Coking coal – a critical raw material of Poland and the European Union

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A b s t r a c t. The significance of coking coal in the European Union in relation the standing of this raw material in the global economy is outlined, as well as the occurrence and resources of coking coal in Poland, its importance for the domestic economy, and the possibilities of increasing its resource base in Polish coal basins. Since 2014, coking coal has been treated as a critical raw material for the economy of the European Union. Its annual consumption in the EU countries currently amounts to ~40 million tonnes and is mostly covered by imports. Poland is the only EU country with significant coking coal production (~12–13 million tonnes per year) and substantial resources and reserve base (21.3 and 1.7 billion tonnes, respectively), as well as the potential to increase the resource base, in particular in the Upper Silesian Coal Basin. The Polish government's official prognosis for the coming years is that the domestic coking coal deposits will continue to be developed, and the current coking coal production should be maintained. The existing coking coal resource conditions also allow for an increase in domestic production, including the opening of new mines; under this scenario, coking coal development should take into account mining, environmental, economic and even geopolitical aspects.

Keywords: *coking coal, critical raw material, Poland, European Union*

THE SIGNIFICANCE OF COKING COAL TO THE EUROPEAN UNION AND THE GLOBAL ECONOMY

Coking coal is a type of hard coal suitable for coke production in the integrated steelmaking process as a component of blast furnace charge. Since 2014, coking coal has been on the list of critical raw materials (CRM) of the European Union because it has a high economic importance and a high supply risk (Communication..., 2014). EU activities related to critical raw materials started in 2008 with an initiative of the European Commission to create a list of critical raw materials, to be updated every 3 years (Communication..., 2008). In subsequent years, starting from 2011, the list of critical raw materials was updated while the position of coking coal has remained unchanged since 2014. Eventually, coking coal was included in the list of critical raw materials in the EU regulation of 11 April 2024, referred to as the Critical Raw Materials Act – CRMA [Regulation (EU) 2024/1252…, 2024], which aims to ensure a secure and sustainable supply of critical raw materials for EU industry, in particular for strategic sectors. In relation to EU industrial ecosystems, coking coal was identified as a critical raw material for the automotive industry, energy-intensive sectors and renewable energy (Communication…, 2020).

In recent years, the annual consumption of coking coal in the EU countries ranged from 40 to 50 million tonnes (40.8 million tonnes in 2023 – Eurostat, 2025a) and was mainly covered by imports (32.0 million tonnes in 2023 – Eurostat, 2025b) (Fig. 1). Currently, EU production of coking coal takes place only in Poland (11.9 million tonnes in 2023 – Eurostat, 2025c) and – at the phase-out stage – in the Czech Republic (0.5 million tonnes in 2023 – Eurostat, 2025c). Historically, coking coal was also mined in other EU countries, in particular in the large coal basins of Germany, France and the UK. However, coking coal mining in those countries definitively ceased in 2019 in the UK (then still in the EU), and a year earlier in Germany. Given the significant depletion of coking coal reserves, as well as a number of other factors, especially economic and environmental, it should be anticipated that this situation will continue and coking coal mining in these EU countries will not be resumed.

The main exporters of coking coal to the EU, according to data from successive lists of critical raw materials (Communication…, 2014, 2017, 2020), are the USA (39–41% of imported coking coal) and Australia (~36–37%). Notably, at the beginning of the current decade, imports to the EU increased from Australia (47% in 2021) and decreased from the USA (33% in 2021). Canada also plays a significant role in coking coal imports to the EU (~8% on average), and until 2022 (before the introduction of coal embargo), Russia also had a considerable share in coking coal imports to the EU reaching 16% in 2018 (Georgitzikis *et al*., 2022).

These, together with China, are among the world leaders in terms of coking coal resources and production which currently amounts to over one billion tonnes per year (1,096 million tonnes in 2022). For years, China has been the largest coking coal producer, at 676 million tonnes in 2022 (62% of the global production), followed by Australia – 169 million tonnes, Russia – 96 million tonnes, the USA – 55 million tonnes and Canada – 34 million tonnes (CRM Alliance, 2025). Among European countries, Ukraine was also an important producer of coking coal with 20 million tonnes in 2013, before the war started (Eurostat, 2025c). On a global scale, the largest reserves of mineable coking coal, according to 2019 estimates, are in Australia – 29,706 million tonnes, the USA – 24,051 million tonnes, China – 19,330 million tonnes, Russia – 18,676 million tonnes, India – 17,933 million tonnes, Ukraine – 7,258 million tonnes and Canada – 2,909 million tonnes (RMIS, 2025). The high potential of coking coal production in India is notable, being in the initial phase of growth. According to the forecasts of the Indian government (ETEnergyWorld, 2024), the country's coking coal production is expected to reach 140 million tonnes in 2030.

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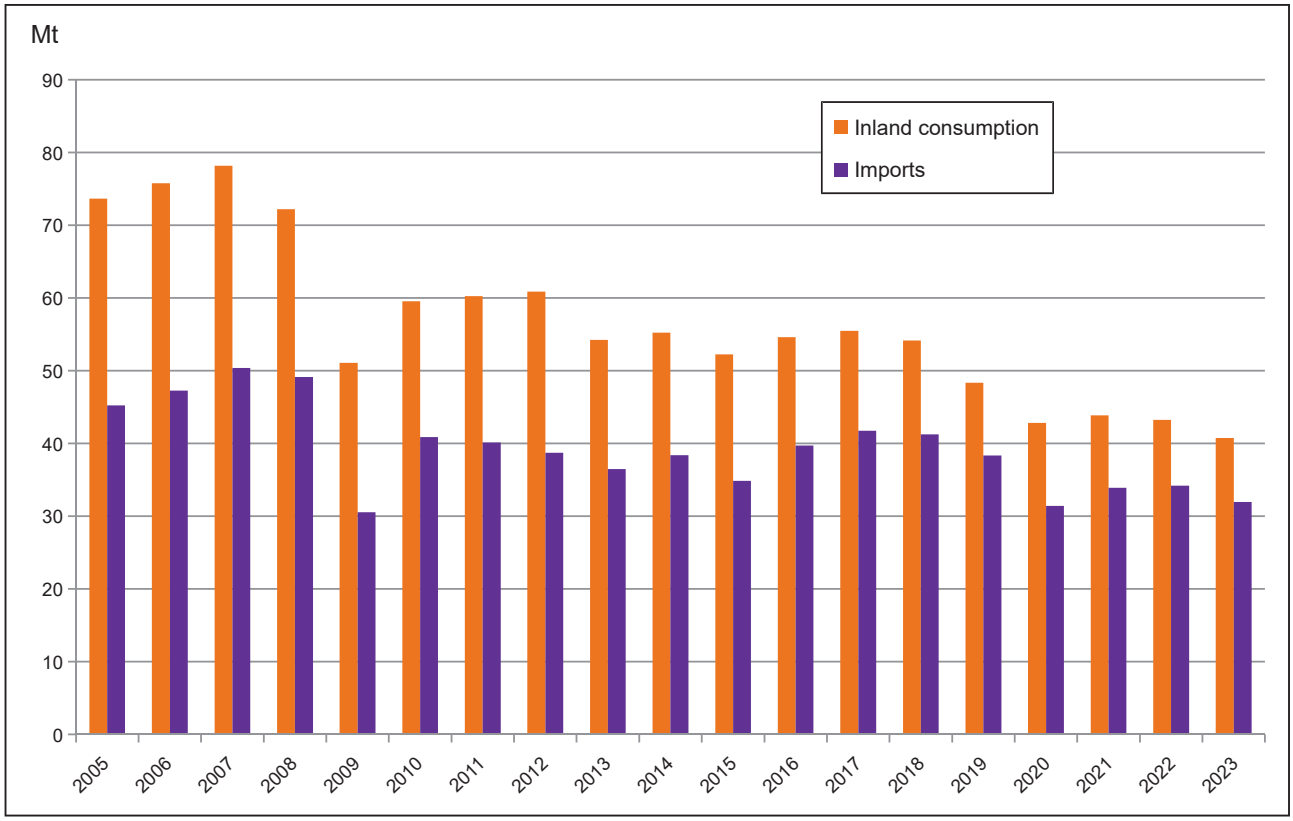

Fig. 1. Coking coal consumption and import in the EU countries in 2005–2023 (based on Eurostat, 2025a, b)

THE OCCURRENCE AND CLASSIFICATION OF COKING COAL IN POLAND

In Poland, coking coal occurs in hard coal deposits in the Upper Silesian Coal Basin (USCB), the Lower Silesian Coal Basin (LSCB) and the Lublin Coal Basin (LCB), although the last of these has coking coals of a marginal quality range (according to current geological knowledge). The Polish coking coals occur in multi-layered deposits of Carboniferous age, genetically related to the evolution of the Variscan orogenic system, chracterized by diverse geotectonic settings and a variety of depositional environment (Fig. 2). The abundance of coking coal in Polish hard coal deposits is variable, from being completely absent, through co-occurrence with other types of coal, to the exclusive occurrence of coking coal.

Coking coal is inseparable from other types of hard coal in terms of resource evaluation, and the same criteria are used to identify its resource and reserves (Table 1; Rozporządzenie…, 2015). The definition of coking coal as a particular type of hard coal is based on coal rank parameters (ASTM D388 – 12, 2012). The Polish hard coal classification standard PN-G-97002:2018-11 (Polska Norma, 2018), which is coal rank related, distinguishes the following types of coking coal, determined based on three threshold limit values: volatile matter on a dry, ash-free basis (V^{daf}); vitrinite reflectance (R); and caking power represented by the Roga index (RI):

- Type 34 (34.1 and 34.2) – gas-coking coal; highly caking coal (RI >60), with a high content of volatile matter (V^{daf} >27%) and vitrinite reflectance greater than 0.7%;
- Type 35 (35.1 and 35.2) – ortho-coking coal; highly caking coal (RI >70), with an average content of volatile matter (V^{daf}: from 21 to 30% for type 35.1 and from 20 to 26% for type 35.2) and vitrinite reflectance greater than 1.0%;
- Type 36 – meta-coking coal; medium or highly caking coal (RI above 45), with a low content of volatile matter (V^{daf} <22%) and vitrinite reflectance not <1.3%;
- Type 37 – semi-coking coal; low caking coal (RI >5) with low volatile matter content (V^{daf}: from 14 to 22%) and vitrinite reflectance not <1.3%.

Table 1. Threshold limit values of parameters defining hard coal deposits

Parameter	Unit	Threshold limit value
Maximum depth of assessment	m	1250
Minimum thickness of hard coal in the seam with partings up to 30 cm thick	m	0.6
Minimum weighted average calorific value of hard coal in the seam, partings included	MJ/kg	15

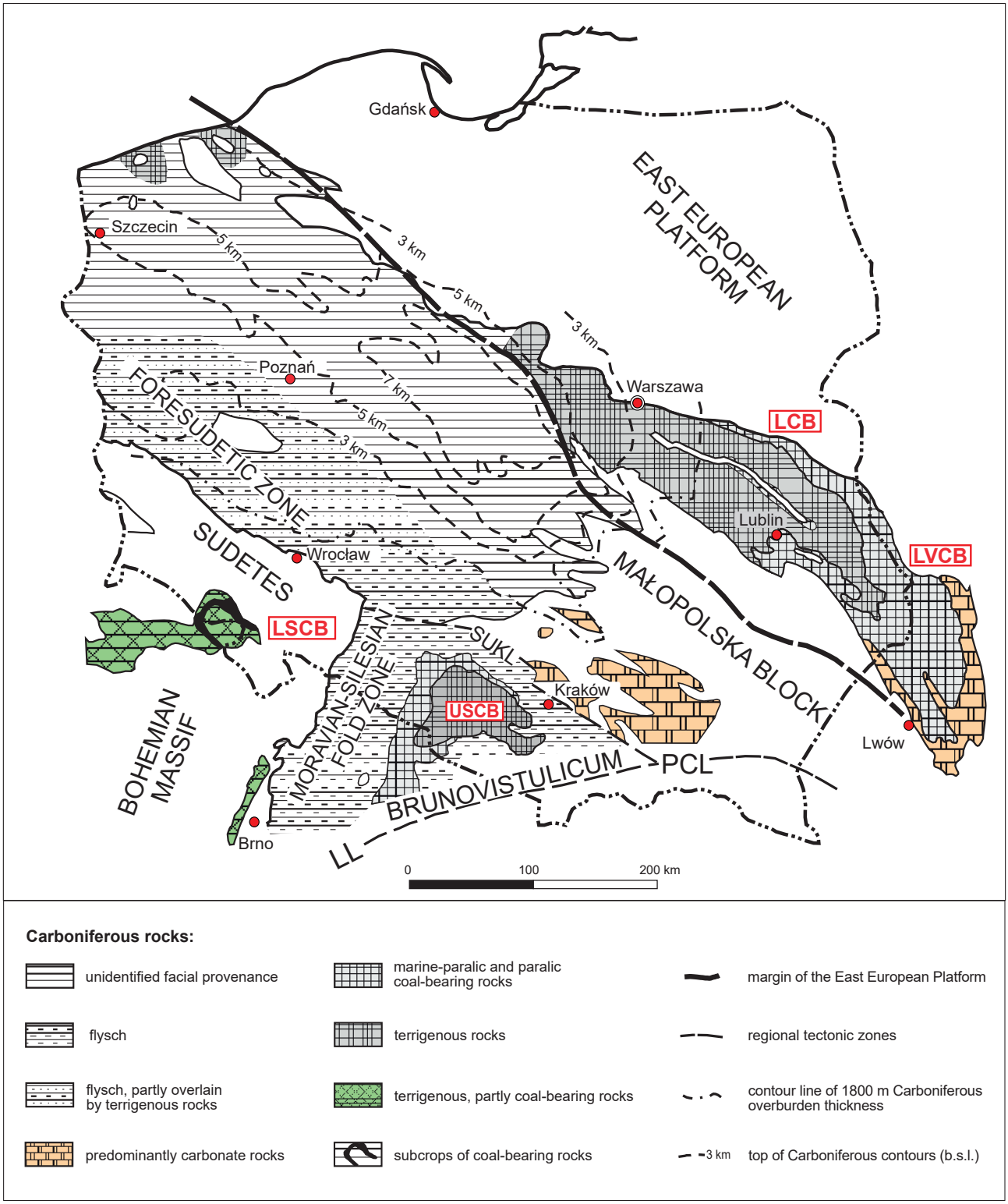

Fig. 2. Geotectonic position of the Polish coal basins (Kotas, Porzycki, 1984; modified by Jureczka, Nowak, 2016)
SUKL – Kraków–Lubliniec fault zone, **LL** – Lednice line, **PCL** – Peri-Carpathian lineament

In detail, the physical-chemical and technological parameters of coking coal are complex and have been subject to modifications that have changed over time, including the threshold limit values for individual types, which translates into various proposals for the classification of this coal (e.g., Karcz *et al*., 2008; Sobolewski *et al*., 2016). This is due to changes in the availability of coking coal from the domestic resource base and its imports, as well as, in particular, the growing requirements of the metallurgical industry. International classifications and classifications used in individual countries are also different in detail (e.g., UNECE, 1998).

Each type of coking coal can be used to produce coke, but with different properties and application possibilities. In Poland, the basic significance is ortho-coking coal type 35, used to produce metallurgical coke, a key material for iron and steel

production. Gas-coking coal type 34.2, apart from the production of heating coke, is used in limited quantities to prepare charge mixtures in the production of blast furnace coke. In turn, meta-coking coal type 36 (used to produce foundry coke) and semi-coking coal type 37 (used as an additive to reduce the coal charge) are of negligible or marginal significance, due to their small quantities in the domestic resource base of coking coal and the limited viability of mining.

THE SIGNIFICANCE OF COKING COAL RESOURCES TO THE POLISH ECONOMY

The reported coking coal resources in Poland are substantial (Table 2). The total coking coal resources (zasoby geologiczne) amount to over 21 billion tonnes, including nearly 19 billion tonnes of identified resources (zasoby bilansowe). Coking coal resources are located mainly in the Upper Silesian Coal Basin (~90% of resources). Of significant importance is the coking coal reserve base (zasoby przemysłowe), amounting to 1.7 billion tonnes (96.3% of which are in the USCB). It should be noted that the portion of resources resulting from the subsequent resources subdivision, which can be technically and economically recoverable – referred to as reserves (zasoby operatywne) – is much smaller. Furthermore, mining practice shows that the percentage of reserves which is actually extracted does not usually exceed 55–60%.

The volume of coking coal resources in particular types of coal deposits is moderately diverse (Table 3). The size of identified resources in the developed coking coal deposits of the USCB is considerable: almost 10.5 billion tonnes, which constitutes almost 60% of the total identified resources for all Polish coal basins. In turn, a relatively small portion of the resources identified is attributed to abandoned coal deposits (in the USCB and LSCB), at 1.9 billion tonnes (10.5% of all resources). Coking coal reserves, obviously, almost entirely belong to coal deposits which are being mined.

The resource base of coking coal in Poland consists mainly of gas-coking coal (type 34) and ortho-coking coal (type 35), with a much larger share of coal type 34. For example, of the reported coking coal reserves (as of 31 December 2020) type 34 coal reserves are 608 million tonnes (55.9% of the total coking coal reserves), and type 35 coal reserves are 453 million tonnes (41.7% of the total reserves) (Ministerstwo, 2022). The coking coal of higher rank (meta-coking – coal type 36, semi-coking – type 37) occur mainly in the LSCB with small reserves, while semi-coking coal occurs also in the USCB coal

Table 2. Coking coal resources (coal type 34–37) in the Polish coal basins – as of 31 December 2023 (Szuflicki *et al.*, 2024)

Coal basin	Coking coal resources [million tonnes]			Reserve base [million tonnes]
	total	identified	non-identified	
Upper Silesian Coal Basin	18,980.52	16,206.42	2,774.10	1,655.14
Lublin Coal Basin	2,061.90	1,494.34	567.56	63.42
Lower Silesian Coal Basin	273.54	273.54	—	0.19
Total	21,315.96	17,974.30	3,341.66	1,718.75

Table 3. Coking coal resources and reserve base (coal type 34–37) broken down by the development status of coal deposits – as of 31 December 2023 (Szuflicki *et al.*, 2024)

Development status of coal deposits	Resources [million tonnes]			Reserve base [million tonnes]
	Total	Identified	Non-identified	
Upper Silesian Coal Basin				
Developed coal deposits	10,908.72	10,459.46	449.26	1,574.48
Undeveloped coal deposits	5,625.70	3,956.14	1,669.56	—
Abandoned coal deposits	2,446.11	1,790.82	655.29	80.66
Lublin Coal Basin*				
Developed coal deposits	427.71	347.79	79.92	63.42
Undeveloped coal deposits	1,634.19	1,146.55	487.64	—
Lower Silesian Coal Basin**				
Undeveloped coal deposits	169.97	169.97	—	0.19
Abandoned coal deposits	103.56	103.65	—	—

* Abandoned coal deposits do not occur in the LCB.
** Developed coal deposits do not occur in the LSCB.

deposits. In turn, according to current geological knowledge, the LCB contains only gas-coking coal type 34 (34.1 and 34.2). This concept of the resource base includes only coal deposits with identified resources as well as prognostic and prospective resources to a depth of ~1250–1300 m. In the case of the USCB, large parts of the coal-bearing Carboniferous strata still contain coal deposits that lie below the maximum depth limits, with a varied coking coal rank which increases with depth: from coking type coal through special type coals to anthracite.

The importance of coking coal as a critical and strategic raw material for the Polish economy is marked by the resolution on the National Raw Materials Policy (Uchwała…, 2022) adopted by the Polish government. This resolution assumes that domestic demand for coking coal will be at the level of 12.5–13.0 million tonnes per year by 2040, decreasing to 10.0–11.0 million tonnes in 2050, which is practically equivalent to the current level of coking coal production. Since 2013, coking coal production in Poland has remained relatively constant at around 12–13 million tonnes per year (Eurostat, 2025c). Coking coal is also included in the Program for the hard coal mining sector in Poland until 2030 (Ministerstwo, 2022). One of the specific objectives of this program includes meeting domestic needs for coke production from Poland's own resources and ensuring access to new coking coal deposits. The EU regulation on Critical Raw Materials Act [Regulation (EU) 2024/1252…, 2024] is also important for the standing of coking coal as a critical raw material in Poland. According to the provisions of this regulation, EU Member States are obliged to develop and implement national programs for the exploration of critical raw materials. Obviously, in the case of coking coal in Poland, the aim of such a program would not be to identify coking coal resources, but to assess the possibilities of expanding its resource base, with the possible identification of new deposits or of increasing the size of existing deposits.

POSSIBILITIES OF INCREASING THE NATIONAL RESOURCE BASE OF COKING COAL

The starting point for the evaluation of coking coal with a view to increasing the volume of identified resources is the current coal resources status as assessed in the "Balance of prospective mineral resources of Poland as at 31 December 2018" (Jureczka *et al*., 2020). The resource assessment of this study covered all three Polish coal basins (USCB, LSCB and LCB) and was focused on areas outside or below the coal deposits already identified to a depth of ~1250/1300 m and with the minimum coal thickness limit value of 1.0 or 0.6 m for the part of the LCB in the area bordering the Lviv-Volhynia Basin (LVCB – Fig. 2). The assessment shows that the resource base of coking coal can be increased mainly in the USCB and, to a limited extent, also in the LCB. There are practically no such prospects in the LSCB, where, apart from the coal deposits already identified, the estimated prospective resources of hard coal (including coking coal and other types of coal) are relatively small and amount to ~100 million tonnes (Jureczka *et al*., 2020).

In the Upper Silesian Coal Basin, coking coal occurs in the western and central parts of the basin (Fig. 3), including a large area (~1000 km^2) outside the deposits identified. How-

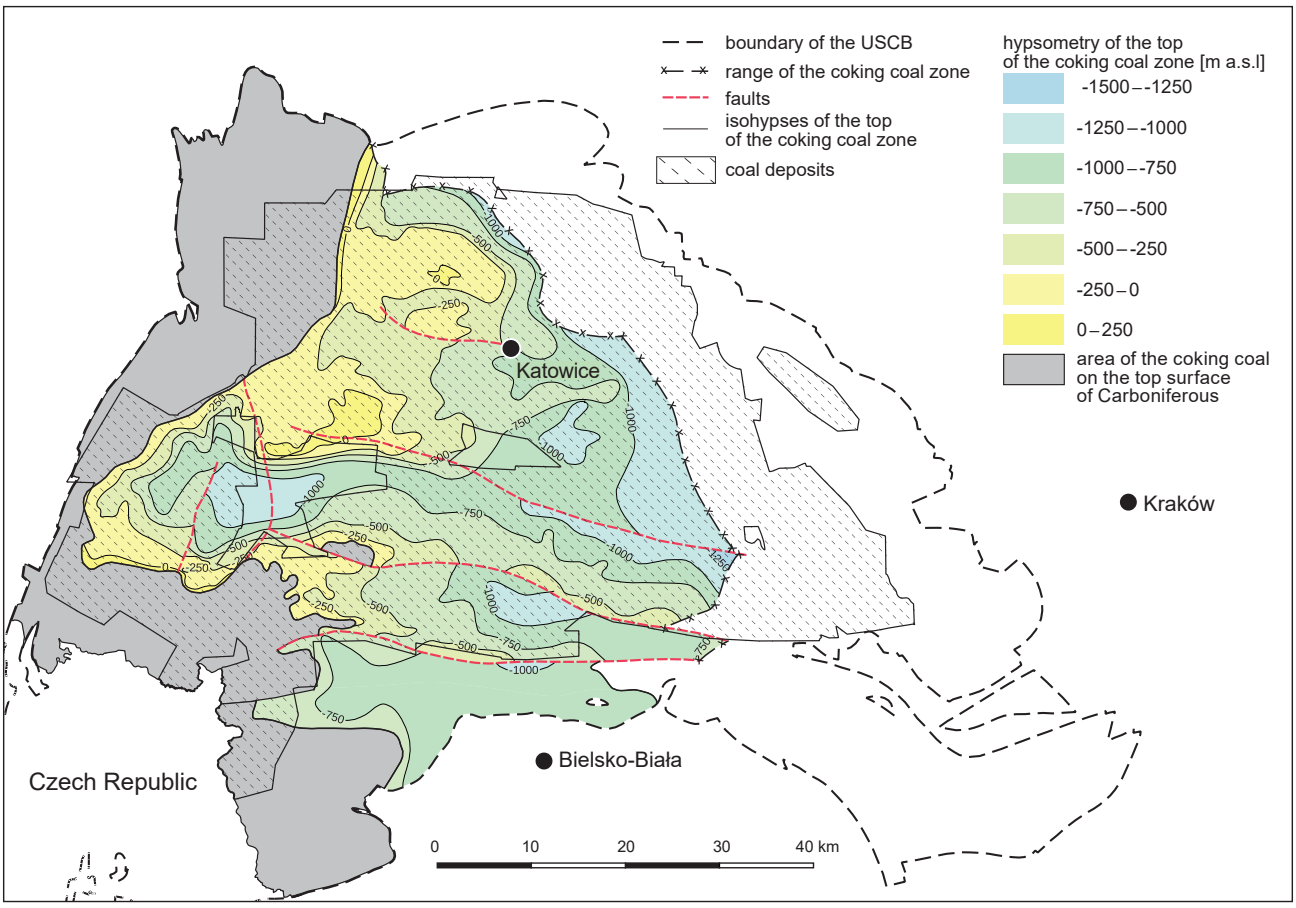

Fig. 3. Structure contours on top of coking coals in the USCB (based on Jureczka *et al*., 2005)

ever, this does not mean that there are many opportunities to identify new deposits. To a large extent, coking coals occur along the western boundaries of the basin, where the Carboniferous succession contains almost exclusively thin coal seams (<1 m thick), as well as in the southern part, where the Carboniferous overburden is of considerable thickness, up to 1000 m (and locally even greater). Nevertheless, it is possible to increase the resource base of coking coal in the USCB, especially taking into account that part of the Carboniferous coal-bearing strata occurring below currently identified deposits.

In the "Bilans perspektywicznych zasobów kopalin Polski wg stanu na 31.12.2018 r." (Balance of prospective mineral resources as of 2018 – in Polish) (Jureczka *et al.*, 2020), potential coking coal resources in the USCB, outside and below the identified coal deposits, were estimated to a subsea depth of 1000 m (~1250–1300 m below ground level). At the base of the coal deposits previously identified (usually before 1994/1995), prognostic resources were estimated. These resources have not been included in the national register, mainly due to the subsequent reduction of the maximum depth of assessment to a depth of 1000 m. Consequently, prospective resources were estimated below the identified coal deposits to a depth of 1000 m, referred to as group A, and in areas outside the identified coal deposits – referred to as group B. The total volume of these coking coal prospective resources is ~7.8 billion tonnes. In many of these areas coking coal coexists with thermal coal and thus coking coal resources are relatively small. Assuming 75 million tonnes as the minimum resource volume of coking coal in a given area, the prognostic and prospective resources of coking coal defined as such in the USCB amount to about 7.2 billion tonnes (Table 4) and occur mainly in the central and southwestern parts of the USCB (Fig. 4). The prognostic resources and the prospective resources of group

Tab. 4. Prognostic and prospective resources of coking coal in the USCB (Jureczka *et al.*, 2020)

Resource type	Total coking coal resource in all areas			Coking coal in areas with resources greater than 75 million tonnes		
	Number of areas	Total area [km^2]	Resources [million tonnes]	Number of areas	Total area [km^2]	Resources [million tonnes]
Prognostic	20	601.46	3,234.93	11	354.00	2,972.35
Prospective of group A	13	543.72	2,394.01	6	339.27	2,187.47
Prospective of group B	15	614.72	2,212.12	8	536.36	2,011.47
Total	48	1,759.9	7,841.06	25	1,229.63	7,171.29

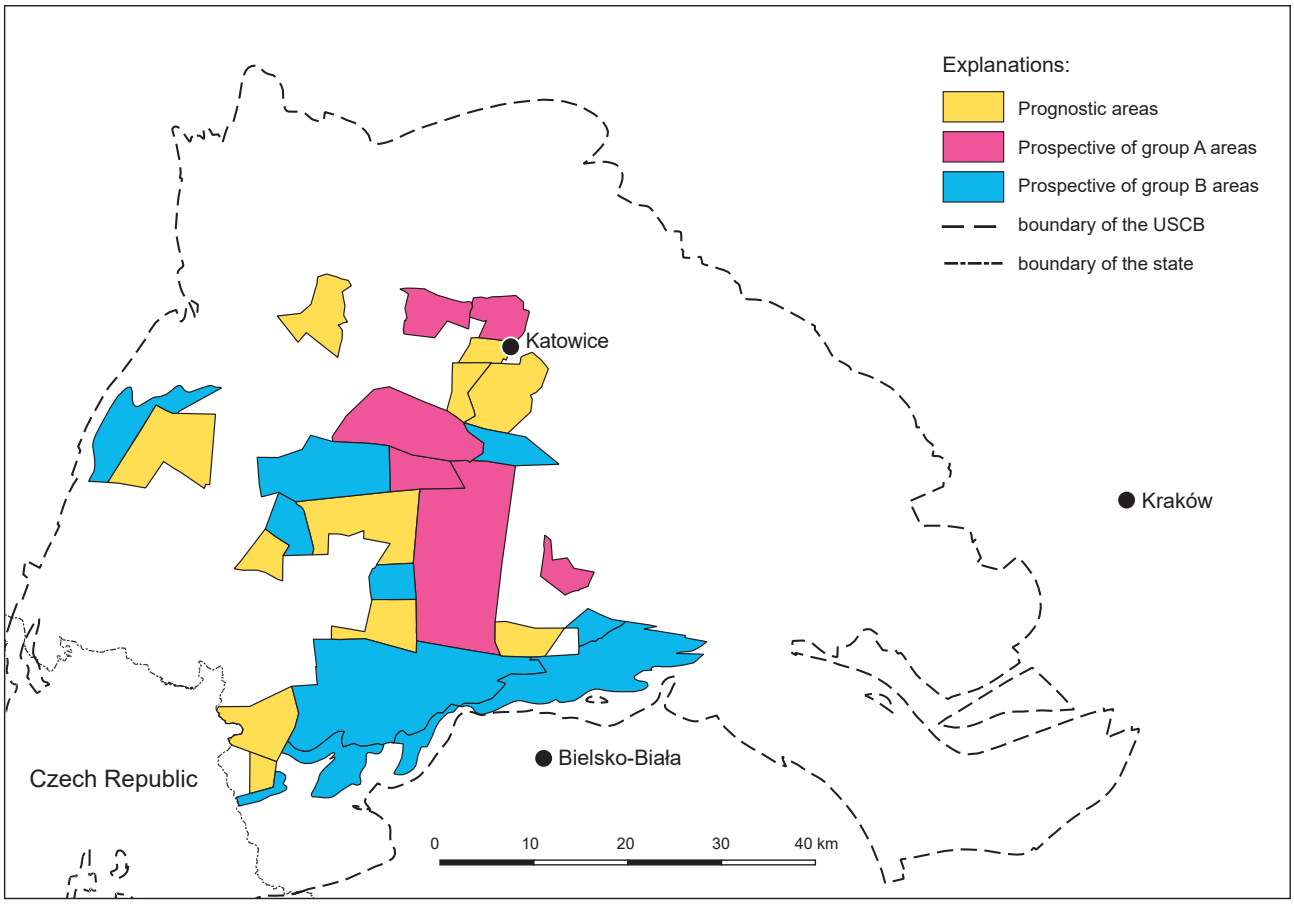

Fig. 4. Coking coal prospective areas in the USCB, with resources greater than 75 million tonnes (based on Jureczka *et al.*, 2020)

A (totaling about 5.2 billion tonnes), estimated with a high degree of geological assurance, to a large extent, have a considerable potential for increasing the identified resource base of coking coal. In turn, the prospective resources of group B mostly occur in the peripheral areas of the basin with low coal content. In this respect, relatively high coal content occurs in the central part of the USCB, which could be included in future exploration activities.

In the Lublin Coal Basin, the assessment of the prognostic and prospective resources of hard coal, which are outside the coal deposits identified, was carried out for areas where the thickness of the Carboniferous overburden is <1000 m (Jureczka *et al*., 2020). Due to the poor knowledge of coking coal occurrence, the estimated coal resources (unlike in the case of the USCB) were not divided into thermal coal and coking coal. The estimated resources to a depth of 1000 m were considered prognostic, and those occurring deeper, to 1250 m, were considered prospective. In total, 16.7 billion tonnes of resources were estimated in an area of ~4,730 km^2, including 10.8 billion tonnes of prognostic resources and 5.9 billion tonnes of prospective resources. By analogy to the estimates of identified resources with the ratio of coking coal resources (1.5 billion tonnes) to total coal resources (12.4 billion tonnes) at the level of 1:8, the same ratio for prognostic and prospective resources was assumed. Therefore, it is inferred that the prognostic and prospective coal resources contain ~2 billion tonnes of coking coal. However, these are rather optimistic estimates which, most probably, take into account gas-coking coal type 34. Other types of coking coal, including the particularly valuable coal type 35 (ortho-coking coal), have not been found in the LCB to date. There are some indications that coal type 35 is likely to occur in the southern part of the LCB, near the border with Ukraine, although such occurrences have not been confirmed by exploration boreholes, including the most recent drilling.

CONCLUSIONS

Since 2014, coking coal has been on the list of critical raw materials for the European Union economy. It is also included in EU regulation, referred to as the Critical Raw Materials Act [Regulation (EU) 2024/1252…, 2024], the aim of which is to ensure a secure and sustainable supply of critical raw materials for EU industry. The annual consumption of coking coal in the EU countries currently amounts to ~40 million tonnes and is mostly covered by imports, mainly from Australia and the USA. The EU consumption of coking coal reached almost 80 million tonnes in 2007 and since that time has shown a clear, steady downward trend, a result of the reduction of the steel industry. However, the current unstable geopolitical situation may cause the decline in metallurgical steel production, for the production of which coking coal is required, to stop in the coming years and reverse this trend. The demand for coking coal will then increase significantly, and one of the most important sources of supply could be the deposits located in Poland. The global trend in coking coal consumption, which is systematically increasing, is quite the opposite. The global coking coal production has exceeded one billion tonnes per year (1,096 million tonnes in 2022). The largest coking coal producer in the world is China (676 million tonnes in 2022). Poland is currently the only significant producer of coking coal among EU countries (~12–13 million tonnes per year). Poland also has significant total resources and reserve base of coking coal (21.3 and 1.7 billion tonnes, respectively), as well as the potential to increase the resource base, in particular in the Upper Silesian Coal Basin. The special importance of coking coal for the national economy in the coming years has been emphasized by the resolution on the National Raw Materials Policy (Uchwała…, 2022) and the Program for the hard coal mining sector in Poland (Ministerstwo, 2022), which have been adopted by the Polish government. These documents assume ensuring access to coking coal deposits and maintaining its production close to the current level. The existing coking coal resource conditions also allow for an increase in domestic production, including the opening of new mines, while under this scenario, coking coal development should take into account mining, environmental, economic and even geopolitical aspects. For any future actions, the new EU regulation on methane emissions reduction in the energy sector [Regulation (EU) 2024/1787…, 2024] is also important because it means a significant increase in the costs of coal production for the Polish coking coal mines. In conclusion, one may note with some consternation that two EU legal acts came into force last year, which have opposite effects on coking coal resource development: CRMA – emphasizing the special significance of coking coal for the EU economy, and EU methane regulation – significantly increasing the costs of coking coal production in EU countries.

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Antimonite, Ptasieniec stream, Western Tatras, Carpathians.
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