

Zbigniew GRUDZIŃSKI<sup>1</sup>, Katarzyna STALA-SZLUGAJ<sup>2</sup>, Mikołaj ŚWIAT<sup>3</sup>

## Pricing of types of thermal coal in international trade

**ABSTRACT:** The paper analyses the pricing of various types of thermal coal on the international market in the period 2015–2025. Coal prices during this period fluctuated significantly under the influence of factors, such as: demand, supply, production costs and global events, e.g., the COVID-19 crisis, Russia's aggression against Ukraine and climate policies. The major benchmark is the price of Australian coal 6,000 kcal/kg (25 MJ/kg) quoted at the port of Newcastle (NEWC), which reflects market trends. During the period under analysis, prices went through three phases: stable, dynamic growth (2021–2022) and stabilization after the peak. The analysis covered the pricing of types with different calorific values, from 6,000 to 3,400 kcal/kg, and examined how changes in calorific value affect pricing. It was calculated that a decrease in calorific value by 1 MJ/kg causes a price change of approximately 6–7% (relative to the base price of coal: 6,000 kcal/kg), although in periods of high volatility this indicator was as high as 8–10%. The results confirm the stability of valuation methods over different periods, and indicate that the valuation of coal types with lower calorific value is proportional to the decrease in the energy content of coal. In summary, despite high price volatility, the relationship between the valuation of different quality coals is largely stable and based on energy parameters, which allows for a rational estimation of their value on the international

---

✉ Corresponding Author: Katarzyna Stala-Szlugaj; e-mail: [kszlugaj@min-pan.krakow.pl](mailto:kszlugaj@min-pan.krakow.pl)

<sup>1</sup> Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland; ORCID iD: 0000-0002-4977-3595; e-mail: [zg@min-pan.krakow.pl](mailto:zg@min-pan.krakow.pl)

<sup>2</sup> Mineral and Energy Economy Research Institute of the Polish Academy of Sciences, Poland; ORCID iD: 0000-0003-3689-7895; e-mail: [kszlugaj@min-pan.krakow.pl](mailto:kszlugaj@min-pan.krakow.pl)

<sup>3</sup> Polska Grupa Górnicza SA, Poland; e-mail: [m.swiat@pgg.pl](mailto:m.swiat@pgg.pl)



© 2026. The Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution-ShareAlike International License (CC BY-SA 4.0, <http://creativecommons.org/licenses/by-sa/4.0/>), which permits use, distribution, and reproduction in any medium, provided that the Article is properly cited.

market. A pricing formula has been proposed to calculate the prices of different coal types using the calculated price gradation coefficient.

KEYWORDS: valuation of energy coal types, energy fines, price quotations, pricing formula

## Introduction

Coal prices on the international market fluctuated greatly between 2015 and 2025. The main factors that shaped prices during this period included: supply and demand (especially in large global economies such as China and India) and production and extraction costs among major thermal coal exporters (Stala-Szlugaj and Grudziński 2021, 2022; Grudziński 2025; Stala-Szlugaj 2025; IEA 2025). For years, the world's largest coal exporters have been producers such as Indonesia, Australia, Russia, South Africa, Colombia, and the USA. Global coal trade amounts to approximately 1.1 billion tonnes per year, and this level of trade is forecast by analysts at the International Energy Agency (IEA 2025) for the coming years.

Coal prices in 2015–2025 were mainly affected by factors such as the COVID-19 crisis, Russia's invasion of Ukraine, climate policies implemented in many countries, and uncertainty surrounding the import policies of China and India. The combination of these factors caused coal prices to be highly volatile (Fig. 1), ranging from relatively low to extremely high. However, there is a strong correlation between prices quoted in the ports of coal-exporting countries

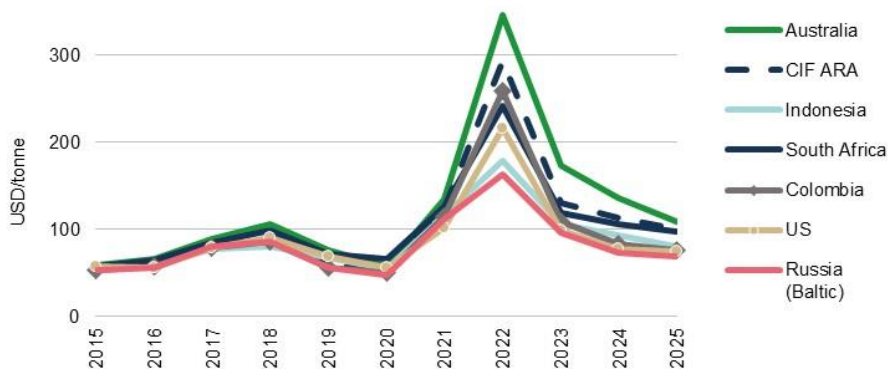


Fig. 1. Annual changes in thermal coal prices in the ports of major exporters and in ARA ports (coal 6,000 kcal/kg – 25 MJ/kg)

Source: own calculations based on data: IDA 2015–2025; Argus 2015–2022, Argus 2022–2025, Platts 2015–2025a, b; WB 2015–2025

Rys. 1. Zmiany cen rocznych węgla energetycznego w portach głównych eksporterów oraz w portach ARA (węgiel 6000 kcal/kg – 25 MJ/kg)

(Australia, Indonesia, the USA, Colombia, South Africa, and Russia). All prices shown in Figure 1 refer to the same type of coal with a calorific value of 6,000 kcal/kg (25 MJ/kg) in Net As Received (in abbreviation – NAR).

Despite different price levels in various geographical regions (especially during periods of high price volatility), the trends are closely linked. Only the correlations relating to Russian coal have been disrupted since 2022. Following the outbreak of war in Ukraine, Russian prices are much lower than coal prices on the ARA (Amsterdam-Rotterdam-Antwerp) and MED (Mediterranean) ports. The Russians are offering large discounts due to restrictions imposed by the EU and Asian countries (South Korea, Japan, Taiwan) on imports of this coal, trying at all costs to maintain supply volumes. It is worth mentioning that the spot price of Australian coal (6,000 kcal/kg) at the port of Newcastle (Australia) is widely recognized as the main benchmark for the entire international market.

There are many types of thermal coal with different quality parameters listed on the international coal market (Argus 2015–2022; Argus 2022–2025; Platts 2015–2025a, b). An increased number of listings of different types of coal (Tivari et al. 2015; Lorenz 2016; Grudziński 2019; Fernández Alvarez 2022), especially those with lower calorific value, began to be observed on the international market along with growing demand from China and India.

The aim of this article is to determine how different types of coal listed on the international market are priced. The issue of pricing different types of coal has already been the subject of previous studies by authors such as Lorenz (2016) and Grudziński (2019). However, the authors of this paper have assessed that there is a certain information gap in the cited publications regarding the calculation methodology. It refers to the analysis of a wider range of coal types, whose behavior will be analyzed in different periods between 2015 and 2025 (first half). Another important factor will be the analysis of the international coal market's response to a period of extreme price changes. In the adopted periods, calculations were made both with and without weights reflecting the importance of a given producer in a given consumer market (identical weights for all producers).

## 1. Selection of thermal coal types for pricing gradation calculation – calculation methodology

There are many types of coal listed on the international market, differing primarily in their calorific value, which is the main price-determining parameter. Other coal parameters are usually given in terms of ranges, e.g., sulphur content not exceeding 1%, ash content not exceeding 15%. All coal prices are quoted in USD/tonne. However, the quality parameters of coal on the European and American markets are given in net as received (Net As Received, in abbreviation – NAR) condition, while in Asia, it is usually in gross as received (Gross As Received, in abbreviation – GAR) condition. Prices quoted in gross air dried (Gross Air Dried, in abbreviation – GAD)

are also encountered, and these are generally for coal imported by Japan. In the calculations presented in this article, all prices are given for NAR (Net As Received) parameters.

Price differentiation based on calorific value is understandable, as this parameter provides information about the amount of energy contained in a tonne of coal. The prices of coal types with a lower calorific value compared to the base coal of 6,000 kcal/kg must therefore be lower.

To answer the question: how are coals with lower calorific values compared to the base coal with a calorific value of 6,000 kcal/kg priced on the international market, based on price data obtained from publications (IDA 2015–2025; Argus 2015–2022; Argus 2022–2025; Platts 2015–2025a, b; WB 2015–2025), only coals meeting the following criteria were selected for comparison and calculation:

- ◆ prices for different types of coal must be quoted in only one country,
- ◆ prices must be quoted continuously over a longer period and be available as monthly averages at a minimum.

As a result of the assumptions presented for this analysis, nine types of coal offered by four exporters were selected, as shown in Table 1.

TABLE 1. Selected coal types offered by exporters on the international market

TABELA 1. Wyselekcjonowane gatunki węgla oferowane przez eksporterów na rynek międzynarodowy

Eksporter	Quality parameters of coal						
Australia	kcal/kg	6,000	5,700	5,500			
	MJ/kg	25.1	23.9	23.0			
Indonesia	kcal/kg	6,000	5,500	4,700	4,000	3,800	3,400
	MJ/kg	25.1	23.0	19.7	17.6	15.9	14.2
South Africa	kcal/kg	6,000	5,700	5,500	4,800		
	MJ/kg	25.1	23.9	23.0	20.1		
Russia (Pacific)	kcal/kg	6,000	5,500	4,700			
	MJ/kg	25.1	23.0	19.7			

Source: own calculations.

The calculation method was as follows:

- ◆ selection of data for choosing coal types that fulfill the two criteria presented above,
- ◆ conversion of prices from USD/Mg to USD/GJ,
- ◆ calculation of price changes for individual coal types in relation to the base coal due to a change in calorific value of 1 MJ/kg,
- ◆ calculation of price gradation due to a change in calorific value for the selected analysis period and the share of a given exporter in total supplies.

## 2. Choice of period for coal price analysis

Another important stage of the analysis was the selection of the period on the basis of which price gradation would be calculated. In this regard, price changes in various periods between 2015 and 2025 were examined.

Changes in the price of thermal coal 6,000 kcal/kg CIF ARA and FOB Newcastle (abbreviated as NEWC) are presented in Figure 2. These are two indices that clearly illustrate the price situation that developed on the international coal market in 2015–2025. Table 2 presents statistical data characterizing the European coal market in 2015–2025. These data were calculated on the basis of monthly spot price quotations.

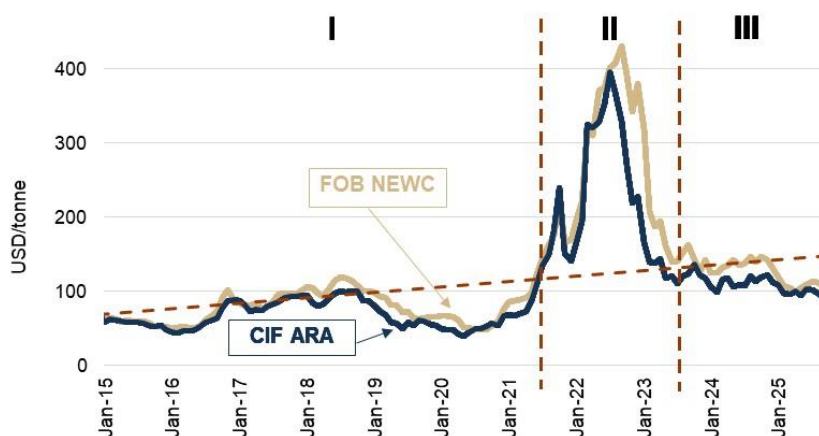


Fig. 2. Thermal coal prices in 2015–2025 – CIF ARA and FOB Newcastle (NEWC) indices  
Source: own work based on: IDA 2015–2025; Argus 2015–2022, Argus 2022–2025, Platts 2015–2025a, b; WB 2015–2025

Rys. 2. Ceny węgla energetycznego w latach 2015–2025 – indeksy CIF ARA i FOB Newcastle (NEWC)

Three periods can be distinguished in the price trend for 2015–2025. The first (I) and third periods (III) are characterized by relative price stability, while the second (II) period is a time of dynamic price changes on the coal market. The first period lasted 6.5 years, while the second and third periods lasted 2 years each.

Between 2015 and 2021 (May), coal prices ranged between USD 40 and USD 100 per tonne. Volatility did not exceed 14%. The first price disturbances on the coal market occurred in the second half of 2021, which was a consequence of the reduced volume of Russian natural gas exports to Europe, which significantly increased the risk of shortages of this raw material in the winter of 2021/2022. The tense situation was exacerbated by Russia's aggression against

TABLE 2. Annual statistical data characteristic of prices quoted in ARA ports (CIF, 6,000 kcal/kg)

TABELA 2. Roczne dane statystyczne charakterystyczne dla cen notowanych w portach ARA (CIF, 6000 kcal/kg)

Year	2015	2020	2021	2022	2023	2024	2025_1H
Average [USD/tonne]	57	50	122	293	129	112	100
Variability [%]	7	14	44	25	12	6	5
Standard deviation [USD/tonne]	4	7	51	64	10	7	3
Minimum price [USD/tonne]	48	39	66	171	110	98	94
Maximum price [USD/tonne]	62	67	240	395	165	121	109
Price fluctuations [USD/tonne]	14	28	174	225	55	23	14

1H – first half of the year.

Source: own calculations.

Ukraine and the imposition of sanctions in the form of a ban on imports of Russian hydrocarbons to EU countries. Price fluctuations in 2021 amounted to USD 174/tonne (the difference between the minimum and maximum prices in the year), and in 2022, they amounted to USD 225/tonne. Prices above USD 200/tonne persisted for 12 months, and the average price over these two years was USD 208/tonne. The dynamic price increase began in June 2020 and peaked at USD 395/tonne (PLN 74/GJ, CIF ARA) in July 2022. After this period, monthly prices continued to fall and stabilised at USD 95–125/tonne between July 2023 and June 2025. Price fluctuations in 2025 were within the range of USD 14/tonne, whereas in previous years they were at significantly higher levels. In period I, the average price was 68 USD/tonne, in period II 221 USD/tonne, and in period III 112 USD/tonne. Currently, prices are 87% higher than in period I, i.e., before the huge wave of growth. The average spot price (6,000 kcal/kg) in the first half of 2025 was USD 100/tonne CIF ARA and USD 107/tonne FOB NEWC.

In order to select a reference period for calculating the valuation of coal types in comparison to the base coal price, changes in the valuation of individual coal types were analyzed in the following periods:

- 1) the entire period – from January 2015 to June 2025,
- 2) from January 2024 to June 2025,
- 3) from January 2020 to June 2025,
- 4) from January 2023 to June 2025,
- 5) last 12 months (from July 2024 to June 2025),
- 6) from July 2021 to June 2023 – a period of significant changes and high prices.

The calculations were performed in the first stage on monthly averages, which were then averaged over the given period. In addition, each final result was weighted by the share of the given exporter in the total calculation of the gradation index. The variants of the share of coal from a selected country in the gradation index calculations are presented in Table 3. In the last

three variants, coal from Russia was not included due to the fact that coal prices from this country are subject to different conditions related to the imposed embargo. As a result of the assumptions made, 30 calculation variants were obtained, differing in terms of the period and the share of individual exporters in determining the level of the price gradation index.

TABLE 3. Various options for the share of coal from a given country in the calculation of the gradation index [%]

TABELA 3. Warianty udziału węgla z danego kraju w wyliczeniach wskaźnika gradacji [%]

Options	South Africa	Australia	Indonesia	Russia	Comments
Participation I [%]	20	20	20	20	Equal share of the weight
Participation II [%]	40	25	25	10	Share by importance for the European market 1
Participation III [%]	34	33	33	–	Shares divided equally – without Russia
Participation IV [%]	20	30	50	–	Shares by weight for the global market
Participation V [%]	40	20	40	–	Share by importance for the European market 2

Source: own calculations.

### 3. The results of the calculations

Throughout the entire period analyzed (i.e., from January 2015 to June 2025), monthly coal prices varied widely, ranging from USD 16/tonne (Indonesia) to USD 431/tonne (Australia). In contrast, quality parameters ranged from 3,400 kcal/kg (14.2 MJ/kg) to 6,000 kcal/kg (25.1 MJ/kg) NAR. The calculations provided information on the percentage change in coal pricing when the calorific value changed by 1 MJ/kg in relation to the base coal (6,000 kcal/kg). The results of the calculations are presented in Table 4 for six selected periods and five variants of coal share from a selected country, taken from Table 3. How to interpret the results presented in Table 4: for example, the gradation coefficient of 5.9 indicates that a decrease in calorific value by 1 MJ/kg in relation to the base coal reduces the price of coal by 5.9% of the base price.

The analysis of the results presented in Table 4 shows that for all periods, the weighted calculations are fairly consistent and range from 5.9 to 7.7. However, the averages for period 1 (January 2015–June 2025), regardless of the share adopted, range from 5.9 to 6.7. It can therefore be assumed that the most important results for the European market are options II and V, i.e., those with the highest share of coal from South Africa. In periods 1 (January 2015–June 2025) and 5 (July 2024–June 2025), the gradation index ranged from 5.9 to 6.2. Considering the whole

TABLE 4. Price gradation coefficient for different types of thermal coal

TABELA 4. Wielkość współczynnika gradacji cen dla różnych gatunków węgla energetycznego

Period	Period description	Participation I	Participation II	Participation III	Participation IV	Participation V	Min	Max
1	From January 2015 to June 2025	5.9	6.2	6.7	6.4	6.0	5.9	6.7
2	From January 2024	5.9	6.0	6.8	6.8	5.9	5.9	6.8
3	From January 2020	6.7	7.0	7.7	7.4	6.7	6.7	7.7
4	From January 2023	6.4	6.5	7.6	7.5	6.3	6.3	7.6
5	From July 2024	6.0	6.0	6.9	6.9	5.9	5.9	6.9
Min		6.7	7.0	7.7	7.5	6.7	–	–
Max		5.9	6.0	6.7	6.4	5.9	–	–
6	From July 2021 to June 2023	8.6	8.7	9.8	9.4	8.2	8.2	9.8

Source: own calculations.

international market, the most representative results were obtained mainly for options III and IV: the valuation index for these periods ranged from 6.4 to 6.9.

The calculation results presented in Table 4 show that exporters use relatively stable methods to price coal types with different calorific values. In general, it can be assumed that price changes with a decrease in calorific value by 1 MJ/kg relative to the base coal vary on average between –6% and –7%, i.e., the gradation coefficient would be 6–7. However, in a situation of very high prices and large price fluctuations (period 6: July 2021 to June 2023), this coefficient could even reach a value of 8–10.

Such large price increases on international markets also occurred in 2008 (Lehman Brothers crisis): at that time, monthly prices reached USD 185/tonne. Hence, in the history of the CIF ARA index (the oldest index listed since 1991), there have only been two such periods of exceptionally unstable prices.

In the next step of the analysis, a simulation was performed to determine what the prices of individual coal types (calorific value classes) would look like with changes in calorific value of 1 MJ/kg for four variants of the price gradation coefficient: 5.5, 6.0, 6.5 and 7.0 (Table 5). In this simulation, it was assumed that the base price level was 100% (25 MJ/kg). In the case of high-energy coals (above 25 MJ/kg), it was assumed that there is no premium for higher calorific value at prices expressed per 1 MJ of energy and that the price for these types is maintained at the same level as for base coal.

TABLE 5. Prices of thermal coal fines depending on the adopted price gradation coefficient  
(base coal price = 100%)

TABELA 5. Ceny mialów energetycznych w zaleźności od przyjętego współczynnika gradacji cen  
(cena węgla bazowego = 100%)

The class Qir [MJ/kg]	Price gradation coefficient			
	5.5	6.0	6.5	7.0
Coal price – % of base coal price				
≤12	28.5	22.0	15.5	9.0
13	34.0	28.0	22.0	16.0
14	39.5	34.0	28.5	23.0
15	45.0	40.0	35.0	30.0
16	50.5	46.0	41.5	37.0
17	56.0	52.0	48.0	44.0
18	61.5	58.0	54.5	51.0
19	67.0	64.0	61.0	58.0
20	72.5	70.0	67.5	65.0
21	78.0	76.0	74.0	72.0
22	83.5	82.0	80.5	79.0
23	89.0	88.0	87.0	86.0
24	94.5	94.0	93.5	93.0
25	100.0	100.0	100.0	100.0
≥26	100.0	100.0	100.0	100.0

Source: own calculations.

The question is what factors determine the price of different types of coal, which mainly are distinguished by their calorific value. The largest user of coal in Poland is the commercial power industry (SP 2015–2025a, b; Grudziński 2012; Grudziński and Stala-Szlugaj 2024). According to Statistics Poland (SP 2015–2025a, b), coal consumption in the commercial power industry in 2015–2024 ranged from 28.3 million tonnes (in 2024) to 41.2 million tonnes (in 2017). Statistics from the Energy Market Authority (EMA 2015–2025) show that between 21.0 million tonnes (in 2024) and 31.6 million tonnes (in 2018) were consumed annually to produce electricity. The share of the commercial power industry in total energy coal consumption in Poland varied from 62% (in 2020) to 70% (in 2024).

Table 6 shows the coal demand of a power plant with a specific conversion efficiency that purchases coal of a specific quality. The lower the calorific value, the more coal needs to be purchased to generate the target amount of energy. For example, with a power plant efficiency of 40%, in order to generate 1 MWh of energy, 0.40 tonnes of coal with a calorific value of 25 MJ/kg

TABLE 6. Volume of coal (of a specified quality) used to produce 1 MWh of electricity at a certain power plant efficiency

TABELA 6. Wolumen węgla (o określonej jakości) potrzebny do wytworzenia 1 MWh energii elektrycznej przy danej sprawności elektrowni

Power plant efficiency	Calorific value of 1 tonne of coal							Difference relative to coal 25 MJ/kg						
	25 MJ/kg	24 MJ/g	23 MJ/kg	22 MJ/kg	21 MJ/kg	20 MJ/kg	19 MJ/kg	24 MJ/g	23 MJ/kg	22 MJ/kg	21 MJ/kg	20 MJ/kg	19 MJ/kg	
	Volume of coal to generate 1 MWh													
30%	0.48	0.50	0.52	0.55	0.57	0.60	0.63	4.2%	8.8%	13.5%	19.0%	25.0%	31.7%	
32%	0.45	0.47	0.49	0.51	0.54	0.56	0.59	4.2%	8.7%	13.6%	19.1%	25.1%	31.6%	
34%	0.42	0.44	0.46	0.48	0.50	0.53	0.56	4.0%	8.5%	13.4%	18.9%	24.8%	31.4%	
36%	0.40	0.42	0.44	0.46	0.48	0.50	0.53	4.3%	8.7%	13.8%	19.0%	25.0%	31.5%	
38%	0.38	0.40	0.41	0.43	0.45	0.47	0.50	4.2%	8.7%	13.7%	19.0%	25.1%	31.7%	
40%	0.36	0.38	0.39	0.41	0.43	0.45	0.47	4.2%	8.6%	13.6%	19.2%	25.0%	31.7%	
42%	0.34	0.36	0.37	0.39	0.41	0.43	0.45	4.1%	8.7%	13.7%	19.0%	25.1%	31.5%	
44%	0.33	0.34	0.36	0.37	0.39	0.41	0.43	4.3%	8.9%	13.8%	19.3%	25.1%	31.8%	
46%	0.31	0.33	0.34	0.36	0.37	0.39	0.41	4.2%	8.6%	13.7%	19.2%	24.9%	31.6%	
48%	0.30	0.31	0.33	0.34	0.36	0.38	0.40	4.0%	8.7%	13.7%	19.0%	25.0%	31.7%	
50%	0.29	0.30	0.31	0.33	0.34	0.36	0.38	4.2%	8.7%	13.5%	19.1%	25.0%	31.6%	

Source: own calculations.

must be purchased, or, for example, 0.42 tonnes of coal with a calorific value of 24 MJ/kg, i.e., at least 4.3% more. Therefore, this is how much more coal needs to be purchased to generate the same amount of energy as when burning coal with a calorific value of 25 MJ/kg (base coal). These costs are compounded by increased transport costs and costs associated with the economic use of the environment (coal with a lower calorific value also has a higher ash content and usually a higher sulphur content). There are also increased costs of preparing the fuel before combustion in the power plant. All these factors mean that coals with lower calorific values are priced lower because they have a lower utility value. The calculated price gradation coefficient of 6–7 (determined on the basis of spot prices over a long period of time) reflects the situation regarding the pricing of different types of coal on the international market.

Considering the presented calculations, a formula for calculating the prices of thermal coal fines (fines in the 0–50 mm class) can be proposed in the following formula:

$$C_1 = C_w \cdot \left[ 1 - \left( \frac{W_{gQ}}{100} \cdot (Q_w - Q_K) \right) \right]$$

where:

- $C_1$  – price of thermal coal [PLN/GJ],
- $C_w$  – the price of base coal [PLN/GJ] with a calorific value of  $Q_{ir} = 25$  MJ/kg,
- $W_{gQ}$  – a gradation factor dependent on calorific value (percentage point) of 6,
- $Q_w$  – calorific value of base coal  $Q_{ir} = 25$  MJ/kg [MJ/kg],
- $Q_K$  – calorific value of thermal coal [MJ/kg].

## Conclusions

The aim of this paper was to analyze the valuation of various types of thermal coal with different calorific values traded on the international market and to determine the price gradation coefficient. The analysis was based on changes in spot coal prices in the ports of major exporters between January 2015 and June 2025. The main factors that influenced price levels during the analyzed period include: supply and demand (especially from China and India), production and mining costs, geopolitical factors, the COVID-19 crisis, climate policy and extraordinary situations (e.g., the war in Ukraine), as well as the interdependence of prices in exporters' ports (with the exception of Russia, whose prices were disrupted after the outbreak of the war).

The methodology adopted used a wider range of coal quotations, whose shares were weighted according to the importance of a particular producer in a particular consumer market. The analysis took into account many different time periods of coal quotations. The use of different periods of coal quotations allowed for observations of relationships in different ranges of coal price volatility. Particular attention was paid to examining the market's reaction during periods

of extreme price changes, i.e., answering the question: how to approach coal pricing during periods of extremely large price changes.

Only those types of coal whose quotations referred to a single country were selected from the coal price quotation database. The continuity of quotations and the availability of monthly data were taken into account. Nine types of coal from the four main global exporters (Australia, Indonesia, South Africa, and Russia) were selected.

In the adopted calculation methodology, USD/tonne prices were first converted to USD/GJ, then price changes were calculated in relation to the calorific value of 1 MJ/kg to determine the price gradation coefficient. All these analyses were carried out for different periods (e.g., the entire period 2015–2025, the period of high prices 2021–2023, the last 12 months). Taking into account the quality parameters of coal offered on international markets, the studies assumed that: the benchmark grade is Australian coal (Newcastle – NEWC) with a calorific value of 6,000 kcal/kg (25.1 MJ/kg); prices are quoted in USD/tonne, in net as received (NAR), and are correlated with each other.

The analysis discussed in this article can be summarized as follows:

- ◆ the price gradation coefficient in relation to changes in calorific value averages between 6 and 7, which means that a decrease in calorific value of 1 MJ/kg causes a decrease in price of approximately 6–7% (base price);
- ◆ during periods of high price volatility (e.g., 2021–2023), this ratio may reach as high as 8–10;
- ◆ the stability of prices for coal types with different calorific values suggests that the market prices them in a relatively predictable manner, despite significant fluctuations in overall market prices;
- ◆ the valuation of thermal coal types is mainly based on calorific value, and price changes are fairly stable and proportional to the decrease in calorific value.

The proposed formula and indicators can be used as instruments for the pricing of thermal coal, which is particularly useful in international trade and market negotiations.

This publication was prepared in part as an element of statutory research conducted by the Institute of Mineral Resources and Energy Management of the Polish Academy of Sciences.

The Authors have no conflicts of interest to declare.

## References

- Argus 2015–2022. Argus Coal Daily International. Argus Media Ltd., daily reports from 2015 to 2022.
- Argus 2022–2025. Argus Media Ltd. Database [Online:] <https://www.argusdirect.com> [Accessed: 2025-12-30].
- EMA 2015–2025. Statistical Information on Electricity – Informacja statystyczna o energii elektrycznej. Agencja Rynku Energii SA. Energy Market Agency, monthly issues from 2015 to 2025. [Online:] <https://www.are.waw.pl/en/oferta/wydawnictwa> [Accessed: 2025-12-30] (*in Polish*).
- Fernández Alvarez, C. 2022. The Trading and Price Discovery for Coal. [In:] Hafner, M., Luciani, G. (eds) *The Palgrave Handbook of International Energy Economics*. Palgrave Macmillan, Cham, [https://doi.org/10.1007/978-3-030-86884-0\\_21](https://doi.org/10.1007/978-3-030-86884-0_21).

- Grudziński, Z. 2012. Methods for evaluating the competitiveness of domestic coal in electricity production (*Metody oceny konkurencyjności krajowego węgla kamiennego do produkcji energii elektrycznej*). *Studia Rozprawy Monografie* 180, Kraków: MEERI PAS, s. 271 (*in Polish*).
- Grudziński, Z. 2019. The value of 1 GJ of energy in thermal coals assessed by the international market. *Polityka Energetyczna – Energy Policy Journal* 22(3), pp. 45–56, <https://doi.org/10.33223/epj/111963>.
- Grudziński, Z. 2025. The thermal coal market – current state and outlook (*Rynek węgla energetycznego – stan obecny i perspektywy*). *Zeszyty Naukowe Instytutu Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk* 1(113). Zagadnienia surowców energetycznych i energii w gospodarce krajowej. Nowe strategie i inwestycje na rynku paliw i energii w kraju i UE, s. 97–110 (*in Polish*).
- Grudziński, Z. and Stala-Szlugaj, K. 2024. The competitiveness of fuels in electricity generation. *Polityka Energetyczna – Energy Policy Journal* 27(3), pp. 193–206, <https://doi.org/10.33223/epj/192860>.
- IDA 2015–2025. Key information on the situation on the thermal coal market in Poland (*Sygnalna informacja o sytuacji na rynku węgla energetycznego w Polsce*). Industrial Development Agency JSC – Agencja Rozwoju Przemysłu S.A. Branch in Katowice. Based on source data obtained by IDA JSC Branch in Katowice as part of the “Public Statistics Research Programme” – statistical survey “Hard coal and lignite mining” Monthly reports from 2015 to 2025 (*in Polish*).
- IEA 2025. Coal 2025, IEA, Paris. [Online:] <https://www.iea.org/reports/coal-2025> [Accessed: 2025-12-30].
- Lorenz, U. 2016. Lower quality steam coals in international trade (*Węgły energetyczne o obniżonej jakości w handlu międzynarodowym*). *Polityka Energetyczna – Energy Policy Journal* 19(3), pp. 19–34 (*in Polish*).
- Platts 2015–2025a. Platts – Coal Trader International. Publ. Platts – McGraw Hill Financial, England. 2015–2025.
- Platts 2015–2025b. ICR Coal Statistics Monthly. Wyd. Platts – McGraw Hill Financial. England. 2015–2025.
- SP 2015–2025a. Energy statistics Gospodarka paliwowo-energetyczna. Publ. Statistics Poland, Warszawa, annual editions from 2015 to 2025. [Online:] <https://publikacje.new.stat.gov.pl/en> [Accessed: 2025-12-30].
- SP 2015–2025b. Zużycie paliw i nośników energii. Wyd. Główny Urząd Statystyczny, Warszawa, annual editions from 2015 to 2025. [Online:] <https://publikacje.new.stat.gov.pl/en> [Accessed: 2025-12-30].
- Stala-Szlugaj, K. 2025. Impact of the Russian-Ukrainian war on the international thermal coal market 2022–2024 (*Wpływ wojny rosyjsko-ukraińskiej na międzynarodowy rynek węgla energetycznego w latach 2022–2024*). *Zeszyty Naukowe Instytutu Gospodarki Surowcami Mineralnymi i Energią Polskiej Akademii Nauk* 1(113). Zagadnienia surowców energetycznych i energii w gospodarce krajowej. Nowe strategie i inwestycje na rynku paliw i energii w kraju i UE, s. 97–110 (*in Polish*).
- Stala-Szlugaj, K. and Grudziński, Z. 2021. Price trends on the international steam coal market in 2000–2020. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 37(4), pp. 5–30, <https://doi.org/10.24425/gsm.2021.139743>.
- Stala-Szlugaj, K. and Grudziński, Z. 2022. Alternative directions of coal supply to Poland as a result of the Russian-Ukrainian war. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 38(3), <https://doi.org/10.24425/gsm.2022.142790>.
- Tiwari et al. 2015 – Tiwari, R., Bhattacharya, S. and Raghav, P. 2015. A Discussion on Non-coking Coal Pricing Systems Adopted in Different Countries. *Vikalpa: The Journal for Decision Makers* 40(1), pp. 62–73, <https://doi.org/10.1177/0256090915573615>.
- WB 2015–2025. World Bank: Commodities Price Data. [Online:] <https://www.worldbank.org/en/research/commodity-markets> [Accessed: 2025-12-30].

## Wycena gatunków miałów węgla energetycznego w handlu międzynarodowym

### Streszczenie

W artykule analizowana jest wycena różnych gatunków miałów węgla energetycznego na rynku międzynarodowym, w kontekście zmian cen spot w latach 2015–2025. Ceny węgla w tym okresie ulegały dużym wahaniom pod wpływem czynników takich jak: popyt, podaż, koszty produkcji oraz globalne wydarzenia, np. kryzys COVID-19, agresja Rosji na Ukrainę czy polityki klimatyczne. Głównym benchmarkiem jest cena węgla australijskiego 6000 kcal/kg (25 MJ/kg) notowanego w porcie Newcastle (NEWC), która odzwierciedla trendy rynkowe. W okresie analizy ceny występowały w trzech fazach: stabilnej, dynamicznej wzrostowej (2021–2022) oraz stabilizacji po szczycie. Analiza obejmowała wycenę gatunków o różnej wartości opałowej, od 6000 do 3400 kcal/kg, sprawdzono podczas niej, jak zmiany wartości opałowej wpływają na wycenę. Obliczono, że spadek wartości opałowej o 1 MJ/kg powoduje zmianę ceny o około 6–7% (w stosunku do ceny bazowej węgla 6000 kcal/kg), choć w okresach dużej zmienności wskaźnik ten kształtował się nawet na poziomie 8–10%. Wyniki potwierdzają stabilność metod wyceny w różnych okresach i wskazują, że wycena gatunków węgla o niższej wartości opałowej jest proporcjonalna do spadku energii zawartej w węglu. Podsumowując, mimo dużej zmienności cen relacja wyceny węgla o różnej jakości jest w dużej mierze stabilna i oparta na parametrach energetycznych, co pozwala na racjonalne szacowanie wartości surowca na rynku międzynarodowym. Zaproponowano formułę cenową do wyliczenia cen różnych gatunków węgla, wykorzystując obliczony współczynnik gradacji cen.

**SŁOWA KLUCZOWE:** wycena gatunków węgla energetycznego, miały energetyczne, notowania cen, formuła cenowa