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HARD COAL IN THE FUEL-MIX OF POLAND: THE LONG-TERM PERSPECTIVE

WĘGIEL KAMIENNY W BILANSIE PALIWOWO-ENERGETYCZNYM POLSKI – PERSPEKTYWA DŁUGOTERMINOWA

This paper reviews the coal policy of Poland. It analyzes the forecasts of production and consumption of hard coal, the size of exports and imports and its importance for the energy sector on the basis of strategic documents. The main aim of the article is to show the role of hard coal in the fuel – energy balance of Poland until 2050. The adoption of appropriate assumptions for each scenario, including the maximum supply of hard coal from domestic mines, coal price curves, CO_2 emission allowances and several calculations performed allowed to obtain certain results on the basis of which the future role of hard coal was determined.

Keywords: hard coal, forecast, energy policy, power sector, energy security, coal reserves, coal consumption

W artykule dokonano przeglądu polityki państwa polskiego wobec górnictwa węgla kamiennego. Przeanalizowano jak kształtowały się w dokumentach strategicznych prognozy w zakresie wydobycia i zużycia węgla kamiennego, wielkości eksportu i importu oraz jego znaczenie dla sektora energetycznego. Głównym celem artykułu było ukazanie roli węgla kamiennego w bilansie paliwowo-energetycznym Polski w perspektywie do 2050 r. Po przyjęciu odpowiednich założeń dla poszczególnych scenariuszy, m.in. dotyczących maksymalnej podaży węgla kamiennego z krajowych kopalń oraz ścieżek cenowych węgla i uprawnień do emisji CO_2 oraz przeprowadzeniu obliczeń uzyskano wyniki, na podstawie których określono przyszłą rolę węgla kamiennego.

Słowa kluczowe: węgiel kamienny, prognoza, polityka energetyczna, energetyka, bezpieczeństwo energetyczne, zasoby węgla, wydobycie, zużycie

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1. Introduction

Hard coal mining in Poland is currently facing a number of serious challenges resulting from rapidly changing conditions in which the sector operates, while its long-term role is dependent on many factors, both at the national and international levels. Mining remains a key source of primary fuels for the domestic economy, giving Poland one of the highest levels of energy security in Europe. Historical conditions have led to the formation of the structure of electricity and heat generation based on solid fuels. Investments in increasingly efficient generating units and flue gas cleaning installations significantly reduced their negative impact on the environment. However, the next challenge facing the national fuel and energy sector is the European climate policy, which intensification can directly affect the position of coal as a fuel for power generation and, in consequence, on the whole economy. What is more, the "shale gas revolution" in North America is responsible for significant changes in global trends and plays an important part in the energy picture of the world (Szurlej & Janusz, 2013; Kaliski et al., 2012a; Janusz et al., 2015).

Determining the future role of coal – taking into account its crucial importance for the security of fuel supplies in electricity and heat sector – corresponds with governmental efforts on the development of a new energy policy. The domestic fuel – energy balance is a particularly important issue, to which special attention should be paid, as negligence in this sensitive area at the stage of defining the directions of development of the Polish energy sector can lead to irreversible and negative effects in the long run.

In the light of the above conditions, the aim of this paper is to determine the role of hard coal mining in meeting the country's energy needs by providing synthetic results of domestic demand forecasts for hard coal, mainly for the production of electricity and heat. Given the complexity of the question, the mutual interactions between coal mining and energy sector and the long-term horizon of research, the mathematical modeling methods were applied. Currently, they an commonly used for solving such problems, allowing to recognize the complexity of the fuel and energy systems and to quantitatively analyze their development (further discussed by: Kamiński & Kudełko, 2010; Pałka, 2011; Kamiński, 2009; Kamiński, 2011). The paper also discusses the national energy security for different scenarios evaluated using the level of energy self-sufficiency.

2. Hard coal mining in the strategic documents

The most important are documents in the field of Polish energy policy since 1989 are:

- Assumptions of the Polish Energy Policy for the years 1990-2010, August 1990,
- Assumptions for Poland's Energy Policy until the year 2010, adopted by the Council of Ministers on 17 October 1995,
- Assumptions for Poland's Energy Policy until the year 2020, adopted by the Council of Ministers on 22 February 2000,
- Evaluation of Implementation and Amendments to Assumptions for Poland's Energy Policy until the year 2020 with annexes, adopted by the Council of Ministers on 2 April 2002,
- Poland's Energy Policy until 2025, adopted by the Council of Ministers on 4 January2005,
- Poland's Energy Policy until 2030, adopted by the Council of Ministers on 10 November 2009.

Subsequent documents and changing conditions on the energy policy of Poland resulted in the reduction of the projected demand for coal. Yet, today, it is often forgotten that the document of August 1990 projected the domestic production of hard coal in 2010 in the range from 145 to 162 million tonnes, and imports from 4 to 16 million tonnes (depending on the scenario). For comparison, production of hard coal in 1988 amounted to 193 million tonnes while exports amounted to 31 million tonnes (Ministerstwo Przemysłu, 1990). The Polish energy balance projections in the subsequent documents on the energy policy expected a decline in demand for hard coal. According to the *Assumptions for Poland's Energy Policy until the year 2010* from 17 October 1995, the demand level in 2010 was projected to be around 115 million tonnes. The *Assumptions for Poland's Energy Policy until the year 2020,* adopted by the Council of Ministers on 22 February 2000, projected the demand in 2010 in the range of 84-88 million tonnes. A comparison between these two projections show a decline – to a level of 82-84 million tonnes – by 2020. The current *Poland's Energy Policy until 2030*, adopted by the Council of Ministers on 10 November 2009, projects a decline in domestic demand for hard coal to a level of 61.7 million tonnes in 2015, 60.4 million tonnes in 2020 and 64.0 million tonnes in 2030 (Minister Gospodarki, 2009). For reference, domestic sales of hard coal in 2012 amounted to 71.2 million tonnes at the production level of 78.1 million tonnes. Therefore, the discrepancy between projected demand for hard coal and the real domestic demand, resulting from much more intensive changes both in the surrounding environment and in the domestic mining industry, becomes apparent. Hard coal mining, due to its important role and the abundance of domestic coal resources was also the subject of separate studies of a strategic nature, of which: "*the Strategy of hard coal mining industry activities in Poland for 2007-2015"* adopted by the Council of Ministers on 31 July 2007 seems to be the most important one. The document emphasizes that the aim of the governmental policy in relation to the coal mining industry is rational and as well effective in the management of coal deposits located in the territory of Poland.

3. The supplies of hard coal in Poland

Steam coal is the main energy source used by the power industry. It provides more than half of the electricity and three-quarters of the heat. Poland is the largest hard coal producer in the European Union and ranks in the top ten global producers. The structure of energy resources is dominated by hard coal and lignite, while natural gas and oil account for only about 1%. The eventual success of the ongoing exploration work in the field of unconventional gas may change this structure.

The main hard coal basin in Poland is the Upper Silesian Coal Basin (USCB) located in the southern part of the country. All currently active mines are located in this area, with the exception of Lublin Coal "Bogdanka" SA, which is located in the Lublin Coal Basin (LCB). The major hard coal producer in Poland is Kompania Węglowa SA (15 mines). Its extractable resources during and after the concession period amount to 1.990.6 million tonnes (as of 03/07/2013) and its production capacity of 15 mines is about 40 million tonnes per year. The share of the largest company in hard coal mining in Poland is currently almost 50%; as concerns sales of coal, it amounts to about 55%. The second largest power coal producer in the country is Katowicki Holding Węglowy (5 mines) with 17.8% share in the total production in 2012 (12 million tonnes). The third largest power coal producer is Lubelski Węgiel "Bogdanka" SA (7.8 million tonnes in 2012) with approximately 14% share in domestic sales. Extractable reserves are currently around 237 million tonnes of coal. Other power coal producers include: TAURON Mining SA (up to 23 February 2014, the Southern Coal Concern SA), 2 mines, with production at the level of 5-5.5 million tonnes. Jastrzębska Spółka Węglowa SA (6 mines), the leading coking coal producer with a share in 2012 of 5.9% in the domestic steam coal production. Other smaller companies producing steam coal include: ZG "SILTECH" Sp. z o.o., PG "Silesia" Sp. z o.o. and "ECO-PLUS" Sp. z o.o. The total share of small companies does not exceed 2% of the coal market.

Production and sale of hard coal has been steadily declining. In 2012, sales amounted to around 72 million tonnes, while 10 years ago exceeded 100 million tonnes. What is more, coal export is also declining; the share of exports in total sales decreased from approximately 20% in 2005 to 10% in 2012. Steam coal represents approximately 75-80% of the exported hard coal. More than 90% of the exported hard coal goes to European Union countries, where the major recipients of Polish coal include Germany, the Czech Republic and Austria. When it comes to exports outside the EU, the main recipients of steam coal are Turkey and Norway, the major recipient of coking coal is Bosnia and Herzegovina. Since 2008, Poland is a net importer of coal (the largest imports from Russia) although for many years it was known as the world's leading exporter of coal. The main customer of steam coal on the domestic market is power industry – Fig. 1. In the years 2008-2012, the average consumption of coal by power industry amounted to 37.8 million tonnes, a decrease of almost 7 million tonnes.

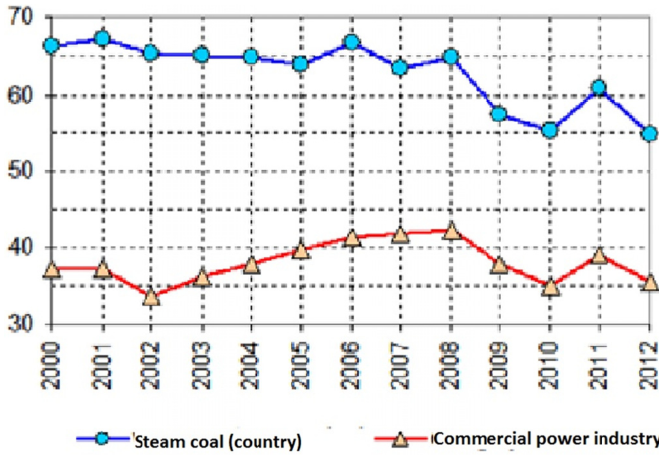

Fig. 1. The sale of coal to power plants against the coal sales in the domestic market, million tonnes (Gawlik (ed.), 2013)

The reasons for this decrease include, inter alia, gradual change in the structure of electricity generation, the increasing role of renewable energy, especially biomass and wind energy, as well as a systematic increase in the use of lignite in power industry in recent years (2010 – 49.46 TWh, 2011 r. – 53.62 TWh; 2012 r. – 55.59 TWh; 2013 r. – 56.96 TWh) (Polskie Sieci Elektroenergetyczne SA, 2014). The share of hard coal in electricity generation structure in 2013 was 52%, while in 2008 it amounted to 55.6% (Polskie Sieci Elektroenergetyczne SA, 2014) – Fig. 2. Although in recent months the EU receives signals indicating a tightening of energy – climate policy, an example of which is the decision to postpone the auctioning of 900 million CO_2 al-

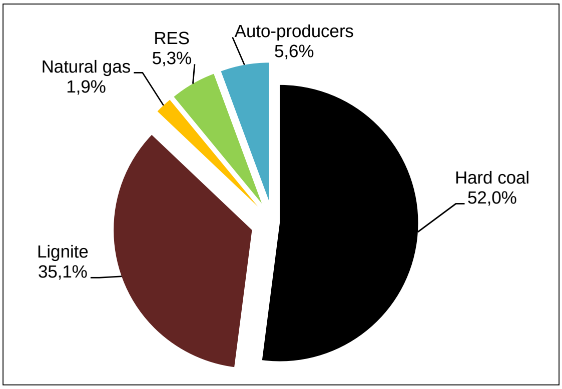

Fig. 2. The structure of electricity production in 2013 (own work on the basis of Polskie Sieci Elektroenergetyczne SA, 2014)

lowances from the years 2014-2016 until 2019-2020 (the so-called *backloading*), the decisions at the political level do not correspond with the activities of energy companies. A good example of that might be the analysis of the electricity generation fuel-mix in the EU and the leading producers of electricity, i.e. Germany (the share of hard coal and lignite in electricity production in 2013 amounted to 45.5% and increased by 1.5% compared to in 2012) and the UK. In the case of UK, the third largest electricity producer in the EU, increasing importance of hard coal in electricity production is observed in recent years – Figure 3. The reasons for the strengthening of the position of hard coal as a fuel in electricity production should be sought in its price advantage over natural gas in the European market. In the case of the U.S. energy market, the situation, mainly due to the "shale gas revolution", is the opposite; lower natural gas prices

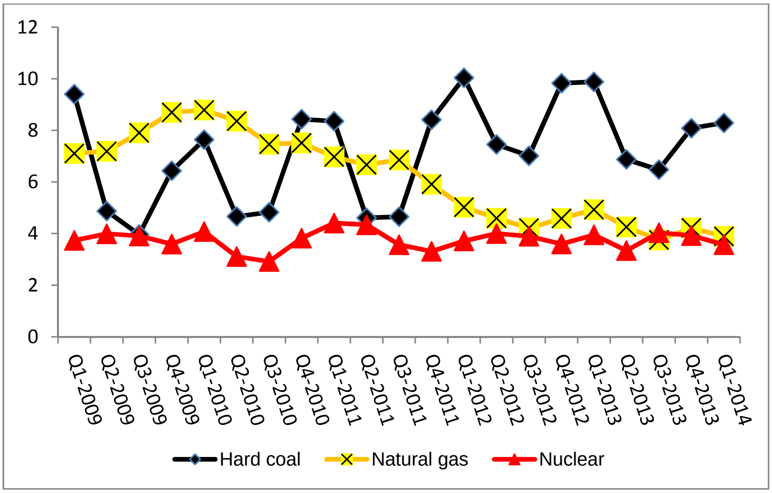

Fig. 3. The use of hard coal, natural gas and nuclear power in electricity production in the years 2009-2014 (1 quarter), million toe (own work on the basis of DECC, 2014)

translate into the development of its use in the power industry. In the years 2007-2012 there was an increase in the use of natural gas in this sector by 36.6%, while the consumption of coal during this period decreased by 25% (U.S. Energy Information Administration, 2014). Given this situation in the energy market in the U.S., hard coal imports from that country have increased in recent years. In 2011, the net export of coal from the United States amounted to 85 million tonnes and in 2012 has increased to 106 million tonnes, which has elevated the U.S. to the position of the third largest coal exporter in the world. It is important to mention that coal from the U.S., is also exported to Poland (million tonnes): 2010 – 1.85; 2011 r. – 1.32 and 2012 – 0.8 (Grudziński, 2012, 2013; Olkuski, 2013).

The forecasts of hard coal supplies in this paper were adopted from the review written by (Gawlik (ed.), 2013). The variant of low supply – *Status quo* – assumes the production capacity of domestic coal producers based on the state of industrial resources at the end of 2012 and the level of output as of 2012. On the other hand, a variant of the increased supply – *Development* – takes into account the increase in coal production through the implementation of planned investments in individual mining companies (Fig. 4). Differences between these variants exceed 20 million tonnes /year after 2030.

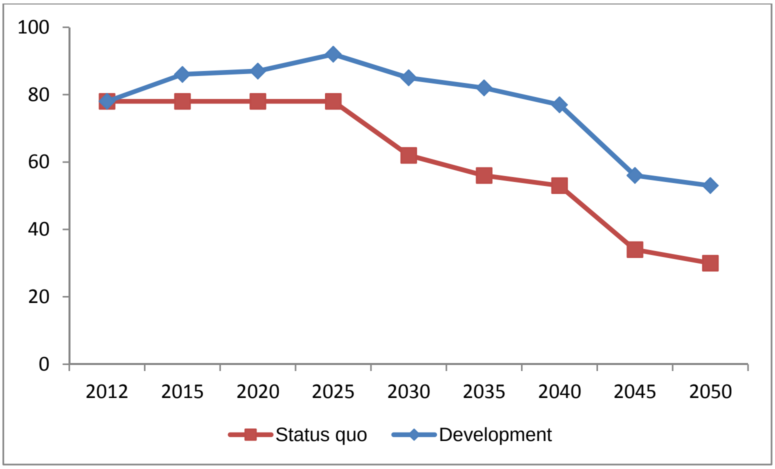

Fig. 4. The forecast variants of the possible hard coal supply until the year 2050, million tonnes (Gawlik (ed.), 2013)

Narrowing the analysis of supplies to domestic steam coal, significant differences between the two options can be observed – Table 1. In the case of *Status quo* variant, a decrease in the supplies of steam coal is observed after 2020, while a continuous decline is expected in the years 2040-2050. The supply of steam coal from domestic sources at the end of the analyzed period is only 33% compared to the level of the year 2012. In the *Development* variant, investments increase domestic supply of steam coal by approximately 10 million tonnes/year in the period 2015 to 2030 when compared to 2012. This will be followed by a decrease in production, while the expected level of steam coal supplies in 2050 amounts to 44 million tonnes which accounts for 68% of the amount offered on the market by domestic producers in 2012 and 2040.

TABLE 1

The forecast variants of steam coal supplies until the year 2050, million tonnes (Gawlik (ed.), 2013)

Year	2012	2015	2020	2030	2040	2050
Status quo	65	65	65	50	42	22
Development	65	73	74	73	65	44

4. Basic assumptions

The forecasts of hard coal price curves and other energy sources used in further calculations are shown in Figure 5. It was assumed that the domestic prices of coal for power industry will equal to 96 percent of the price of imported coal (The model calculations assumed that these prices are average prices for large domestic customers, that is power engineering, industrial power engineering, municipal and industrial heating plants) (Gawlik (ed.), 2013). In addition, it was assumed that the price level for small customers and households will be 50% higher compared to domestic prices for power industry. As it can be seen from Figure 5, it is expected that the prices of solid fuels will be competitive with natural gas prices (only the prices of fuel for nuclear power stations are lower, but in the case of this technology fuel prices have little impact on the total cost of electricity generation). The liberalization of the gas market and the possible production of gas from shale formations may give hope for a decrease in natural gas prices. (Frączek & Kaliski, 2009; Nagy & Siemek, 2011; Gawlik, 2013; Frączek et al., 2013). By the first quarter of 2014, 57 exploratory holes have been drilled. In March 2014, the government approved the regulations on gas exploitation. Their adoption is positively accepted by the companies involved in shale gas exploration. However, the fact that the leading oil companies: MarathonOil, ExxonMobil and TalismanEnergy withdrawn from the gas exploration in Poland does not speed up the transition to the exploitation of this energy resource It is worth noting that although the prices of various energy sources for most energy technologies play a fundamental role in shaping the overall cost of electricity, in the case of EU countries one also needs to take into account the cost of purcha

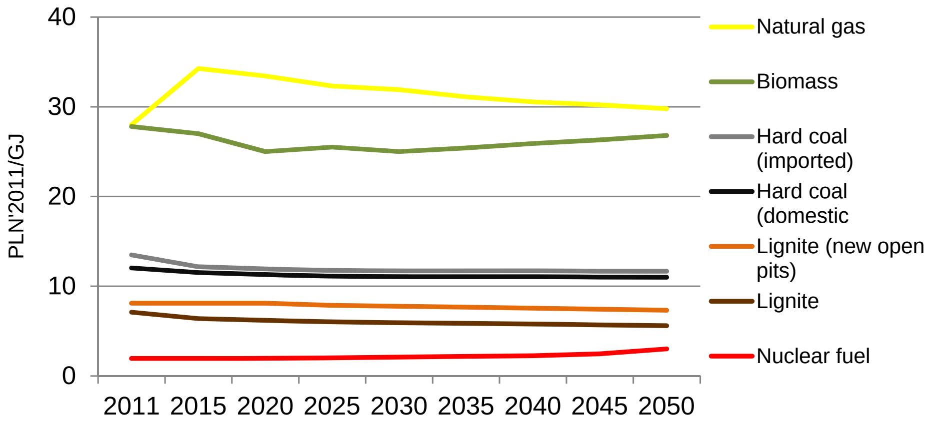

Fig. 5. The forecast of hard coal prices compared to other energy sources until 2050, PLN'2011/GJ (Gawlik (ed.), 2013)

of CO_2 emission allowances. Although the costs associated with CO_2 in 2013 remained at a low level, a significant increase with the beginning of 2014 can be observed (the beginning of January – 19 February 2014 – an increase of 40%, up to 6.91 Euro/Mg). A further increase of these prices can be a serious problem for the price competitiveness of coal-fired generating units and will be beneficial for technologies based on renewable energy sources, while also can improve the profitability of gas units, where investments are planned (Kaliski et al. 2009; Rychlicki & Siemek, 2013). Further model calculations assumed future prices of CO_2 emission allowances as shown in Table 2.

In this paper, five scenarios selected from 16 described in the book by Gawlik (ed.), (2013) were discussed. On their basis, conclusions can be drawn on the future role of hard coal in the fuel and energy balance.

The choice of these scenarios is supported by an attempt to define the future role of hard coal, depending on the variant of domestic supply of this fuel (*Development / Status quo*), the change in demand for electrical energy (The *Low* variant assumes an increase in final demand for electricity in Poland up to 179 TWh by 2050; the *REF* variant determines this demand, at the level of 204 TWh, while the *High* variant – at the level of 225 TWh; to approximate the scale of growth in different variants, the final electricity demand in 2011 amounted to 122 TWh), and the prices of CO_2 emission allowances. The current price of CO_2 emission allowances is less than 7 Euro / Mg (March 2014) and significantly differs (in minus) from the values listed in the variants (Table 2), but with the experience from the beginning of 2014 it can be expected that political agreements in the EU could translate into a significant increase in prices. It is worth noting that the comparison of the forecast of electricity demand set out in the report of the Minister of Economy from 2013 (Minister Gospodarki, 2013) in the baseline scenario of demand is between the *REF* and the *High* variants.

TABLE 2

The price evolution models of CO_2 emission allowances (fixed prices PLN'2011) (Gawlik (ed.), 2013)

Ordinal Number	Variant name	2015	2020	2025	2030	2035	2040	2045	2050
1.	REFERENCE	41	62	62	70	74	78	82	87
2.	CO_2HIGH	41	62	95	132	165	202	206	210

TABLE 3

The summary of the analyzed scenarios (Gawlik (ed.), 2013)

Ordinal Number	Scenario name	Adopted variant of the assumed parameter		
		Coal supply	Electricity demand	CO_2 emission allowances
1.	REF	Development	REF	REFERENCE
2.	REF-HIGH	Development	HIGH	REFERENCE
3.	REF-LOW	Development	LOW	REFERENCE
4.	REF-CO2HIGH	Development	REF	CO2HIGH
5.	STATUSQUO	Status quo	REF	REFERENCE

5. Summary of the results of scenario analysis

The overall objective of scenario analysis was to determine the demand for steam coal in the domestic economy at different development conditions of individual sectors of the economy and the changing external conditions. To determine the future role of steam coal, the share of this energy source in the structure of electricity production in the years 2020-2050, depending on the analyzed research scenarios, has been shown in Figure 6. Significant changes in the structure of electricity production in the coming decades are not expected – power coal will retain its dominant position; the highest share of coal is observed for the STATUSQUO scenario in 2050 64%, and the lowest in the case of REF-LOW scenario 36.7%.

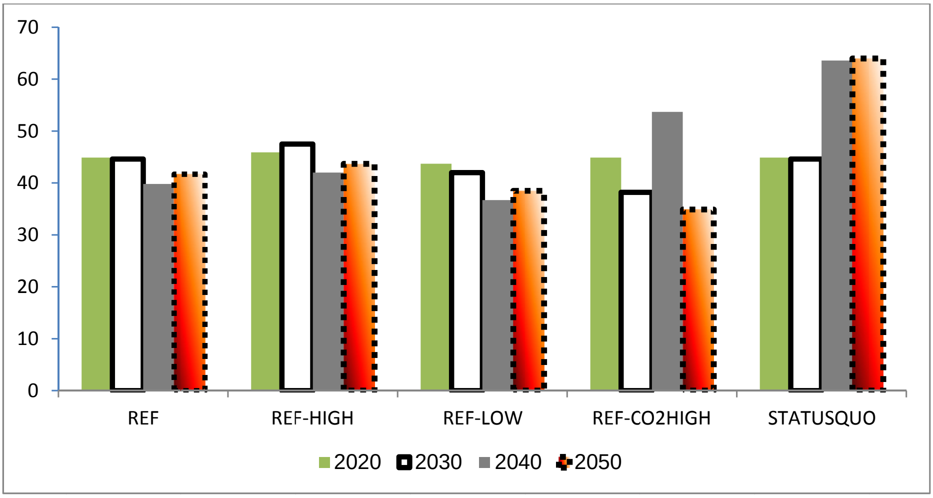

Fig. 6. The share of steam coal in the Polish electricity production in the analyzed scenarios in 2020-2050 in percentage values (own work on the basis of Gawlik (ed.), 2013)

The analysis of the individual research scenarios in terms of the share of steam coal in the structure of primary energy indicates that this share is the highest for the STATUSQUO scenario (in the years 2040-2050 it exceeds 70%), and the lowest for the REF-LOW scenario (nearly 50% between 2040-2050) – Fig. 7.

The comparison of REF, REF-HIGH and LOW REF scenarios shows that the higher the level of electricity demand, the higher the share of coal in the structure of demand for primary energy sources. Given the reference prices of CO_2 emission allowances, coal-based power production is cheap. Consequently, a growing energy demand is covered by the development of additional – usually coal-based – capacities (Table 4).

A comparison of the results of the STATUSQUO and the REF scenarios shows that the only difference is the volume of domestic steam coal and lignite supply. The assumed stagnation of the mining industry in the STATUSQUO variant results in a power coal supply reduced to the level shown in Table 1 and halting the development of new lignite open pits. Therefore, no new lignite-based capacities are built until 2050. In this case, the best solution is to build new coal-

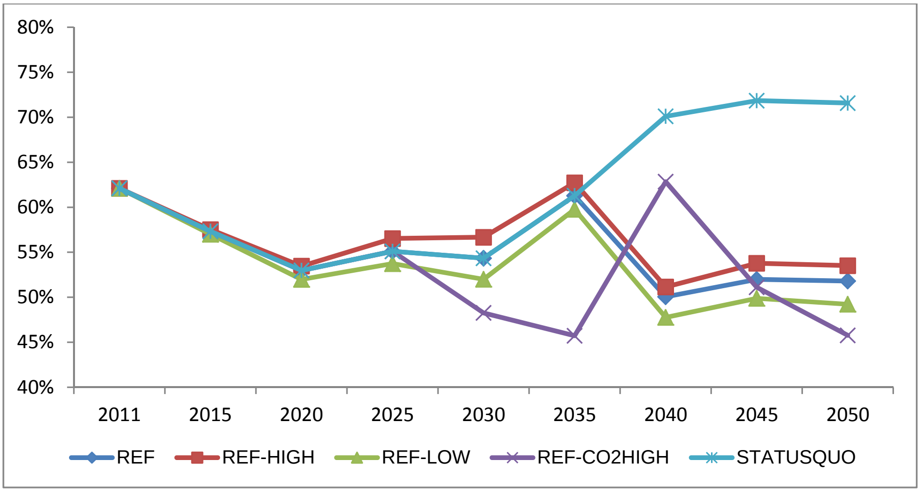

Fig. 7. The share of steam coal in the structure of consumption of primary energy sources in Poland in the years 2011-2050 (own work on the basis of Gawlik (ed.), 2013)

based power plants using primarily Polish coal and – when domestic supplies are low – also imported coal. Indicative coal balance sheets for the REF and STATUSQUO scenarios are shown in figures 8 and 9.

TABLE 4

The development of new capacities in 2015-2050 [GW] and their fuel structure, percentage values (own work on the basis of Gawlik (ed.), 2013)

Item	Unit	REF-LOW	REF	REF-HIGH
Development of new capacities	GW	50,3	61,9	70,6
based on:				
Hard coal	%	19,2	19,4	19,7
Lignite	%	13,5	11,0	9,6
Natural gas	%	12,3	11,8	11,5
Hydropower	%	0,3	0,4	0,5
Biomass	%	5,8	4,7	4,3
Biogas	%	2,4	2,0	1,7
Wind power	%	39,9	35,3	31,9
Solar power	%	6,5	15,5	20,8

In 2011, the excess of supply over demand for steam coal was about 12 million tonnes (excluding imports of coal to the power sector, which can be estimated at around 3 million tonnes). Thus, Polish coal producers, besides supplying coal to the power sector, offered approximately 15 million tonnes of steam coal to other market participants (both domestic and foreign). It can be expected that the demand for steam coal from aforementioned domestic and foreign consumers in the analyzed period will be comparable or slightly smaller. Therefore, the domestic steam

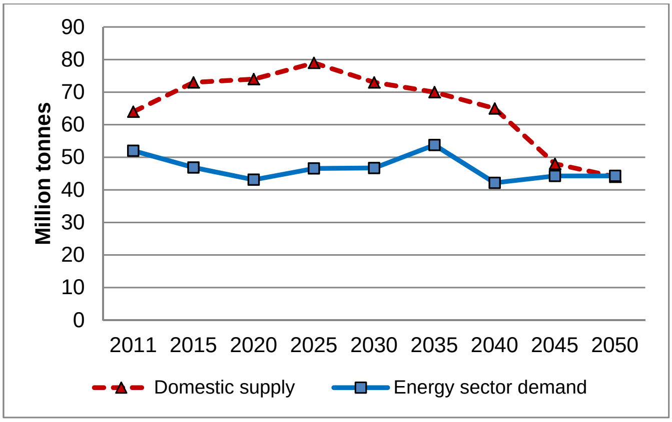

Fig. 8. The power industry demand for steam coal against its possible maximum supply in the REF scenario, million tonnes (own work on the basis of Gawlik (ed.), 2013)

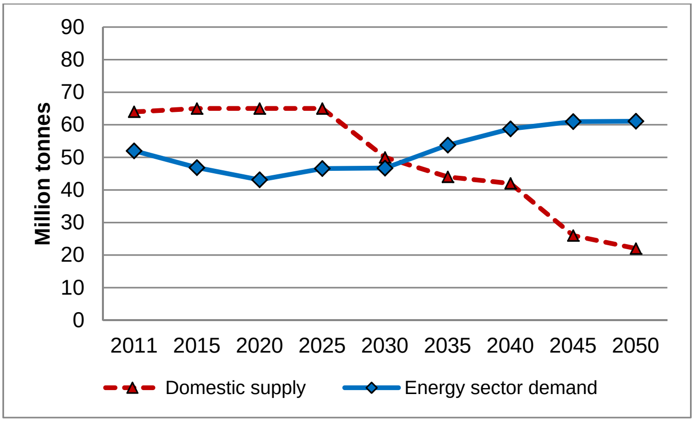

Fig. 9. The power industry demand for steam coal against its possible maximum supply in the STATUSQUO scenario, million tonnes (own work on the basis of Gawlik (ed.), 2013)

coal supply should be about 15 million tonnes higher than the requirements of the energy sector. Another problem is the price competitiveness of domestic coal compared with imports. The coal supplies in the REF scenario by 2040 is high. The excess demand of the energy sector is as high as 32 million tonnes in 2025. In 2045-2050, the energy sector will consume almost all of the available coal from domestic producers, not leaving it for other coal consumers. This analysis indicates that a development of new capacities in the mining industry will be needed in Poland. The pace and scale at which shall expand must be coordinated across the entire sector so that an early development of production capacity will not result in an oversupply of steam coal on the market and contribute negatively to the deterioration of the economic situation of the coal companies.

Figure 9 shows clearly that the lack of development of hard coal mining industry in the long run is harmful to the domestic energy sector. In the STATUSQUO scenario, despite the assumed lack of development of new capacities by 2025, a coal surplus of 22 million tonnes in 2020 – can be observed, which makes it difficult for producers to sell it in the domestic or international market. However, later on – starting from 2030 – the domestic supply of coal will not only fall short to meet the needs of domestic steam coal customers (except energy sector), but also the needs of power industry. The demand will be met by imported coal. A general conclusion is that the restructuring of hard coal mining companies – with an emphasis on reducing the costs of coal mining – will become essential in the coming years. (Gawlik, 2008; Gawlik & Mokrzycki, 2014). However, plans for the development of the mining sector cannot be postponed, at least because of the long duration of the investment, while new production capacities of the mining industry should take into account the construction of new production capacities in the power industry.

The comparison of the REF scenario and the REF-CO2HIGH scenario shows the effects of a drastic increase in prices of CO_2 emission allowances. With such prices, the optimal solution is the construction of two nuclear energy blocks, but at the same time the development of new coal-based capacities (13.4 GW compared to 12.0 GW – REF scenario) This solution depends on the use of CCS technology, which according to the adopted assumptions will be possible to implement after 2035. The demand for coal from the energy sector – although differently distributed over time (higher in the last years of the analysis – Figure 6) – will be comparable in both scenarios. The high prices of CO_2 emission allowances will obviously have an impact on the level of required investment expenditures (Gawlik, 2011) and the level of electricity production costs (Fig. 10).

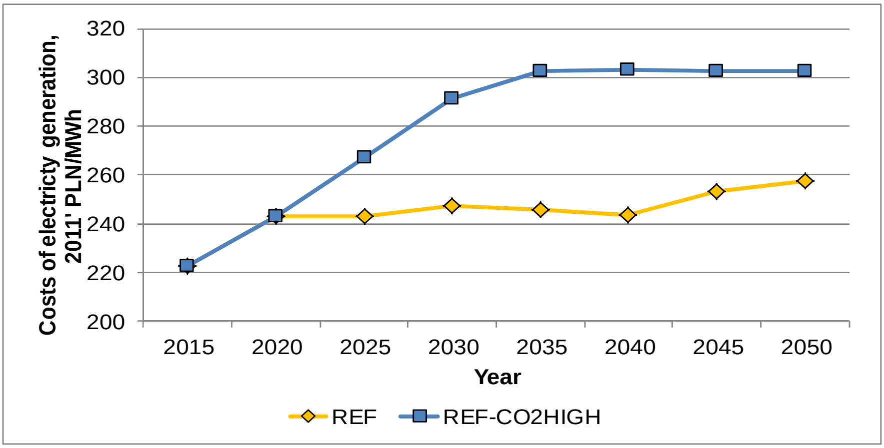

Fig. 10. The total costs of electricity generation for low (the REF scenario) and high (the REF-CO2HIGH scenario) prices of CO_2 emission allowances, 2011'PLN/MWh (own work on the basis of Gawlik (ed.), 2013)

It is noteworthy that despite the reduction in the level of coal product in the last two decades, Poland is still the EU leader in hard coal mining, which is the main reason for the high level of energy security, assessed on the basis of energy self-sufficiency. Poland ranks sixth out of the 28 EU countries in terms of its independence from imported energy, and taking into account the self-sufficiency in terms of hard coal, Poland ranks second, after the Czech Republic, in the ranking of EU countries (Eurostat, 2013). The analysis of Polish dependence on imported energy after the transition period shows an upward trend; this indicator was 0 in 1995 (energy self-sufficiency), while in subsequent years it was increasing: 1999 – 10%, 2006 – 20% 2008 – 31% and 34% in 2011 (Janusz, 2013). Figure 11 shows the results of calculations of the energy security for the analyzed scenarios, calculated according to the following relationship:

$$WSK = \frac{D}{Z} \cdot 100\%$$

D — Total fuel supplies from domestic deposits to the energy sector, PJ,
Z — Domestic consumption of fuels in the energy sector, PJ.

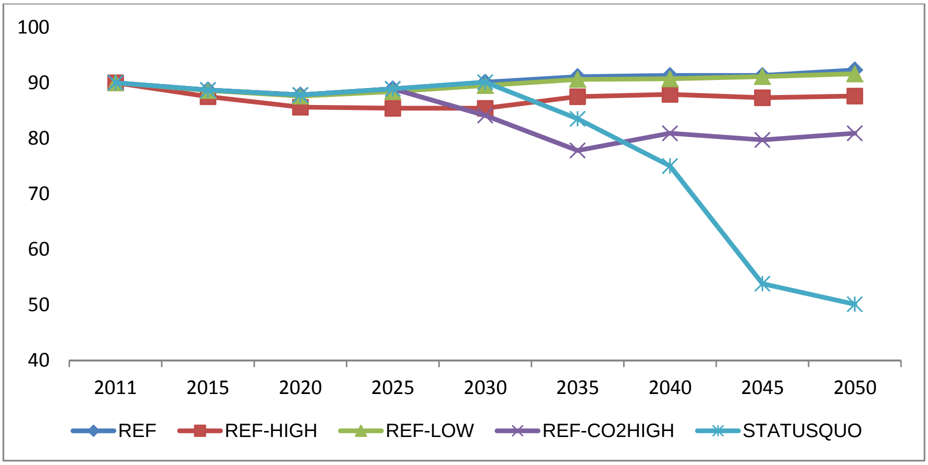

Fig.11. The values of energy security indicator for the individual scenarios, percentage values (own work on the basis of Gawlik (ed.), 2013)

As shown in Fig. 11, the highest values of energy security can be expected in the case of the REF and REF-LOW scenarios (nearly 90%, nearly at the level of 2011), and the lowest in the case of STATUSQUO scenario – 50% in the year 2050 (this value is influenced by the need to import significant amounts of coal).

6. Summary

The results of the research show that hard coal is likely to remain the primary fuel for the domestic power industry in the long run. This is supported not only by significant – in Europe – resources of this fuel and historical conditions of the development of the energy sector, but also by the results of calculations indicating that the cost of hard coal-based electricity generation can be competitive for many years when compared to the costs of energy from other energy technologies (Gawlik (ed.), 2013). This competitiveness (or lack of it) will depend on, *inter alia*, changes in the natural gas market due to the construction of the LNG terminal in Świnoujście, the price of CO_2 emission allowances (Siemek et al., 2011) and the ability to maintain domestic coal prices at a level not higher than the prices in global markets (Gawlik, 2010). As shown by the experience from the beginning of 2014, the prices of CO_2 emission allowances are largely dependent on political decisions at the EU level. However, it should be emphasized that although coal power units are characterized by high CO_2 emissions, the ongoing technological development increases the efficiency of coal technologies (e.g. supercritical, IGCC or coal-gas units), which translates into the reduction of emissions (Bartela et al. 2014; Kotowicz et al. 2011). Maintaining a sufficiently high supply of hard coal and lignite from domestic deposits guarantees Poland a high level of energy security. The basis of this scenario (REF) is to provide an appropriate level of investments in the mining industry, as rationally managed hard coal and lignite reserves will meet the energy needs of Poland for several decades (Mokrzycki et al. 2008). This will require a lot of effort from coal companies due to the current difficult financial situation. Without local investments in mining, coal will continue to be widely used in power generation, but the difference will be that some or a significant amount will need to be imported. In this scenario (STATUSQUO), the energy security described by the WSK ratio will deteriorate.

World's hard coal resources, as the analyses show, are more evenly distributed than natural gas resources. This advantage is one of the reasons why coal prices, as shown by analyses of historical price trends, are characterized by a higher stability compared to the prices of natural gas, whose resources are located mainly in Russia and in the Middle East. Despite the fact that recent years have shown an increase in the importance of spot contracts in the gas market, long-term contracts remain an important part of international gas trade, while the gas price is dependent on the price of petroleum products and these remain at high levels in recent years (Kaliski et al. 2012b, Kaliski et al. 2012c; Kaliski et al., 2013; Grudzinski & Szurlej, 2011).

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