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Change in the state of hard coal reserves in Poland in the years 2007-2023

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Abstract:

During the transition period of the transformation of the economy to achieve zero emission, hard coal plays and will play the role of a stabilizing medium. The assessment of the state of this raw material's resources is of great importance both in the context of the country's energy security and ensuring supplies of raw materials for other industries. Understanding the state of resources is also important in planning and conducting transformation processes in the hard coal mining sector. The article presents the current state of hard coal resources in Poland in statistical terms. According to data from the end of 2023, geological resources (balance and off-balance within the deposit) amounted to 33,776 million Mg and were 0.16 million Mg lower than in 2022. On the other hand, the size of industrial resources amounted to 6,050 million Mg, of which 5,394 million Mg lies outside the protective pillars for surface and underground facilities.

Key words: mining, hard coal mining transformation, energy transformation, hard coal resources

1. Introduction

The Russian Federation's attack on Ukraine directly affected the continuity of the raw material supply chain, including the energy security of Poland and the European Union (Hebda, 2023). In Poland, the new geopolitical situation has led to the need to update strategic documents related to the country's energy security, in particular: the Energy Policy of Poland until 2040 and the National Energy and Climate Plan for 2021-2030. According to the draft of the National Energy and Climate Plan until 2023 of 29.02.2024, Poland has identified strengthening energy sovereignty as the main goal in the area of general security (KPEiK, 2023). It is assumed that the demand for hard coal for energy and industry will be satisfied by domestic mining, and import will only supplement its own production. The document specifies the demand for hard coal at around 30 million tons per year.

It will not be possible to meet the challenges related to climate change while ensuring an adequate level of energy supply without a transition period in which at least part of the energy will come from the combustion of fossil fuels. Poland as a country must ensure the security of energy supplies to its citizens and plan its activities so that the energy transformation does not have negative health or economic effects. Such security in the coming years will only be provided by hard coal and lignite mining. A sudden departure from coal combustion and an incorrect path to decarbonization of the energy sector may cause a state of energy poverty in the country. The ongoing energy transformation processes must be preceded by detailed planning and solving any emerging problems on an ongoing basis (Górska, 2023).

In the context of the transformation of the sector, decarbonization of the economy and the war in Ukraine, the assessment of the size of domestic hard coal resources is of great importance. The aim of the article is to present research conducted on the basis of data on the size of hard coal resources in the years 2007-2023. This data was collected in annual cycles and processed by Industrial Development Agency JSC (Agencja Rozwoju Przemysłu S.A. – ARP S.A.) on behalf of the Ministry of Industry, and previously the Ministry of State Assets. The data is obtained from the G-09.9 reports on hard coal resources (ARP, 2024). The analysis did not take into account the qualitative parameters of the resources.

2. Changes in the state of hard coal resources in the years 2007-2023 according to statistical studies

Determining the size of industrial or non-industrial resources, as well as their composition, should be preceded by a detailed analysis of balance and non-balance resources, taking into account the following issues (Borówka, 2012; Rozporządzenie, 2015):

- quantity and structure of the deposit (Probierz, 2010; Yousuf et al., 2023),
- technical possibilities of making the deposit available, preparing it and safely exploiting it (Turek, Lubosik, 2008; Wodarski et al., 2017),
- geological conditions of the deposits, mining conditions with particular emphasis on the occurrence of natural hazards (Kicki, Sobczyk, 2007; Sobczyk, 2009),
- quality parameters of coal in the deposit and the possibility of enriching the mined material (Kudełko et al., 2014),
- use of accompanying minerals (Dragan, Zdyrko, 2023; Kopacz, 2014),
- protection of excavations, mining facilities and equipment, protection of surface development facilities, and in particular, compliance with the conditions of local spatial development plans (Nieć, Młynarczyk, 2014),
- management of mining waste (Kulczycki, Sowa, 2010; Olkuski, 2013),

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- economic and organizational and social conditions (Kozioł, Kozioł, 2019; Magda et al., 2008),
- possibilities and directions of coal sales (Dubiński, Turek, 2007).

3. Hard coal mining in Poland

The largest part of domestic hard coal for the energy sector comes from mining in the Upper Silesian Coal Basin (GZW). The area of the GZW is approximately 5,600 km², of which over 3,000 km² is the documented area of deposits (Bilans, 2024). Coal is also mined in the Lublin Coal Basin (LZW), the area of which is estimated at over 4,700 km², and the area of documented deposits is over 1,200 km².

The Industrial Development Agency S.A. (ARP S.A.) conducts an annual statistical survey called "Hard coal and lignite mining", which is included in the public statistics program (ARP, 2024). In 2023, the ARP S.A. survey covered the following companies:

- Polska Grupa Górnicza S.A. (PGG S.A.)
- Jastrzębska Spółka Węglowa S.A. (JSW S.A.)
- Spółka Restrukturyzacji Kopalń S.A. (SRK S.A.)
- Południowy Koncern Węglowy S.A. (do 2 stycznia 2024 r. Tauron Wydobycie S.A.)
- Lubelski Węgiel „Bogdanka" S.A. (LW „Bogdanka" S.A.)
- Węglokoks Kraj S.A.
- Przedsiębiorstwo Górnicze „Silesia" Sp. z o.o.
- Zakład Górniczy SILTECH Sp. z o.o.
- Zakład Górniczy EKO-PLUS Sp. z o.o.

As of the end of 2023, PGG S.A. had seven active mines, JSW S.A. had four mines, and the remaining mining companies, apart from Spółka Restrukturyzacji Kopalń S.A. (Mines Restructuring Company), which does not conduct mining, had one active mine each (ARP, 2024).

Table 1. Coal production in 2007-2023 along with the number of mines

	2007	2010	2015	2016	2017	2018	2019	2020	2021	2022	2023
Number of mines	30	30	29	23	21	20	20	21	20	20	17
Extraction (million Mg)	87.4	76.1	71.2	69.7	65.5	63.4	61.6	54.4	55.0	52.8	48.4

Source: own study based on (ARP, 2024)

Table 1 presents changes in the level of extraction with a comparison of the number of active mines in the analyzed period from 2007 to 2023 (ARP, 2024). The change in the number of mining units resulted not only from the transfer of mines to Spółka Restrukturyzacji Kopalń S.A. for their liquidation, but also from the processes of merging mines in mining companies. In the analyzed period from 2007 to 2023, the number of active mines decreased from 30 in 2007 to 17 at the end of 2023 (a decrease of 43%), and extraction decreased from 87.4 million Mg in 2007 to about 48 million Mg in 2023 (a decrease of 45%).

4. Database of hard coal resources in Poland

For the purposes of assessing the size of hard coal resources resulting from the conducted public statistics, ARP S.A. conducts annual research on the resource base of subordinate mining companies called "Hard coal and lignite mining". Its part includes, among others, the Report on Hard Coal

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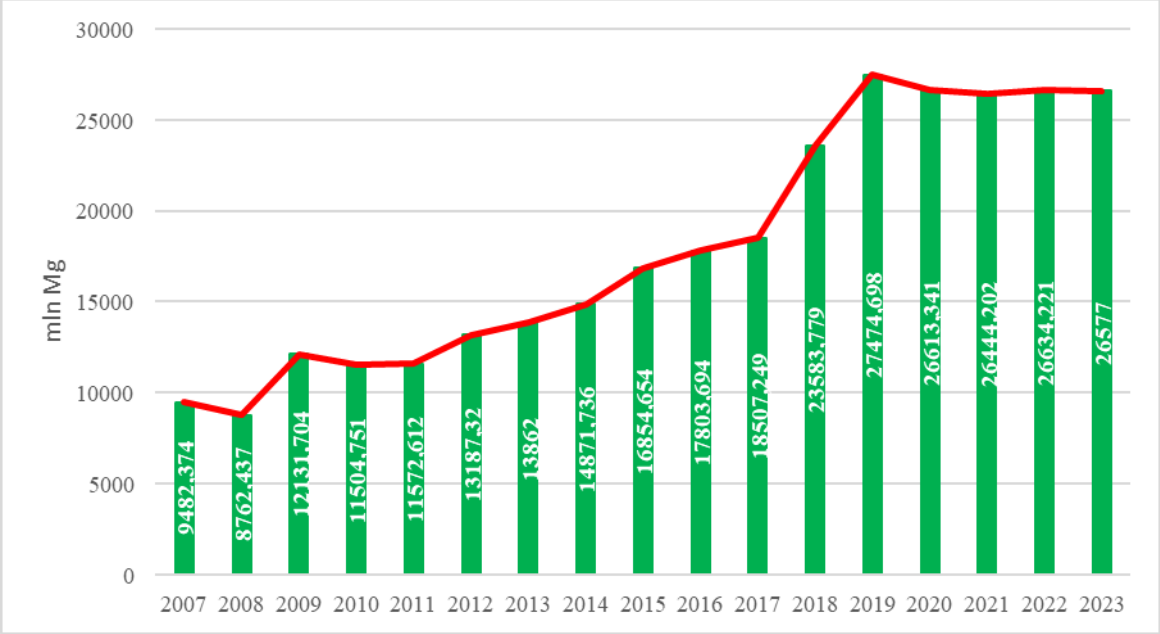
Resources (ARP, 2024). All mining companies subordinate to ARP S.A. provide the documents required in the research. In the obtained documentation, data on the size of hard coal resources are presented in two versions: during the validity period of the concession and for the entire deposit. When assessing the state of hard coal resources, geological resources of the deposit are defined as the total amount of mineral or minerals within the boundaries of the deposit. Geological resources consist of both balance and off-balance resources. Balance resources are resources that meet the limit values of the parameters defining the deposit (Nieć, Sobczyk, 2017). Resources that do not meet these values are called off-balance resources. The size of hard coal balance resources during the concession period in 2007-2023 is shown in Fig. 1. According to data at the end of 2023, geological resources (balance and off-balance within the deposit) amounted to 33,776 million Mg and were 0.160 million Mg lower than in 2022. In the period under review (2007vs2023), balance resources during the concession period increased almost 3-fold. This is due to, among other things, new exploration concessions and changes in balance criteria. The largest increase was recorded in 2018, when these resources increased by over 27% compared to the previous year.



Source: own study based on (ARP, 2024)

Fig. 1. Balance reserves within the borders of mining concession validity in years 2007-2023

As of 31.12.2023, the balance resources until the end of the concession amounted to 26,577 million Mg, of which 20,385 million Mg are resources lying outside the protective pillars, and 3.9 million Mg are resources lying in protective pillars for surface or underground facilities (ARP, 2024). Extraction of resources trapped in protective pillars requires the use of appropriate mining technologies. In Poland, when assessing the geological resources of a mineral deposit, excluding hydrocarbon deposits, five categories of recognition of a mineral deposit or its part are used: D, C2, C1, B, A (Regulation, 2015). The Regulation refers to precise and extensive definitions of each category, due to the volume of the article, full definitions have not been cited. One of the most important criteria for the definition of deposit categorization is the error in estimating the average values of deposit and resource parameters in individual categories:

- for category A the error cannot exceed 10%,
- for category B the error cannot exceed 20%,

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- for category C1 the error cannot exceed 30%,
- for categories C2 and D the error cannot exceed 40%.

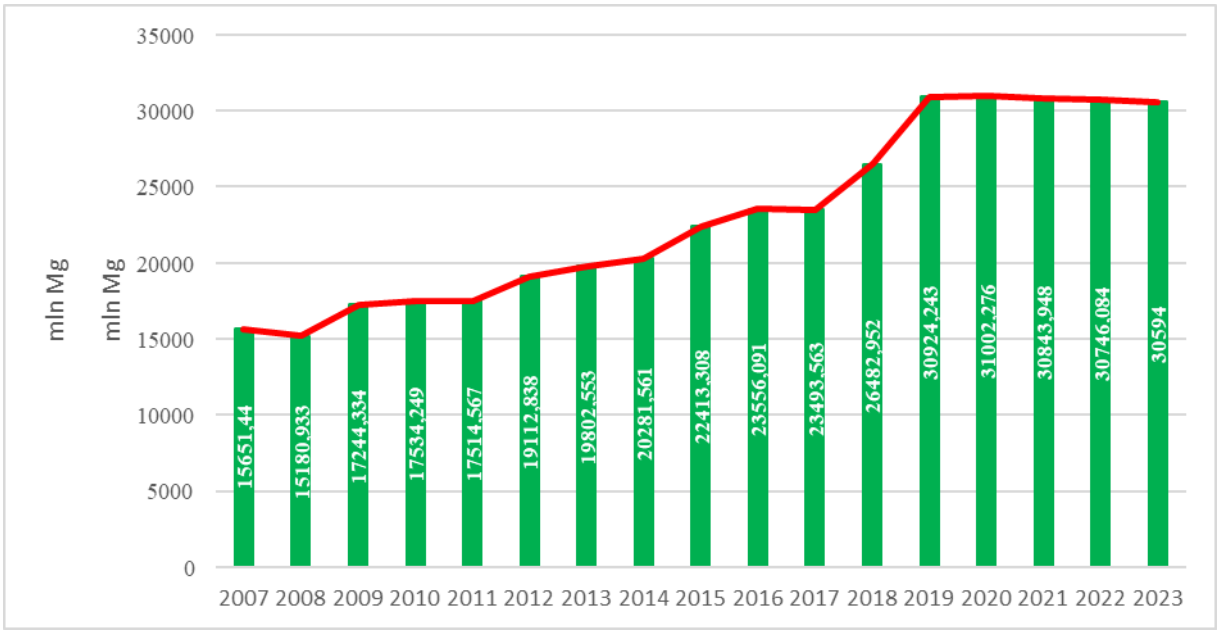
In the category of knowledge of deposits in Polish hard coal mines, category C1 dominates. The largest increase was recorded for this category (2007 vs. 2023 – Table 2) amounting to approximately 9,142 million Mg.

Table 2. Reserves by deposit's recognition category within the borders of mining concession (mln Mg)

Category of knowledge	2007	2010	2013	2016	2019	2022	2023
A+B	3 202	3 621	3 821	3 957	4 325	4 094	4 098
C1	4 057	5 005	6 210	8 137	13 722	13 249	13 209
C2	2 223	2 879	3 759	5 518	9 230	9 086	9 074
D	*	*	73	192	198	205	196
Sum	9 482	11 505	13 862	17 804	27 475	26 634	26 577

Source: own study based on (ARP, 2024)
* the regulations in force at that time did not provide for such a category

An almost twofold increase from 2002 to 2023 was also recorded in the case of the balance resources for the entire deposit (Fig. 2). As of 31.12.2023, the balance resources in the entire deposit amounted to 30,594 million Mg, of which 23,813 million Mg are non-pillar resources, and 6,781 million Mg are resources lying in protective pillars.



Source: own study based on (ARP, 2024)

Fig. 2. Balance reserves for the whole deposit in years 2007-2023

A similar relationship was noted for the balance resources within the concession, where the largest increase in the period under study was noted for the C1 exploration category (Table 3) and amounted to approximately 8.148 million Mg.

Table 3. Reserves by deposit's recognition category for the whole deposits (mln Mg)

Category of knowledge	2007	2010	2013	2016	2019	2022	2023
A+B	4 071	4 424	4 685	4 682	4 815	4 702	4 663
C1	6 662	7 838	8 712	10 410	15 395	14 897	14 810
C2	4 918	5 272	6 318	7 436	10 501	10 886	10 869
D	0	0	87	207	213	261	252
Sum	15 651	17 534	19 803	22 735	30 924	30 746	30 594

Source: own study based on (ARP, 2024)
* the regulations in force at that time did not provide for such a category

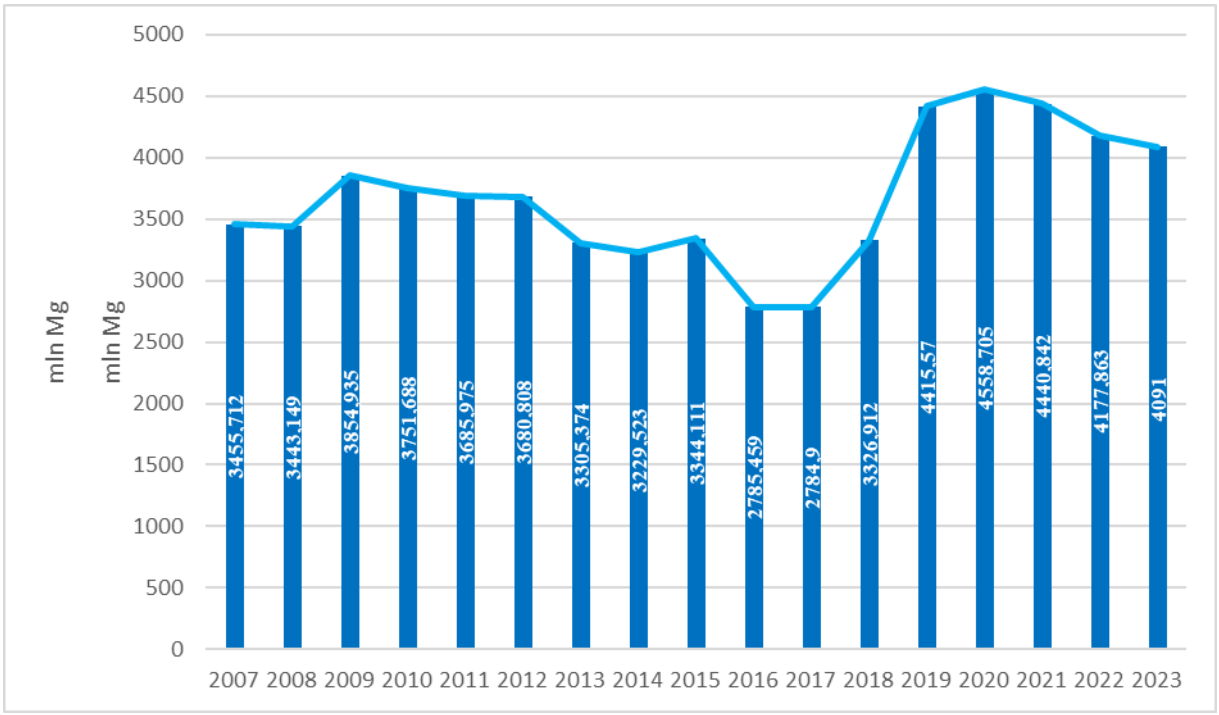
The dynamics of changes in the balance resources in selected years are presented in Table 4 (ARP, 2024). To facilitate the analysis, the balance resources from 2007 were assumed as the reference value, and the size of the balance resources from the remaining years was recalculated and given as a fraction of the reference value expressed as a percentage. The increase in the size of the balance resources is mainly due to the acquisition of new concessions. According to data presented by coal companies in 2007, industrial resources constituted 21% of geological resources (during the period of validity of the concessions), in 2017-2018 - approx. 12%. At the end of the period under review (in 2023), this share increases to 15.4%.

Table 4. Dynamics of changes in balance reserves

	2007	2010	2013	2016	2019	2022	2023
until the end of the concession period	2007=100	121,33%	146,19%	187,76%	289,74%	280,88%	280,28%
for the entire deposit	2007=100	112,03%	126,52%	150,50%	197,58%	196,44%	195,47%

Source: own study based on (ARP, 2024)

Industrial resources (intended for extraction) are part of the balance or off-balance resources of a deposit, within the boundaries of the planned mining area or a separate part of the deposit intended for development. These resources may be subject to exploitation if it is technically and economically justified. Extraction may take place provided that the conditions specified in the provisions of law, including environmental protection regulations, are met. Non-industrial resources are part of the balance resources of a deposit and are not included in the industrial resources in the area intended for development, but whose exploitation may become justified in the event of technical, economic or legal changes. Operable resources are defined as the amount of coal that can be extracted using typical mining systems (Paszcza, 2012; PIG, 2024; Sobczyk, 2023). Figure 3 presents the change in the size of industrial resources until the end of the concession. As of 31.12.2023, industrial resources in this area amounted to 4,091 million Mg, of which 3,764 million Mg are non-pillar resources and 327 million Mg are resources trapped in protective pillars. In the deposits located in active levels, the volume of industrial resources by the end of the concession period amounted to 1,964 million Mg (non-pillar resources), and 239 million Mg (pillar resources) (ARP, 2024).



Source: own study based on (ARP, 2024)

Fig. 3. Commercial reserves within the borders of mining concession validity in years 2007-2023

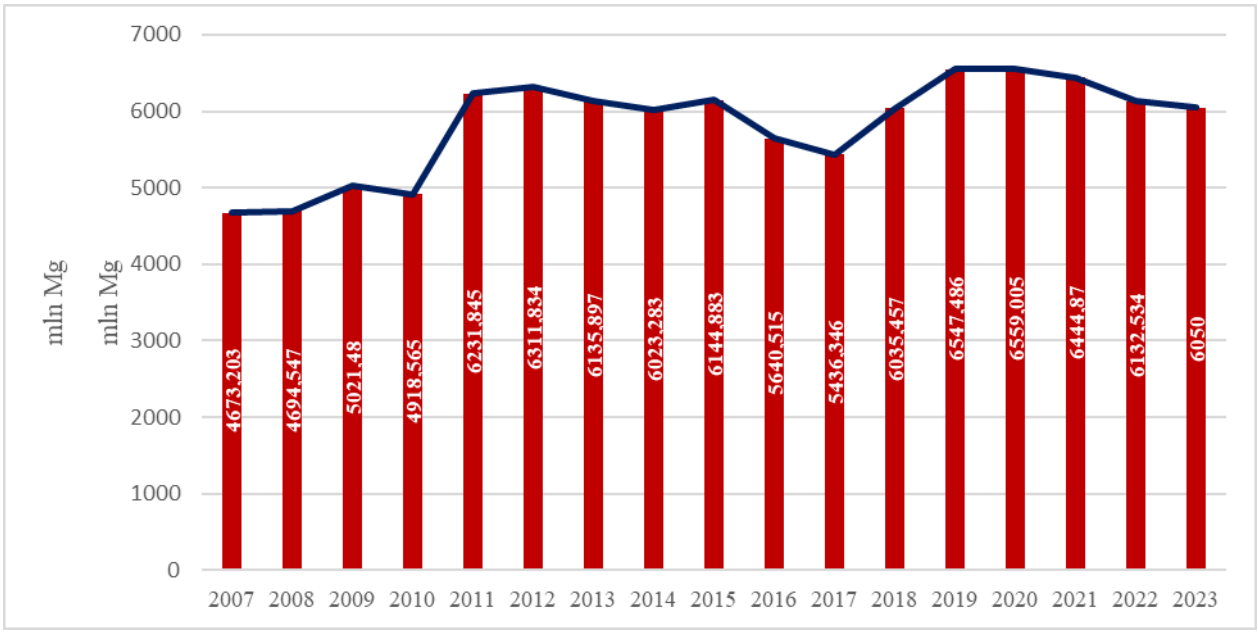
The increase in the size of industrial resources observed since 2019 is mainly due to the acquisition of new concessions by mining companies and the update of the concessions held (ARP, 2024). On the other hand, the observed decrease in the size of resources in category A + B is mainly due to the current exploitation of deposits and the transfer of mines to liquidation. Similarly to the case of balance resources, in the analyzed period an increase in the size of industrial resources in category C1 is observed (Table 5).

Table 5. Reserves by deposit's commercial category within the borders of mining concession validity (mln Mg)

Category of knowledge	2007	2010	2013	2016	2019	2022	2023
A+B	1 437	1 455	1 258	1 031	1 047	1 018	994
C1	1 448	1 651	1 501	1 340	2 533	2 360	2 309
C2	570	646	547	415	835	800	788
D	0	0	0	0	0	0	0
Sum	3 456	3 752	3 305	2 785	4 416	4 178	4 091

Source: own study based on (ARP, 2024)

Changes in the size of industrial resources in the entire deposit are presented in Figure 4. As of 31.12.2023, these resources amounted to 6050 million Mg, of which 5394 million Mg are non-pillar resources, including 2542 million Mg in active levels, and 656 million Mg are pillar resources, including 512 million Mg in active levels.



Source: own study based on (ARP, 2024)

Fig. 4. Commercial reserves for the whole deposits (mln Mg)

Similar trends as in the case of industrial resources during the concession period are observed when analysing the size of resources according to the recognition category for the entire deposit (Tables 6, 7).

Table 6. Reserves by deposit's commercial category for the whole deposits (mln Mg)

Category of knowledge	2007	2010	2013	2016	2019	2022	2023
A+B	1 556	1 605	1 765	1 496	1 416	1 317	1 295
C1	1 955	2 226	2 817	2 705	3 579	3 302	3 247
C2	1 029	1 088	1 554	1 230	1 553	1 513	1 508
D	0	0	0	0	0	0	0
Sum	4 540	4 919	6 136	5 431	6 547	6 133	6 050

Source: own study based on (ARP, 2024)

As of 31.12.2023, the volume of industrial resources (for the entire deposit) of hard coal amounted to 6050 million Mg, of which 5394 million Mg are resources not restricted by deposition in protective pillars (non-pillar resources), and 656 million Mg are resources trapped in protective pillars, the exploitation of which can only be carried out using appropriate mining technologies (ARP, 2024). Table 7 presents the dynamics of changes in industrial resources. As before, to facilitate the analysis, the volume of resources from later years is given as a fraction of the reference value from 2007 and expressed as a percentage. An increase in the volume of industrial resources by 29% was recorded compared to 2007 (Table 7).

Table 7. Dynamics of changes in commercial category reserves

	2007	2010	2013	2016	2019	2022	2023
Industrial resources during the concession period	3 456=100%	108,6%	95,6%	80,6%	127,8%	120,9%	118,4%
Industrial resources for the entire deposit	4 673=100%	105%	131%	121%	140%	131%	129%

Source: own study based on (ARP, 2024)

The above change in the state of resources results mainly from changes in the concessions of active mines, changes in the balance sheet criteria, ongoing restructuring processes and closure of permanently unprofitable mines, as well as ongoing operation in active mines.

5. Conclusions

The classification of coal resources used in Poland is insufficient, as noted in the Hard Coal Mining Program in 2018. The above-mentioned change in the state of the resource base is caused by changes in the concessions of active mines (assessments of deposits made by mines), ongoing transformation processes - closing permanently unprofitable mines and changing the criteria for resource balance. Geological and mining conditions in mines are constantly deteriorating as mining activity progresses, which has affected the assessment of mining efficiency. The state of the resource mass was relatively little affected by the current extraction of active mines.

Despite the ongoing processes of decarbonization of the economy, which have accelerated significantly in connection with Russia's aggression against Ukraine and the rigorous climate policy of the European Union, it is worth being aware that hard coal will play a dominant role in the national energy mix in the coming years, and thus be of key importance in ensuring Poland's energy security.

It seems necessary to develop an industrial policy and energy policy for Poland, and consequently a program for hard coal and lignite mining. In order to prepare these key strategic documents, it is important to have up-to-date information on the state of hard coal resources, which is presented in the attached study.

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