www.czasopisma.pan.pl PAN POLSKA AKADEMIA NAUK www.journals.pan.pl

DE GRUYTER OPEN

Arch. Min. Sci., Vol. 59 (2014), No 2, p. 395–411

Electronic version (in color) of this paper is available: http://mining.archives.pl

DOI 10.2478/amsc-2014-0028

JÓZEF DUBIŃSKI*, MARIAN TUREK*

CHANCES AND THREATS OF HARD COAL MINING DEVELOPMENT IN POLAND – THE RESULTS OF EXPERTS RESEARCH

SZANSE I ZAGROŻENIA DLA ROZWOJU GÓRNICTWA WĘGLA KAMIENNEGO W POLSCE – WYNIKI BADAŃ EKSPERCKICH

The actual situation of hard coal mining in Poland has been presented. In particular, these factors, which have impact on the competiveness of mining sector were highlighted and need of its improving has been stressed. Outlining present situation of hard coal mining an attention was paid to its specific threats. The primary analytical material is based on the results of questionnaire conducted among 92 specialists and experts from the mining sector. The questions were related to chances and threats for development of hard coal mining in Poland. The factors determining them were grouped in such domains as economy, technology, geology, social and law aspects. Moreover, the special attention was paid to the problem of increasing and high costs of coal production which constitute significant threat for the financial and economic situation of the mining enterprises. Also the adverse influence of these high cost on the competitiveness of Polish hard coal with other world producers and with other energy carriers was emphasized. The conclusions summarize the achieved results of analysis.

Keywords: hard coal mining sector, factors determining chances for development, factors determining threats for development, cost of coal mining.

Górnictwo węgla kamiennego jest strategicznym sektorem polskiej gospodarki, z uwagi na wysoki, blisko 90%, udział paliwa węglowego w wytwarzaniu energii elektrycznej, z czego około 60% stanowi węgiel kamienny. Różnego rodzaju prognozy długoterminowe wskazują, że pomimo zmian w strukturze polskiego miksu energetycznego węgiel kamienny nadal pozostanie ważnym nośnikiem energii. Tym niemniej istotnym problemem jest to aby był nim nadal węgiel wydobywany w polskich kopalniach. Stąd, analiza szans i zagrożeń dla rozwoju górnictwa węgla kamiennego w Polsce jest niezwykle ważna, a jej wyniki mogą stanowić podstawę racjonalnych planów i działań zapewniających konkurencyjność cenową tego paliwa w wymiarze globalnym. Ponadto, należy mieć na uwadze fakt, że górnictwo węgla kamiennego jest jednym z największych pracodawców w Polsce, ocenianym na blisko 500 tysięcy miejsc pracy, zarówno tych bezpośrednich w kopalniach jak i otoczeniu tego górnictwa. Niestety negatywnym zjawiskiem, które stwarza istotne zagrożenie dla rozwoju polskiego górnictwa węgla kamiennego są

* CENTRAL MINING INSTITUTE, PL. GWARKÓW 1, 40-166 KATOWICE, POLAND.
E-mail: j.dubinski@gig.eu; m.turek@gig.eu

stale rosnące koszty produkcji. Przyczyną tego są zarówno uwarunkowania zewnętrzne, w tym liczne obciążenia podatkowe, jak i wiele przyczyn powstających wewnątrz samego górnictwa, jak na przykład niedobór wysoko wykwalifikowanych i doświadczonych pracowników.

Dla rozpoznania przedmiotowego problemu szans i zagrożeń w polskim górnictwie węgla kamiennego została zastosowana metodyka badań eksperckich, polegająca na pozyskaniu, a następnie specjalistycznej analizie opinii, odpowiednio licznego zbioru danych, uzyskanego od 92 respondentów uznanych jako ekspertów. Dane te zostały zawarte w specjalnie opracowanym kwestionariuszu, który składał się z trzech części: A – dotyczącej szans rozwojowych górnictwa, B – dotyczącej zagrożeń dla tego przemysłu i C – dotyczącej diagnozy stanowiącej podsumowanie sytuacji w analizowanych obszarach. W metodologii analizy wyników została zastosowana jednolita skala ilościowej oceny stopnia ważności wyróżnionych czynników, od 5 – bardzo ważny, do 1 – trudno powiedzieć.

Na wstępie przedstawiono ekspercką diagnozę aktualnej sytuacji polskiego górnictwa węgla kamiennego w oparciu o opracowaną metodologię, która pozwoliła ocenić stopień ważności spośród 24 stwierdzeń opisujących ten sektor i jego otoczenie (Tabela 2 i Rys. 1). Natomiast w grupie 9 czynników dotyczących szans rozwojowych górnictwa (Rys. 4) za najbardziej ważne eksperci uznali dysponowanie kadrą o wysokich kwalifikacjach oraz szybki transfer wiedzy do kopalń. Interesujących informacji dostarczyła analiza powyższych czynników przyporządkowana wyróżnionym sferom działalności kopalń – ekonomiczna, technologiczna, geologiczna, społeczna i prawna (Rys. 3). Wskazuje ona, że szans rozwojowych górnictwa węgla kamiennego w Polsce należy poszukiwać przede wszystkim w sferze społecznej i technologicznej. W odniesieniu do analizy zagrożeń dla rozwoju górnictwa zostało wyróżnionych 19 czynników, których ważność została oceniona przez ekspertów. Za najważniejsze uznano (Rys. 6): wysoką dynamikę wzrostu kosztów produkcji, malejącą bazę zasobową, wysokie koszty emisji gazów cieplarnianych związane z polityką klimatyczno-energetyczną Unii Europejskiej, rosnący import węgla oraz rosnące koszty infrastruktury górniczej. Podobnie jak w przypadku szans rozwojowych dokonana została analiza wyróżnionych czynników w odniesieniu do wydzielonych sfer działalności kopalni. Wskazuje ona, że główne zagrożenia związane są ze sferą ekonomiczną i prawną. Interesujących informacji dostarcza wspólne porównanie szans i zagrożeń (Rys. 8).

Biorąc pod uwagę fakt, że czynnik całkowitych kosztów pozyskiwania węgla został zidentyfikowany jako najważniejszy zarówno z pozycji szans jak i zagrożeń, poddano go również analizie ekspertów, formułując 9 rodzajów kosztów wraz z przypisaniem im odpowiedniej skali ważności i punktacji. Wyniki tej szczególnie ważnej analizy (Rys. 11) wskazują, że koszty produkcji węgla, koszty wynikające ze sczerpywania złóż i w związku z tym prowadzenia eksploatacji w coraz bardziej trudnych warunkach oraz koszty dotyczące emisji gazów cieplarnianych stanowią największe zagrożeniu dla przyszłości i rozwoju górnictwa węgla kamiennego w Polsce. W rozdziale podsumowanie i wnioski zawarto najważniejsze stwierdzenia wynikające z treści artykułu oraz sformułowano kierunki działań, których realizacja zwiększałaby szanse i zmniejszała zagrożenia dla rozwoju górnictwa węgla kamiennego w Polsce.

Słowa kluczowe: górnictwo węgla kamiennego, czynniki określające szanse rozwoju, czynniki określające zagrożenia dla rozwoju, koszt wydobycia węgla.

1. Introduction

Mining in Poland can be recognized as a special branch of industry, as to a large extent it decides about the character of the energy sector, and even whole Polish economy. More than 90% of electricity in Poland is being produced from hard and brown coal. Despite of the fact, that in the forthcoming years we can expect increase of electricity production based on other sources of energy (nuclear energy, natural gas) than coal – it will remain basic energy resource. The specialists from the branch pretty often emphasize, that there is no alternative for coal so far; for many years Polish energy sector will have to rely on it (Turek, 2005). It is important however to rely on Polish coal and not from importation (in 2011 import of coal to Poland exceeded 15 mln tones.) The question, which arises is: what shall be done to keep Polish position as major coal producer on world's economic map?

It should be also emphasized, that mining sector is still significant "employer". In Poland, it provides for about 500 thousand people, including miners, contractors of coal companies and families of coal mines' employees. Besides, mining sector it is significant taxpayer, but also the branch where the new technologies are being developed and innovative solutions implemented. The segment producing machines and mining equipment is very well known abroad and Polish producers have very good opinion on the world's market.

The very serious threat, however for the competiveness of Polish hard coal mining and financial-economical situation of the mining companies is an excessive dynamics of increasing the production costs in comparison with other world's producers, as well as with other energy carriers. The reason for that are the external circumstances, consisting in very substantial increase of the material costs and necessity to conduct the mining operations in more and more difficult geological and technical conditions. The need to develop new deposits or going deeper in already existing mines requires additional investment expenditures. At the same time the tighten regulations connected with labor safety and surface protection must be followed. Besides, more than 50% of the expenditures connected with coal mining in Poland are not flexible – fixed costs, including mainly labor costs and social benefits (Sierpińska & Bąk, 2012).

Significant element, which has to be faced by the mining sector, not only in Poland but also all over the world is the shortage of qualified employees. This HR gap is systematically growing and covers more and more specialist posts. Some of the mining companies are trying to compensate this by technology. In Poland lack of qualified staff is first of all connected with numerous leavings of experienced persons for the retired pensions. It is also negative consequence of mining schools' liquidation, and blockades of new employees' admissions in the 90's. Presently, in the hard coal mining sector there are more than 100 thousand people employed directly, comparing with about 250 thousand in the 90's.

Additional burden for the mining companies in the future will be anticipated so called "minerals' tax". Similar regulations already exist in other countries and their calculation basis are the profits or incomes from the raw material sales. The legal and public strains of Polish mining are already high and their continuous increase may have negative impact on the investment potential and competitiveness of whole sector. What should be the future plans of mining sector decision-makers' in Poland then?

There was a research conducted among the specialists and experts from the mining sector on the subject of chances and threats of hard coal mining development in Poland. As a tool the questionnaire was used, which was divided into three parts. Part A concerned chances of development, part B threats' factors, part C covered statements concerning diagnosis of present situation in the selected fields of Polish hard coal mining. The questionnaires were completed by the experts from various institutions like: Institute for Chemical Processing of Coal (IChPW), Central Mining Institute (GIG), Supervisory Board of selected Polish hard coal mining company (SB), AGH University of Science and Technology (AGH), Silesian University of Technology (POLSL). Totally 92 questionnaires were correctly filled out including 5 from ICHPW, 20 from GIG, 25 from SB, 16 from AGH and 26 from POLSL (Dubiński et al., 2005c, 2005d).

In the analysis, both: number of individual answers for various questions as well as grades attributed to individual statements (Table 1) were used. Assigning the grades was meant to putting in order the factors according to their importance, in the context of the **chances (part A), threats (part B)** but also the statements concerning **diagnosis (part C)** of Polish hard coal mining.

TABLE 1

Assigning the grades for individual answers

Answers for parts A and B	Grade	Answers for part C	Grade
It is of very big importance	5	Definitely yes	5
It is of big importance	4	Rather yes	4
It is of marginal importance	3	Rather not	3
Not important	2	Definitely not	2
Hard to say	1	Hard to say	1

Source: own study

2. Diagnosis of the actual condition of Polish hard coal mining in the selected domains

The experts in the questionnaire were asked to evaluate state of development of Polish hard coal mining (Table 2). They were asked to determine to what extent they agree with twenty four statements. To each statement they could assign the attribute: *Definitely yes, Rather yes, Rather not, Definitely not, Hard to say*.

TABLE 2

Diagnosis of the actual condition of Polish hard coal mining

#	Opinions concerning development of hard coal mining sector	Mean of grades
1	**2**	**3**
1	Situation of fossil fuels on the world's market is the chance for development of Polish hard coal mining	3.78
2	Situation of fossil fuels on the European market is the chance for development of Polish hard coal mining	**4.05**
3	Politics of social responsibility is the chance for the reduction of the local community opposition against development of hard coal mining exploitation	3.94
4	Development of hard coal mining sector is the chance for holding energy safety of the country	**4.53**
5	Strong research-development back-up facilities are of significant importance for the development of hard coal mining sector.	**4.28**
6	Highly qualified management is of significant importance for the development of hard coal mining sector	**4.51**
7	Increase of EU demand for the energy resources, including coal, is significant chance for the development of hard coal mining sector	**4.27**
8	Dynamic increase of the oil and natural gas prices will result in the increase of hard coal importance as an energy carriers' producer	3.99
9	Polish hard coal mining is capable to keep competitive cost of coal deliveries on EU market comparing with coal producers from outside EU	3.21
10	Development of clean coal technology is significant chance for the development of Polish hard coal mining	3.95
11	Supply of other fossil fuels may create threat to the development of hard coal mining in Poland	3.51

TABLE 2. Continued

1	2	3
12	Cost of hard coal production in Poland will be growing significantly limiting development of mining sector	3.51
13	Cost of hard coal transportation in Poland will be growing significantly limiting development of mining sector	3.45
14	There will be drop in coal prices, which will significantly decrease profitability of Polish coal mines	3.24
15	High cost of green house gases' emission will significantly limit development of coal exploitation in Poland	3.85
16	Poland will not be able to compete with the Eastern producers' coal prices	3.53
17	Necessity of modernization the machinery and development of present infrastructure will result in the costs incommensurately with potential profits from the coal sales	3.31
18	Depleting coal resources significantly limit potential development of hard coal mining sector	3.38
19	Natural hazards occurring in Polish coal mines generate too high cost of exploitation, what will make the coal production not profitable.	3.30
20	Presently binding tax and exploitation fees' regulations limit profitability of mining production	3.29
21	Increase of the requirements concerning the issues related to the environmental protection will significantly limit possibility of development hard coal mining exploitation in Poland	3.47
22	Demand for coal from the developing countries is significant chance for development of hard coal exploitation	3.84
23	Variability of sale prices will have negative impact on the financial condition of Polish coal mines	3.42
24	Relatively low age of experienced miners when acquiring the pension's rights will result in the shortage of qualified staff in Polish mining.	3.44

Source: own study

After adding up number of answers for the attributes: *definitely yes and rather yes* and separately for the attributes *rather not* and *definitely not* it is difficult to select opinions which have the most important and less important meaning for the diagnosis of Polish hard coal mining condition.

As the most important element the experts recognized: **highly qualified managing staff, who is of significant importance for the development of hard coal mining sector (6)**. Besides, they affirmed as: *very important* : **development of hard coal mining sector is the chance for holding energy safety of the country (4)** but also **increase of EU demand for the energy resources, including coal, is significant chance for the development of hard coal mining sector (7)**.

According to the experts the less important is the statement: **natural hazards occurring in Polish coal mines generate too high cost of exploitation, what will make the coal production not profitable**. Having assigned to the individual statements appropriate grades (table 1) the mean of the grades for the individual comments was calculated (table 2).

The highest mean was gained by the following statements:

- development of hard coal mining sector is the chance for holding energy safety of the country (mean 4.53),

- highly qualified management is of significant importance for the development of hard coal mining sector (4.51),
- strong research-development back-up facilities are of significant importance for the development of hard coal mining sector (4.28),
- increase of EU demand for the energy resources, including coal, is significant chance for the development of hard coal mining sector (4.27),
- situation of fossil fuels on the European market is the chance for development of Polish hard coal mining (4.05).

In turn, the lowest mean was gained by the statements:

- Polish hard coal mining is capable to keep competitive cost of coal deliveries on EU market comparing with coal producers from outside EU (3.21),
- there will be drop in coal prices, which will significantly decrease profitability of Polish coal mines (3.24),
- natural hazards occurring in Polish coal mines generate too high cost of exploitation, what will make the coal production not profitable (3.30).

It must be mentioned, that when answering the question: **Polish hard coal mining is capable to keep competitive cost of coal deliveries on EU market comparing with coal producers from outside EU** the experts had diametrically different opinions. Almost half of the experts (48%) agreed with this opinion but almost the same number of them disagreed (52%). (Fig. 1). Similar situation can be observed for the statements: **Necessity of modernization the machinery and development of present infrastructure will result in the costs incommensurately with**

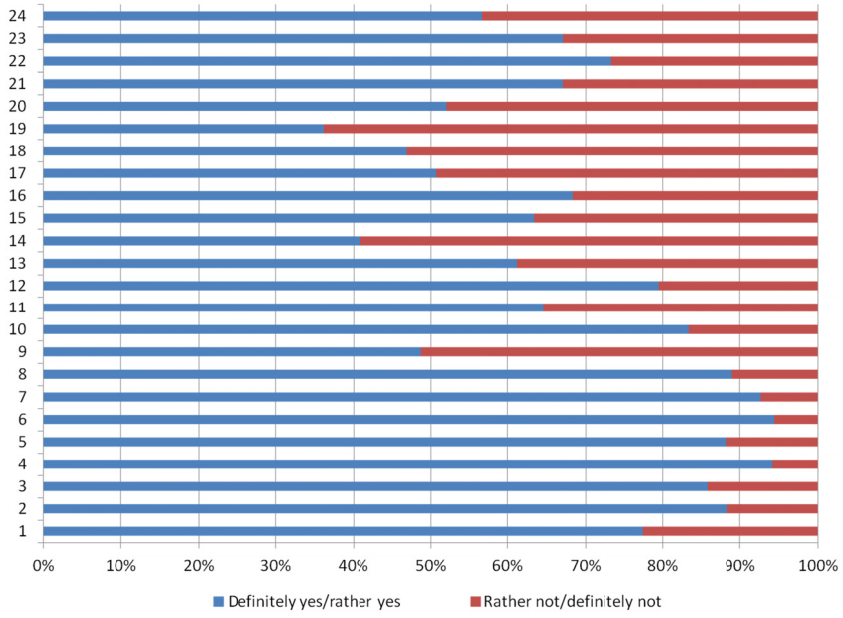

Fig. 1. Opinions concerning Polish sector of hard coal mining
Source: own study

potential profits from the coal sales (51% of experts marked the option *definitely yes/rather yes, 49%* of experts marked *rather not /definitely not*) and **presently binding tax and exploitation fees' regulations limit profitability of mining production** (53% of experts marked the option *definitely yes/rather yes, 47%* of experts marked *rather not / definitely not*).

3. Chances of hard coal mining sector development

The experts evaluated importance of individual factors in the context of hard coal mining sector development chances. Each of nine factors could have been determined as the-one with: *very big importance*, *big importance, marginal importance, no importance, hard to say*.

In most cases, the experts marked for each of the factors option *big importance* (50% answers). However the largest number of indications for the option *very big importance* was gained by: **friendly law and binding regulations** (Fig. 2).

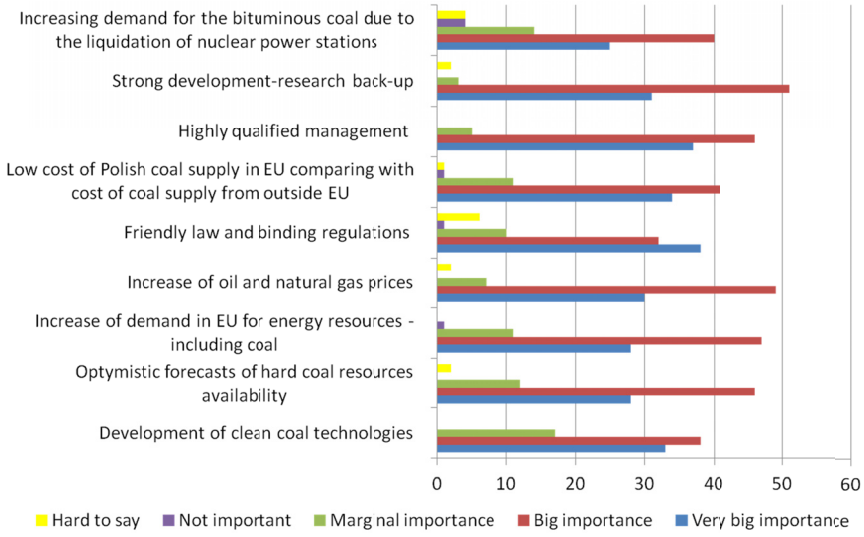

Fig. 2. Importance of the factors in the context of chances – number of answers
Source: own study

It means that friendly law and binding regulations are recognized as a very important factor in the context of chances for development of hard coal mining sector. However the largest number of indications for the option *not important* gained the statement – **increase of bituminous coal demand due to liquidation of nuclear power stations** and for the option **marginal importance** the statement **development of clean coal technologies** (Dubiński et al., 2005b).

Adding up number of indications for the statements *very big importance* and *big importance* and also separately for the statements *marginal importance* and *not important* individual factors were compared (Fig. 3). It turned out, that both statements i.e. **highly qualified management** but also **strong development-research back-up** gained more than 90% of the answers: *very big importance* and *big importance*.

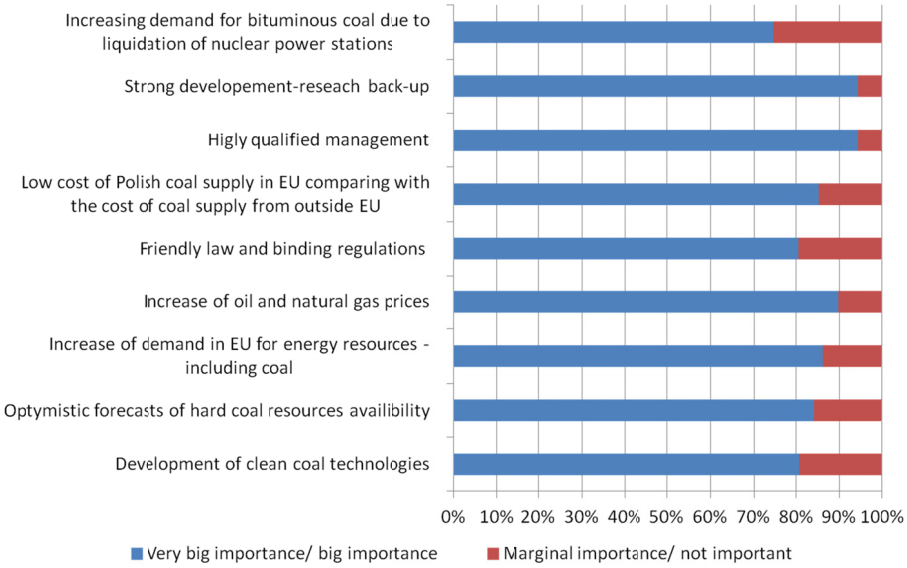

Fig. 3. Comparison of the factors in the context of the chances
Source: own study

Having attributed to individual statements appropriate grades (Table 1) the mean of the grades for individual factors was calculated, later on the factors were ranked according to the mean grades (Fig. 4). The highest mean was gained by the factor concerning **highly qualified**

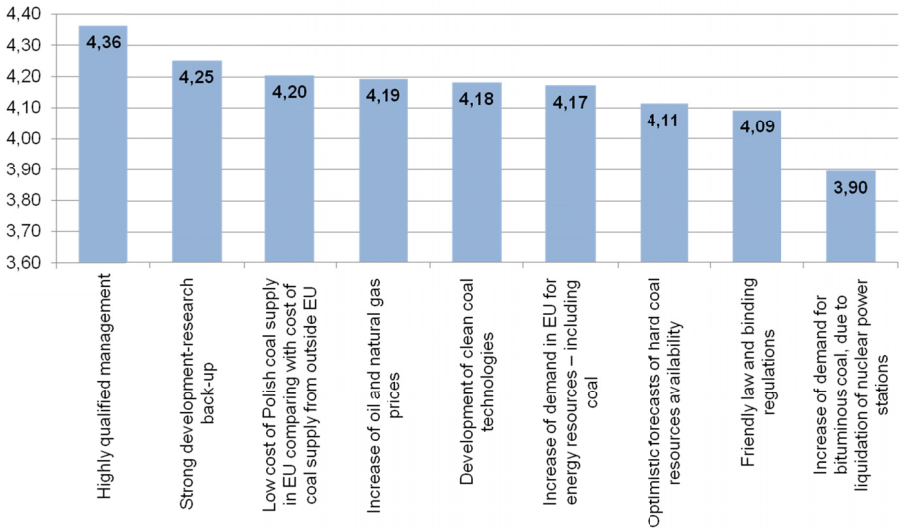

Fig. 4. Factors determining chances of coal sector development settled according to the mean grades
Source: own study

management (4.36), then **strong development research back-up** (4.25) and **low cost of Polish coal supply in EU comparing with cost of coal supply from outside EU** (4.2). Next, the lowest mean was gained by the factor **increase of demand for the bituminous coal, due to liquidation of nuclear power stations.**

Individual factors of the coal mining development chances were classified for certain domains: economic, technological, geological, social, legal (Dubiński & Turek, 2012) (Table 3).

TABLE 3

Factors of coal mining development chances' with division into domains

Domain	Factors in the context of coal mining development chances
economical	Increase of demand for bituminous coal, due to liquidation of nuclear power stations
	Increase of demand in EU for energy resources – including coal
	Increase of oil and natural gas prices
	Low cost of Polish coal supply in EU comparing with cost of coal supply from outside EU
technological	Development of clean coal technologies
geological	Optymistic forecasts of hard coal resources availability
social	Highly qualified management
	Strong development-research back-up
legal	Friendly law and binding regulations

Source: own study

Next, the mean grades of the factors from the individual domains were calculated and their results were compared (Fig. 5).

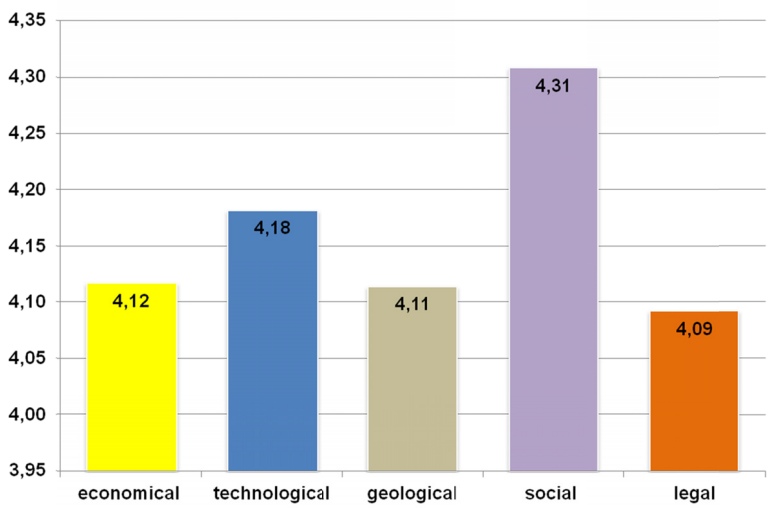

Fig. 5. Chances of coal mining sector development with division into various domains
Source: own study

It can be clearly seen, that the biggest chances of mining sector development are in the social domain (mean 4.31). The factors in this domain are **highly qualified management** and **strong development-research back-up**. The lowest mean was registered in the domain of law where the factors are: **friendly law and binding regulations**.

4. Factors causing threats for development of hard coal mining sector

In the second part of the questionnaire the experts were asked about the factors causing threats for development of hard coal mining sector. Similar like in the first part the statements were evaluated by the experts as those which are of: *very big importance, big importance*, *marginal importance, not important, hard to say*. The factors causing threats for development of hard coal mining sector were nineteen (Table 4).

TABLE 4

Statements concerning factors causing threats for development of hard coal mining

#	Factors causing threats for development of hard coal mining sector	Mean of grades
1	Development of clean coal technologies in the context of adjusting and modernization of the coal mines, retraining the management and essential investments	3.70
2	Supply of oil and natural gas	3.80
3	Strong dependence of UE from oil and natural gas supplies	3.90
4	Problems with gaining the funds for mining activities	4.01
5	High dynamics of increasing the production costs	**4.25**
6	High dynamics of increasing the transportation costs	4.00
7	Potential coal prices drop	3.96
8	High cost of greenhouse gases emission	**4.19**
9	Price competition from the eastern producers' side	4.16
10	Increase of the technological modernization cost (e.g. in the context of the requirements resulting from the demand on the higher quality product)	3.60
11	Increase of infrastructure development cost (e.g. in the context of coal mining from deeper and deeper seams)	**4.10**
12	Increase of cost connected with minimalization of natural hazards, payouts of potential financial compensations etc .	3.91
13	Depleting resources (in the context of the costs connected with developing more and more difficult resources)	**4.21**
14	Objection of local community (e.g. against mining damages)	3.81
15	Not favorable age structure of the employees	3.38
16	Not favorable legal notations (e.g. with increased environmental protection standards)	3.96
17	Increase of mining cost due to increased environmental protection standards	3.94
18	Cost of mining areas' reclamation	3.68
19	The regulations not favorable for development of hard coal mining	3.95

Source: own study

Adding up number of indications for the statements *very big importance* and *big importance* and also separately for the statements *marginal importance* and *not important* the individual threat factors were compared (Fig. 6).

The highest importance in the context of threats for development of hard coal mining were attributed to the factors (the highest number of answers for *very big importance and big importance*): **high dynamics of increasing production costs (5), High cost of greenhouse gases emission (8), Price competition from the eastern producers' side (9), Increase of infrastructure development cost (e.g. in the context of coal mining from deeper and deeper seams) (11)**.

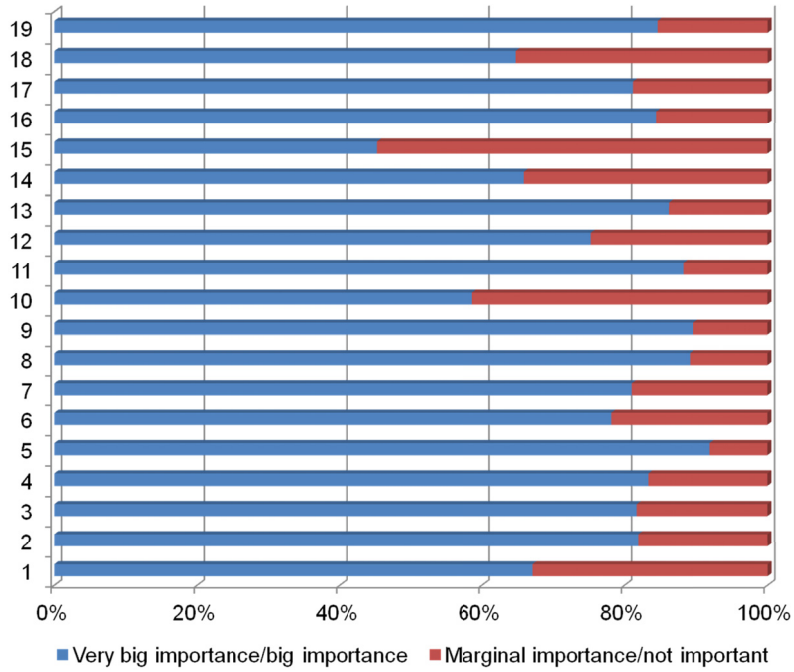

Fig. 6. Comparison of the factors causing threat for the development of hard coal mining sector
Source: own study

Similar like in the part concerning factors determining the chances, the individual statements concerning the threats were attributed to the following grades: *very big importance* – 5, *big importance* – 4, *marginal importance* – 3, *not important* – 2, *hard to say* – 1 (Table 1).

Having analyzed the results of mean grades for the factors causing threats for the development of hard coal mining sector it can be noted, that the highest mean was gained by the factors connected with cost (Table 4) These were the following factors: **High dynamics of increasing the production costs (mean 4.25), depleting resources (in the context of the costs connected with developing more and more difficult resources) (mean 4.21), High cost of greenhouse gases emission (4.19), Increase of infrastructure development cost (e.g. in the context of coal mining from deeper and deeper seams) (4.1).**

Individual factors causing threats for development of coal mining were classified for the following domains: economical, technological, geological, social, legal (Table 5). Next, the mean grades of the factors from each domain were calculated and their results were compared (Fig. 7).

TABLE 5

Factors of the coal mining development threats with the division into domains

Domain	Factors in the context of threats for the development of coal mining
Economic	Supply of oil and natural gas
	Strong dependence of UE from oil and natural gas supplies
	Problems with gaining the funds for mining activities
	High dynamics of increasing the transportation costs
	Potential coal prices drop
	High cost of greenhouse gases emission
	Price competition from the eastern producers' side
	Increase of mining cost due to increased environmental protection standards
Technological	High dynamics of increasing the production costs
	Increase of the technological modernization cost (e.g. in the context of the requirements resulting from the demand on the higher quality product)
	Increase of infrastructure development cost (e.g. in the context of coal mining from deeper and deeper seams)
Geological	Depleting resources (in the context of the costs connected with developing more and more difficult resources)
	Objection of local community (e.g. against mining damages)
Social	Increase of cost connected with minimization of natural hazards, payouts of potential financial compensations etc .
	Objection of local community (e.g. against mining damages)
	Not favorable age structure of the employees
Legal	Not favorable legal notations (e.g. with increased environmental protection standards)
	Not favorable regulations for the hard coal mining development

Source: own study

Having analyzed the results of the research it can be noted, that the highest number of threats for coal mining sector can be found in the economic domain (mean 3.99) and in legal (3.96). However the geological domain gained also pretty high mean (3.94). The factors in the economic domain are the following:

- Supply of oil and natural gas,
- Strong dependence of UE from oil and natural gas supplies,
- Problems with gaining the funds for mining activities,
- High dynamics of increasing the transportation costs,
- Potential coal prices drop,
- High cost of greenhouse gases emission,
- Price competition from the eastern producers' side (Dubiński et al., 2005c, 2005d),
- Increase of mining cost due to increased environmental protection standards (Dubiński et al., 2005a).

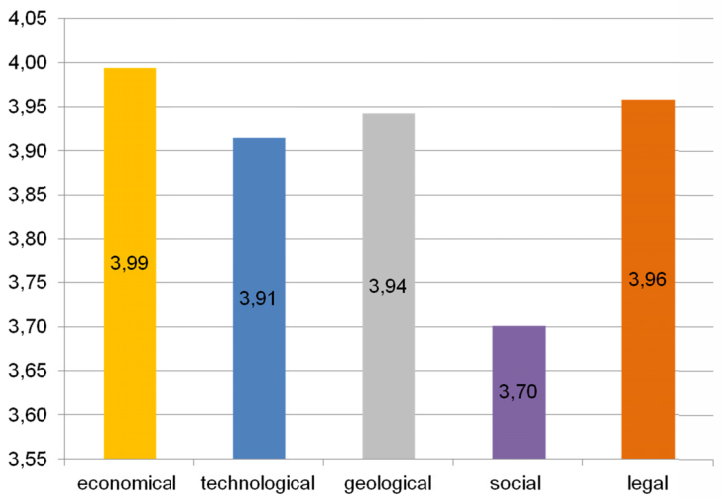

Fig. 7. Threats for development of coal mining sector with division into domains
Source: own study

Factors in the legal domain are the following: Not favorable legal notations (e.g. with increased environmental protection standards) and Not favorable regulations for the hard coal mining development.

Having still analyzed the results of the research, the factors of the chances as well as the threats for the development of coal mining sector in Poland were compared in the economic, technological (Dubiński & Turek, 2006), geological, social and legal domains (Fig. 8).

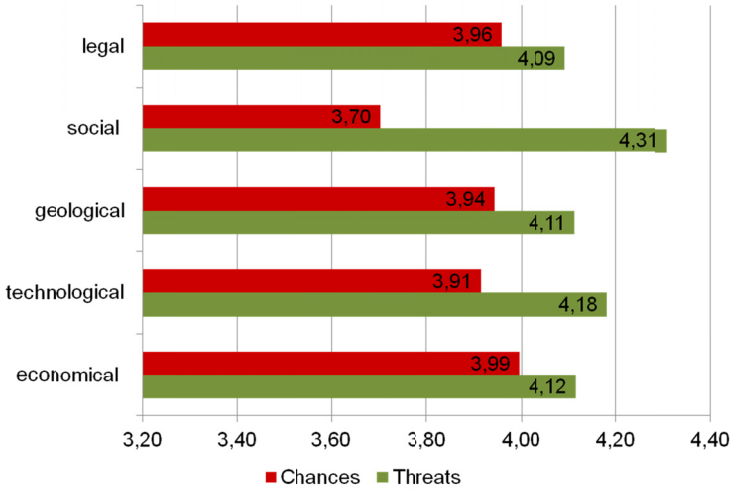

Fig. 8. Comparison of the threats and chances of coal mining sector in Polandin the individual domains
Source: own study

Such comparison of the results shows, that the economic domain can be characterized by similar number of chances and threats. More chances than threats can be observed in the social domain however.

5. Cost of coal mining

Having analyzed the questions concerning the chances and threats for development of coal mining sector in Poland it can be stand out nine various statements concerning the costs (Table 6). The importance of individual costs can be determined based on the analysis of the experts' answers for the individual statements (Fig. 9).

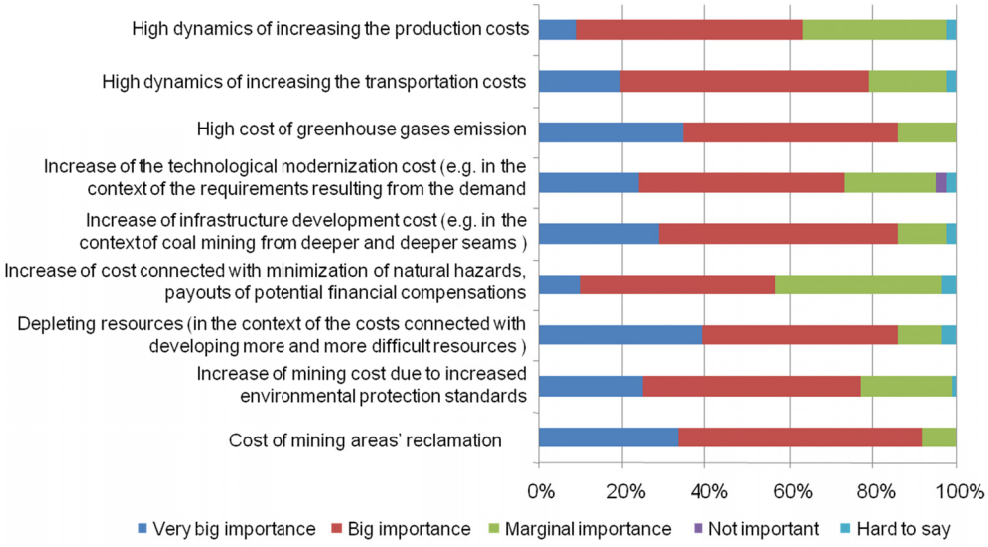

Fig. 9. Importance of individual costs. Number of answers
Source: own study

The experts when determining the importance of costs in the context of threats for the development of coal mining most often selected the option: *big importance* (Fig. 9).

TABLE 6

Costs occurring in hard coal mining

#	Type of costs
1	2
B14	High dynamics of increasing the production costs
B15	High dynamics of increasing the transportation costs
B17	High cost of greenhouse gases emission

TABLE 6. Continued

1	2
B19	Increase of the technological modernization cost (e.g. in the context of the requirements resulting from the demand on the higher quality product)
B20	Increase of infrastructure development cost (e.g. in the context of coal mining from deeper and deeper seams)
B21	Increase of cost connected with minimization of natural hazards, payouts of potential financial compensations etc.
B22	Depleting resources (in the context of the costs connected with developing more and more difficult resources)
B26	Increase of mining cost due to increased environmental protection standards
B27	Cost of mining areas' reclamation

Source: own study

Adding up number of indications for the statements *very big importance* and *big importance* and also separately for the statements *marginal importance* and *not important* it can be indicated which cost has the highest and the lowest importance (Fig. 10).

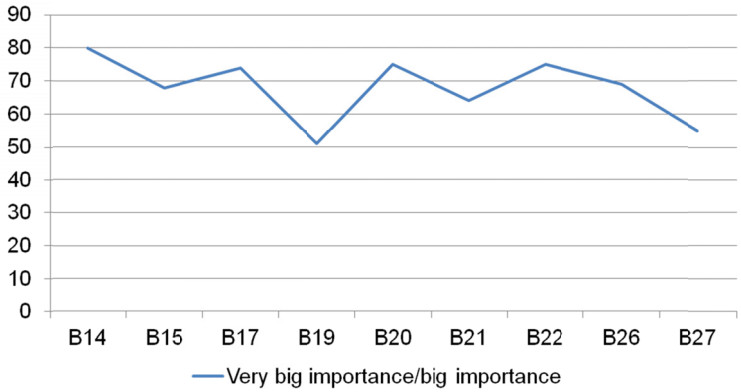

Fig. 10. Importance of the costs in mining
Source: own study

Among all nine types of costs the highest importance has the cost concerning **high dynamics of increasing the production costs (B14)** and the lowest-one **increase of the technological modernization cost (e.g. in the context of the requirements resulting from the demand on the higher quality product) (B19).**

Similar results are obtained when the grades are attributed to the answers of individual experts (table 1) and the costs are ranked according to the mean grades. Linear order of importance of individual costs is shown on the Fig. 11. In above comparison the highest mean was gained by the costs: **high dynamics of increasing the production costs (4.25), depleting resources (in the context of the costs connected with developing more and more difficult resources) (4.21), high cost of greenhouse gases emission (4.19).**

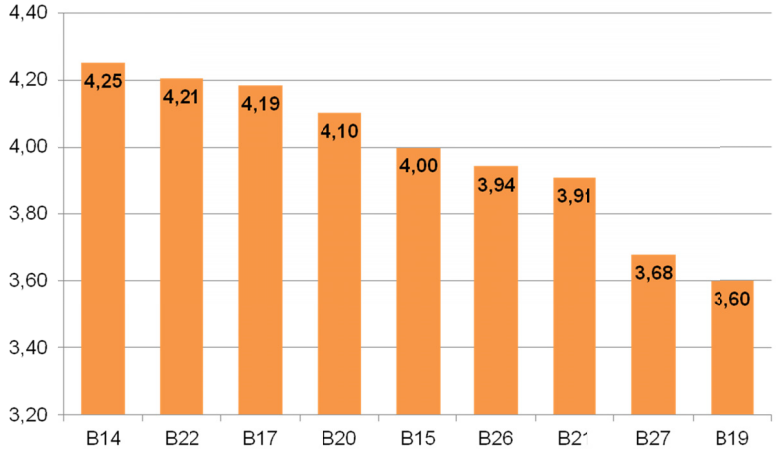

Fig. 11. Linear order of individual costs' importance
Source: own study

On the other hand, the lowest mean was gained by the costs connected with **increase of the technological modernization cost (e.g. in the context of the requirements resulting from the demand on the higher quality product (3.6)** and **cost of mining areas' reclamation (3.68).**

6. Summary and conclusions

Presented results of the research, conducted among 92 experts from various institutions: (IChPW, GIG, SB, AGH, POLSL), confirmed what was already emphasized many times by the specialists from mining sector.

Development of hard coal mining sector should be recognized as a big chance for keeping the energy safety of our country (Dubiński & Turek, 2008). However, significant importance for this development has highly qualified staff (including managing staff) and also strong development and research back-up facilities (Dubiński et al., 2005c, 2005d).

On the other hand the highest threats for the development of coal mining sector can be recognized in the economic domains. It especially refers to the price competition from the eastern producers' side, but also to the high costs. Among the others to the increasing costs of production, costs of greenhouse gases emission (Dubiński & Turek, 2007), costs of developing the infrastructure (e.g. in the context of coal mining from deeper and deeper seams).

Problem of qualified staff shortage requires system solutions. Apart from appropriate planning the employment, which should take into consideration real demand and sources of new employees' "supply", the cooperation with the universities, schools, regulatory changes, as well as appropriate motivation system for the employees are needed.

High level of fixed expenditures and increasing costs in mining make the proper management of the costs the major issue in mining sector. This makes undoubtedly the implementation of long-term methods of optimization and rationalization a must.

It should be emphasized, that for some time already there is a striving for increasing the effectiveness of the work and efficient utilization of the machines. Mining sector also announces the investments aiming at construction of the power stations, increasing methane utilization for the energy production purposes as well as management of the post mining wastes.

Considering diagnosis of the hard coal mining sector and especially conducted analysis of the chances and threats, certain, necessary following actions in this sector should be undertaken:

- using innovative technologies in order to increase price competitiveness, labor safety and environmental protection,
- keeping the coal production costs in the coal mines at the competitive level comparing with coal prices what should result in economic effectiveness of coal concerns,
- keeping the satisfactory level of financial liquidity and credit ability of the coal concerns; conducting by the management effective politics,
- providing stable and economically safe jobs in the hard coal mines as well as rational management of HR.

References

Dubiński J., Turek M., 2006. *Assumptions for Development of New Technologies for Exploatation the Coal.* Proc. International Coal Congress "Sustainable Development of Coal for Energy Security". ed. The Institution of Engineers. New Delhi, p. 109-115.

Dubiński J., Turek M., 2007. *Prognoza wydobycia węgla kamiennego dla energetyki.* [w]: Uwarunkowania wdrożenia zero-emisyjnych technologii węglowych w energetyce, red. Ściążko M., Instytut Chemicznej Przeróbki Węgla, Zabrze, s. 27-33.

Dubiński J., Turek M., 2008. *Analiza bazy zasobowej węgla kamiennego w aspekcie dostaw dla polskiej elektroenergetyki do 2030 roku.* [w]: Materiały Konferencji Naukowej nt. „Czyste technologie Węglowe". Wyd. PKE, Katowice-Sosnowiec, s. 87-97.

Dubiński J., Turek M., 2012. *Szanse i zagrożenia rozwoju górnictwa węgla kamiennego w Polsce*. Wiadomości Górnicze, nr 11, Katowice, s. 626-633.

Dubiński J., Turek M., Aleksa H., 2005a. *Węgiel kamienny dla energetyki zawodowej w aspekcie wymogów ekologicznych.* Prace Naukowe GIG, Górnictwo i Środowisko, Kwartalnik, 2, Katowice, s. 5-21.

Dubiński J., Turek M., Prusek S., 2005b. *Technologia węgla kamiennego – stan aktualny i perspektywy.* Przegląd Górniczy, nr 7-8, s. 2-20.

Dubiński J., Turek M., Wachowicz J., 2005c. *Szanse i możliwości węgla kamiennego – wybrane problemy badawcze.* Przegląd Górniczy nr 9, s. 3-11.

Dubiński J., Turek M.: Wachowicz J., 2005d. *Wzrost konkurencyjności kopalń węgla kamiennego wyzwaniem dla jednostek badawczo-rozwojowych*. Bezpieczeństwo Pracy i Ochrona Środowiska w Górnictwie, Wyd. WUG Katowice, 8, s. 4-8.

Dehghani H. Ataee-Pour M., 2012. *The Role of Economic Uncertainty on the Block Economic Value – a New Valuation Approach*. Arch. Min. Sci., Vol. 57, No 4, p. 991-1014.

Sierpińska M. Bąk P., 2012. *Financial structure of mining sector companies during an economic slowdown*. Arch. Min. Sci., Vol. 57, No 4, p. 1089-1100.

Turek M., 2005. *Węgiel a pozostałe nośniki energii w polityce energetycznej Polski.* Polityka Energetyczna, T. 8, z. 1, s. 5-25.

Received: 22 November 2013