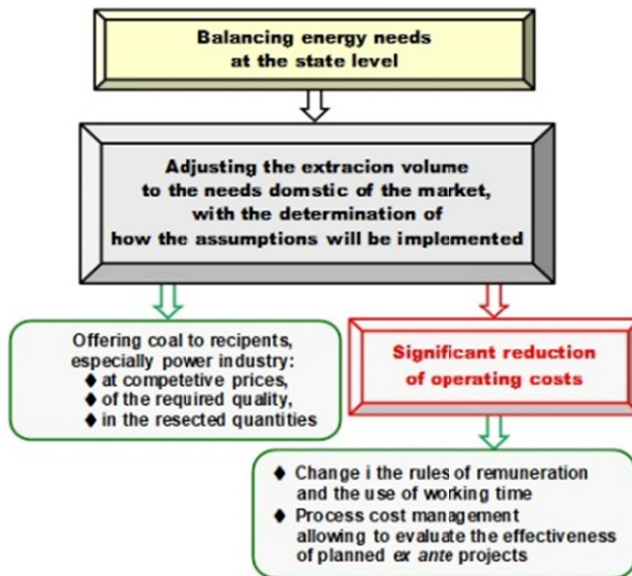


Fig. 15. Key issues of strategic reorientation processes in mining enterprises

Source: own study

On the basis of the demand for individual raw materials used in the energy sector, determined in the project (Polityka 2018), while taking into account the production capacity of individual mines belonging to them, mining enterprises should (Prusek & Turek, 2018; Prusek et al., 2018; Bąk, 2018):

- identify all available resources (geological, factual, personal, financial), and then determine their rational sizes, especially in relation to the organizational and spatial structures of mines, necessary to conduct operations,

- on the basis of available resources, organize the carrying out of works and plan the recoverable quantities. The basic assumption should be that only those deposits are used, in which coal is present with the quality parameters required by customers and that only quantities of coal that can be sold in total are mined.

The second key issue in the field of strategic reorientation must be to constantly reduce costs. It is very significant, especially in aspect of large capital intensity of sector, searching for various sources of founding (Bąk, 2007, 2008; Michalak & Nawrocki, 2015). In this respect, the main emphasis should be placed on labour costs, which usually constitute about 50% of all costs. In addition, these are costs minimally related to the obtained production, economic and performance results. Changes in this area should refer to the creation of such remuneration principles that will link the amount of earnings to the economic effects of coal mining and sales and labour productivity. An inherent element of changes must also be the rational use of very expensive machinery and equipment installed, involving the need to change the work systems in the mines – at present they are used only for several hours a day, five days a week.

In addition, as far as the reduction of operating costs is concerned, the main role should be played by the planning of works directed not on the volume of production, but on its carefully calculated economic effect. Currently, the planning of the amount of costs is based on technical and economic plans, using different forms, the essence of which is the recognition and presentation of costs in a generic manner. Determining their size is most often based on an analysis of the costs of previous works – *ex post*. The new approach should use a cost accounting system that makes it possible to assess the profitability of production and individual projects on an *ex ante* basis. In order to achieve this, the existing solutions for the identification of sources and costs should be supplemented with planning functions taken on a ‘zero budget’ basis.

This can be a starting point for determining the economic viability of the exploitation of specific deposits, seams or their parts even before the commencement of works or conducting cost control in a process approach. It is entirely possible to be accomplished in the developed concept of cost accounting in terms of the process, the principles of which were presented in detail in (Jonek-Kowalska (ed.), 2013).

5. Conclusions

For years, hard coal has been the basis of the national energy balance. Large resources of this raw material, existing energy structure, in which coal-fired power plants have the largest share and very important socio-economic importance of the hard coal mining sector providing numerous workplaces and budget revenues, cause that situation to continue for many years to come. As stated in the project (Polityka, 2018): *‘the need to diversify the electricity generation structure will contribute to reducing the role of coal in the balance sheet, but the absolute (quantitative) use of this resource by the power industry over the next dozen or so years will not change significantly’*. For this reason, it is extremely important for this industry to function profitably and in a stable manner.

Analysis of the results obtained by hard coal mining in 2017 (and probably also in 2018) shows that its economic situation is significantly improving. After the period of collapse in which it found itself from 2013-2015, the year 2017 was the first in which its activity was profitable.

The results obtained are the effect of radical restructuring processes, which the industry has been subjected to since 2015.

However, in order for this situation to be of a lasting nature, further decisive action is needed to mainly:

- adjusting the amount of resources owned to ensure that the produced commercial coal fully finds buyers,
- continuous rationalization of operating costs incurred,

which in turn will result in the profitability of the operations conducted.

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