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**Mineral and Energy
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i Energią
Polskiej Akademii Nauk

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Glossary of terms and symbols

ARA	Amsterdam-Rotterdam-Antwerp
WB	World Bank
CO₂	Carbon dioxide
DWT	Deadweight tonnage
IMP	Imports
JSW S.A.	Jastrzębska Spółka Węglowa S.A.
EC	European Commission
LW	Bogdanka S.A. Lubelski Węgiel Bogdanka S.A.
KWK	Coal mine (pol. kopalnia węgla kamiennego)
IEA	International Energy Agency
RES	Renewable energy sources
PEP2040	Poland's Energy Policy until 2040
PG	Mining company (pol. przedsiębiorstwo górnicze)
PGG S.A.	Polska Grupa Górnicza S.A.
S_KON	Scenario KONCESJE (eng. Licences (supply)
S_POR	Scenario POROZUMIENIE (eng. Agreement) (supply)
S_WYS	High demand scenario (demand)
S_NIS	Low demand scenario (demand)
S_MIN	Minimum demand scenario (demand)
TWd S.A.	Tauron Wydobycie S.A.
EU	European Union
ZG	Mining plant (pol. zakład górniczy)



Introduction

The European Union's climate and energy policy, implemented since 1990, is based on three key pillars aimed at achieving climate neutrality. In particular these pillars are the (i) decarbonisation of the economy, (2) development of renewable energy sources (RES) and (3) increase of energy efficiency. Decarbonisation is defined as striving to reduce the use of fossil fuels (mostly coal and lignite, oil, natural gas) in the economy. This goal can be achieved by replacing the above fuels with energy from renewables (water, wind, sun energy) or improvements in energy efficiency¹.

An important element of the implementation of the EU climate and energy policy is the implementation of relevant regulations, which constitute the legal framework for the member states. In this context, of key importance is the set of initiatives of the European Commission called the European Green Deal and the Fit for 55 package of legislative changes developed as part of this strategy. Its main aim is to reduce carbon dioxide emissions from the previously planned level of 40% to at least 55% by 2030 (compared to 1990) [1]. According to the analyses of the European Commission (EC), this change may result in the need to reduce CO₂ emissions from the energy sector by about 53–76% compared to 2015 [2]. A direct consequence of the EU's climate and energy policy will be a reduction in the demand for solid fossil fuels in the member states over the next decades.

Poland is a country where fossil fuels are still the dominant carrier of primary energy. Thus, it should be expected that EU regulations in the area of climate neutrality will have a significant impact on the use of fossil fuels, which also results in the need to properly adjust supply to domestic demand. This thesis is confirmed by the provisions of the Directive of the European Parliament and the Council on the promotion of energy from renewable sources, defining a 42% target share of RES in the national energy mix [3] (compared to 32% adopted in the Poland's Energy Policy [4]). The resource most affected by the implementation of the reduction targets will be hard coal.

In the light of the presented conditions resulting from the implementation of the EU climate and energy policy, which will affect the domestic demand for fossil fuels, the aim of the study is to analyse the supply-demand balance of hard coal used for energy purposes in Poland in the horizon of 2040. The implementation of this goal requires a series of partial works, which are reflected in the study's plan.

The first chapter analyzes the domestic supply of hard coal. The production capacities of domestic mines were assessed in the light of the concessions currently in force and the extraction of coal for energy purposes was characterised. The applicable legal regulations were also analysed in the context of decisions regarding the closure of hard coal mines. The second chapter analyses steam coal imports. In the third chapter, scenarios of demand for hard coal are presented. The forecasts of the demand-supply balance are presented in chapter four. Chapter five analyses and compares the prices of hard coal mined in domestic mines and imported coal. The summary includes the most important conclusions and recommendations.

This study is a starting point for assessing the supply of hard coal in the context of the Social Agreement signed by the government as a result of consent between the Inter-Union Protest and Strike Committee and the government delegation on the principles and pace of the transformation of the mining sector from September 2020 and regulating the principles of gradual liquidation of the hard coal mining industry (hereinafter: the Agreement).

¹ Improving energy efficiency is understood as using less energy in the economy to produce the same value of GDP.

To facilitate the reading of the study, terminology simplifications have been introduced in selected cases. In the mining industry (and consequently across this study) “extraction” is used for the final production of coal. It should be emphasised that it ***de facto*** means the production of commercial coal, because “extraction” means literally the mechanical separation of the mineral from the solid (exploitation) and its transport to the surface. The extracted ore is then transformed into commercial coal by mechanical processing. Exploitation and processing are the production process of mineral raw materials, in this case hard coal.

Two basic types of hard coal are produced in Poland: steam coal and coking coal used in metallurgy. Since the study focusses on hard coal for energy purposes, verbal substitutes are used in the text, i.e. ***steam coal*** or ***coal***. In other cases, the full name of the raw material is given, e.g. ***coking coal***.



1. Supply of coal for energy purposes from Polish mines

The analysis of hard coal resources and estimation of its supply requires the introduction of a deposit classification system, which is the basis for the assessment of the resource base. For an initial deposit assessment, the deposit classification systems use parameters such as:

- (a) thickness, i.e. the thickness of the mineral layer (coal seam),
- (b) calorific value of coal,
- (c) quality parameters, mainly sulfur and ash content, and
- (d) documentation depth.

Under Polish conditions, the definition of resources that meet the boundary values of the parameters defining a deposit (balance resources) was formulated in the Geological and Mining Law of June 9, 2011 (5). The definition and the currently applicable values of the criteria have been specified in the Regulation of the Minister of the Environment of July 1, 2015 on the geological documentation of a mineral deposit, excluding hydrocarbon deposits (6). These criteria are as follows:

- maximum documentation depth: 1250 m,
- minimum thickness of the hard coal layer in the seam with overgrowths up to 30 cm: 0.6 m and
- minimum weighted average calorific value of hard coal in a seam with overgrowths: 15 MJ / kg.

Meeting the balance conditions by a given deposit is not equivalent to a decision to exploit it. After the resources are described and registered, access to them is granted to mining companies upon license rights. Among the balance resources estimated according to the classification in question, there are resources suitable for economically justified exploitation, classified as "industrial resources", and those excluded from exploitation - "non-industrial resources". The volume of coal intended for direct extraction (extractable) is referred to as "reserves" (7). The resources described and classified as above are the basis for the development of strategic plans for mineral extraction and raw material acquisition.

It should be noted that although the above method of deposit evaluation is usually treated as the basic one, it is not sufficient from the point of view of investment profitability. In order to demonstrate the profitability of the project, and to secure sources of financing, the actual assessment of the economic value of the project is performed using standardized, international systems for business reporting of mineral resources used within the Committee for Mineral Reserves International Reporting Standards (CRIRSCO). The most popular are, among others, the Australian JORC, European PERC and Canadian instrument NI-43101 (8).

1.1 Assessment of the current supply capacity of domestic mines in the light of the current licenses

On the basis of the identified deposits, the mining capacities are formulated, which in turn leads to the determination of the theoretical² lifetime of the mines. The available resources are usually determined for two cases: the documented deposit and the license validity period (9).

In total, the documented balance resources of hard coal deposits (according to the report of the Polish Geological Institute entitled Balance of mineral resources in Poland as of December 31, 2020) amount to 64.4 billion Mg (10). Within this volume, steam coals account for nearly 71% of the resources (type 31-33), and coking coals (type 34 and 35 and others) - about 28%. Other types of coal account for slightly more than 1% of the resources. The resources of currently developed deposits constitute approximately 44% of the balance resources and amount to 28.4 billion Mg. On the other hand, the size of industrial resources in the developed fields, i.e. balance resources the exploitation of which can be economically justified - determined on the basis of the time of current mining concessions - amounts to approximately 4.8 billion Mg (10).

Exploration, discovery and exploitation of hard coal deposits are subject to obtaining a concession. Currently, concessions of the Ministry of the Environment for the extraction of hard coal are held by 12 mining companies:

- Polska Grupa Górnicza Sp. z o.o. (PGG S.A.),
- Jastrzębska Spółka Węglowa S.A. (JSW S.A.),
- Lubelski Węgiel Bogdanka S.A. (LW Bogdanka S.A.),
- TAURON Wydobycie S.A. (TWd S.A.),
- Przedsiębiorstwo Górnicze Silesia Sp. z o.o. (PG Silesia Sp. z o.o.),
- Węglokoks Kraj Sp. z o.o.,
- Zakład Górniczy Siltech Sp. z o.o. (ZG Siltech sp. z o.o.),
- Zakład Górniczy EKO-PLUS Sp. z o.o. (ZG EKO-PLUS sp. z o.o.),
- Karbonia S.A.,
- Spółka Restrukturyzacji Kopalń S.A.,
- Nexano Minerals Sp. z o.o.,
- Brzezinka Sp. z o.o. S.K.A.

As at June 30, 2021, the total number of valid licenses for the extraction of hard coal and the extraction of hard coal and methane as accompanying minerals is 56. Two licenses were also granted for the exploration of hard coal deposits (Fig. 1). When analyzing the dates of the current licenses for hard coal mining (Fig. 2), it should be noted that only a few of them will expire in the coming years. In the period of 2021-25, this applies to 6 concessions.

² In the event of a change in the annual production level, the discussed service life may be lengthened or shortened, other factors (extraction costs, political situation, global coal market situation) also affect the end date of operation.

FIG. 1. NUMBER OF LICENCES ISSUED - AS OF 30 JUNE 2021
SOURCE: BASED ON [11]

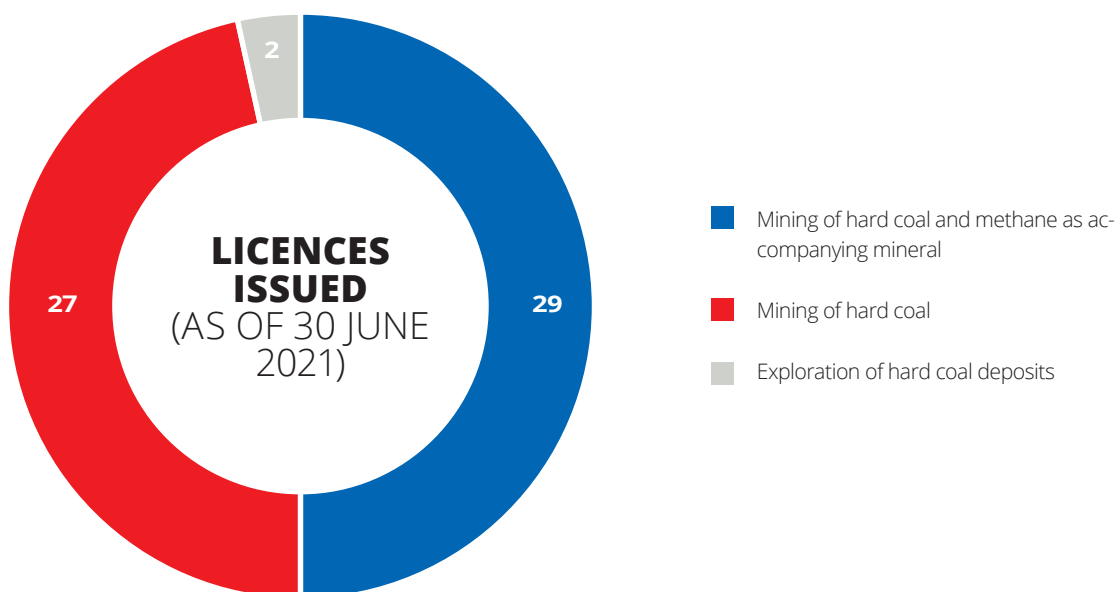
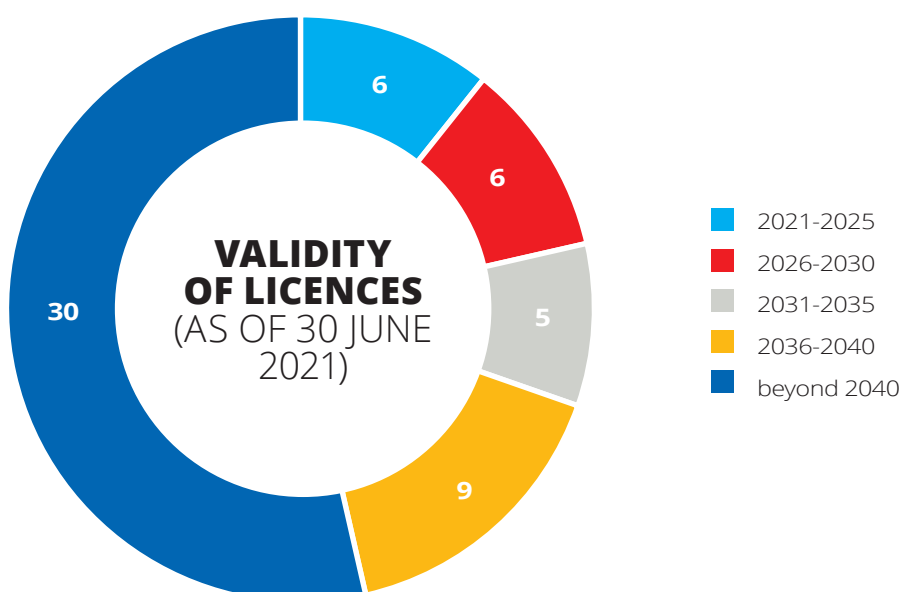


FIG. 2. VALIDITY OF LICENCES - AS OF 30 JUNE 2021
SOURCE: BASED ON [11]

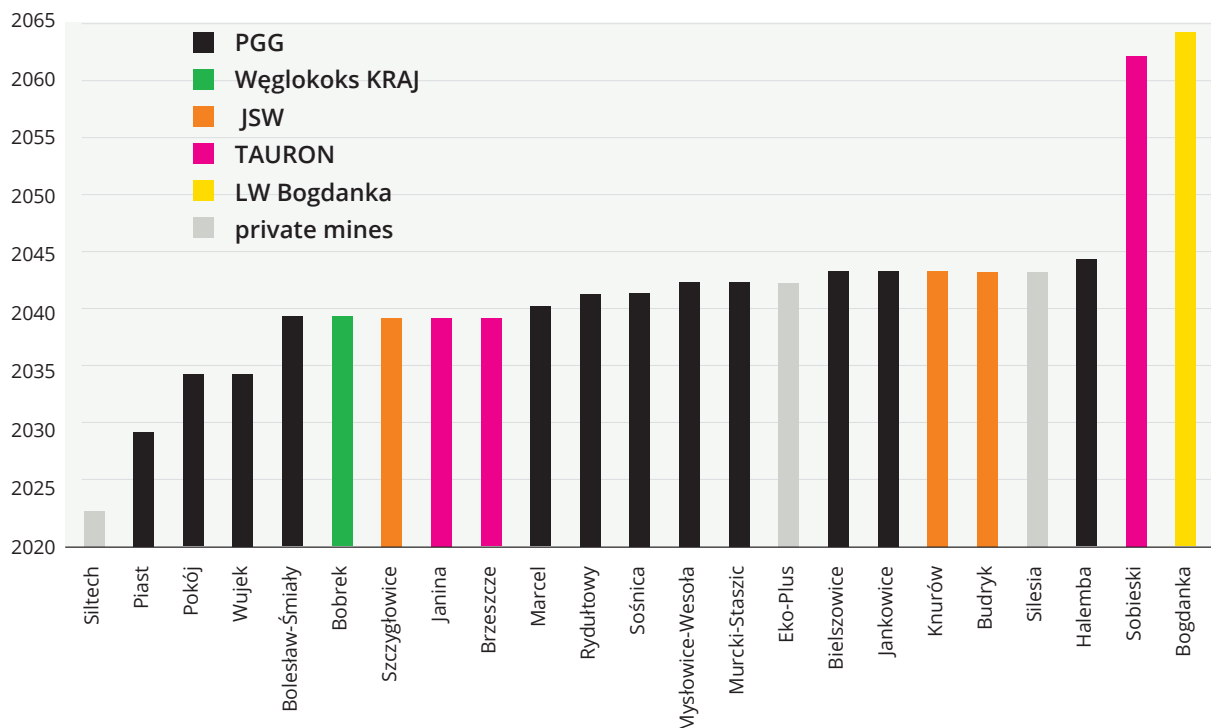


A few years ago, the issue of expiring concessions in the hard coal mining sector was a significant problem for mining companies. As a result of the above, in order to maintain the continuity of production, it was decided to change the regulations, which was to the benefit of the coal companies. The 2018 amendment to the Geological and Mining Law significantly accelerated activities related to the extension and obtaining of mining licenses. The changes introduced an accelerated procedure for accepting the application when extending the license. Currently, such a decision may be issued after obtaining the opinion of the commune head (mayor, city president, etc) competent for the place of business activity, without the need to conduct administrative proceedings in this matter. Additional simplification for the coal companies include, among others, limiting the potential time devoted to submitting comments to the owners of the areas (communes, poviats) covered by the concession, or giving the decisions issued by the local government an opinion-making, rather than obligatory, character. In the case of a one-off extension of the concession term, it was decided that there was no requirement to obtain a decision on environmental conditions.

In June 2021, a decision was made to amend the Act on the provision of information on the environment and its protection, public participation in the field of environmental protection and environmental impact assessment. The amendment revoked the possibility of a one-time extension of the mining concession, of inter alia hard coal, without obtaining a decision on environmental conditions.

Fig. 3 presents the list of concessions held by mining companies. It indicates that virtually all mines extracting coal for energy purposes have licenses for a period of several to several dozen years.. It should be noted that a large number of mines exploit more than one field (11).

FIG. 3. FIG. 3. COMPILATION OF VALID MINING LICENCES AS OF 2020
BASED ON: [10], [11]



Some of the concessions (including for deposits exploited by KWK Ruda - Ruch Halemba, KWK Ruda-Ruch Bielszowice, KWK Pokój, KWKMysłowiceWesoła, KWKPiastZiemowit, KWKMurcki Staszic) have been extended for a period of 15 or 25 years at the end of 2020.

1.2 Coal mining for energy purposes in Poland

The comparison of the size of the deposit resources and the period of the granted concession, in conjunction with the data on the average production of the mine, allows to assess its theoretical viability and the expected period of its operation (lifetime). Of course, to ensure continuity of production is required incurring appropriate investment expenditures, which is not the subject of this study. In Poland, coal mining for energy purposes is currently carried out in 17 mines. Some of them work as combined mines.

Polska Grupa Górnicza Sp. z o.o. it produces coal of types 31.2, 32.1, 32.2 and 33 and coking coal of types 34.1 and 34.2. Steam coal is mined in:

- combined ROW Coal Mine consisting of four plants: Ruch Marcel, Ruch Rydułtowy, Ruch Jankowice, Ruch Chwałowice,
- KWK Ruda consisting of three plants: Ruch Bielszowice, Ruch Halemba and Ruch Pokój (in which mining is to be terminated in 2021),
- KWK Piast-Ziemowit consisting of two plants: Ruch Piast and Ruch Ziemowit
- KWK Staszic-Wujek consisting of two plants: Ruch Murcki-Staszic and Ruch Wujek and
- single-seam mines: KWK Bolesław Śmiały, KWK Sośnica, KWK Mysłowice-Wesoła.

Production of thermal coal in Jastrzębska Spółka Węglowa S.A. takes place in the KWK Budryk and KWK Knurów-Szczygłowice mines. It should be noted, however, that the domain of JSW SA is coking coal, produced (type 34 and 35) in all the company's mines.

TAURON Wydobycie S.A. owns three mines: ZG Janina, ZG Sobieski and ZG Brzeszcze. WĘGLOKOKS KRAJ Sp. z o.o., in turn, extracts coal at the KWK Bobrek-Piekary - Ruch Bobrek mine. Steam coal is also mined in the LW Bogdanka S.A. mine, as well as in three private mines: PG Silesia Sp. z o.o., ZG Siltech Sp. z o.o., Eko-Plus Sp. z o.o.

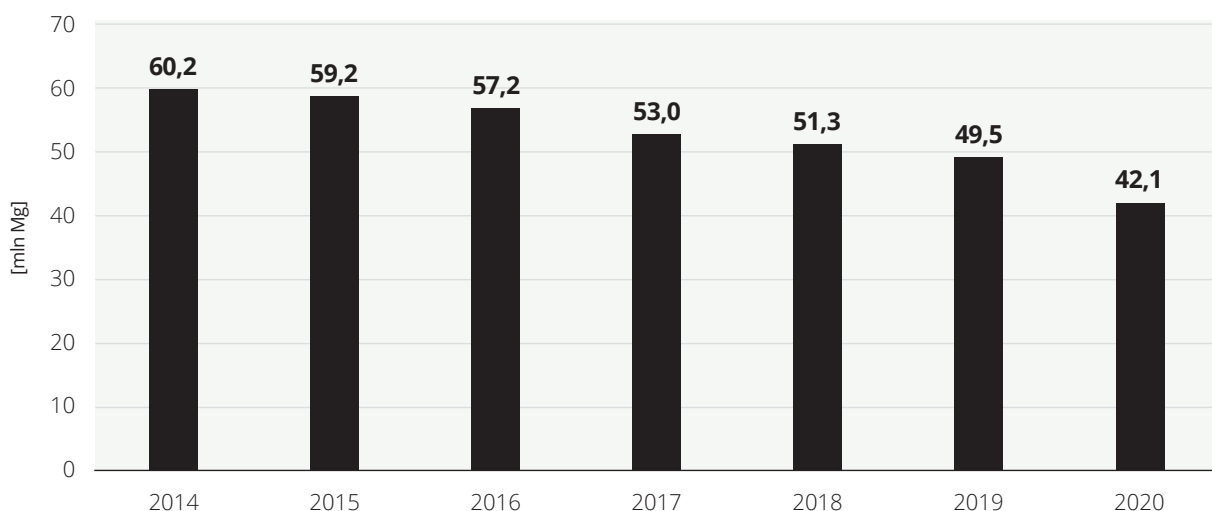
For several years, a decrease in the domestic hard coal production has been observed in Poland, which is caused by the deteriorating geological and mining conditions and the systematically growing production costs. As a consequence, extraction in some of the mines is shut down and the assets are transferred to Spółka Restrukturyzacji Kopalń (Mine Restructuring Company). As a result of these activities and the merger of mines into multi-seam plants, the number of mines is also reducing.

Fig. 4. presents mining volumes of hard coal between 2014-20. When analysing the volume of hard coal extraction in 2019 compared to 2015, it should be noted that the extraction of hard coal for energy purposes in Poland decreased by 17.8% (nearly 10 million Mg). In 2020, domestic coal production amounted to 42.1 million Mg (Fig. 4), i.e. 18.1 million Mg (30.1%) less than in 2014 (12). In addition to the general trend of reducing the demand for hard coal, the reduction in coal production was also

3 Mining volumes have been compared for 2014-19 due to data distortions related to the COVID-19 pandemic.

influenced by the coronavirus epidemic (prior to the pandemic, domestic coal companies estimated the 2020 volume of coal extraction for energy purposes at around 50 million Mg). However, most coal companies during the year reported that their production plans were revised.

FIG. 4. STEAM COAL MINING IN POLAND BETWEEN 2014-20.
BASED ON: [12]



1.3 Decisions regarding phase-out of mining operations

Currently, the basic documents forming the basis of the national energy policy are: Poland's energy policy until 2040 (PEP2030 (4)) and the National plan for energy and climate for 2021-30 (13). The common axis of both documents is the promotion of renewable energy sources and reducing the role of coal in the economy.

To effect the goals connected with reducing coal use in the economy, the government started talks with the social side on the liquidation of the mines. For this reason, a reliable assessment of the viability of mining plants should consider the announcements of coal mining phase out based on the Social Agreement (14). The Agreement regulates rules and pace of the coal sector transformation, i.e. gradual liquidation of hard coal mining in Poland.

The schedule of mine closures foresees complete cessation of coal mining by 2049. Although the relevant agreement was finally signed in May 2021, it requires consent of the European Commission to grant public aid, including subsidies to current production for the hard coal mining sector.

The detailed closure dates of individual mines are presented in Table 1. The presented data shows that, assuming the planned implementation of the Agreement, some mines will require an extension of the current concessions. This situation applies to the following plants: Marcel, Rydułtowy, Jankowice, Chwałowice and Piast.

TAB. 1. LICENCE VALIDITY DATES AND MINE LIQUIDATION DATES BASED ON THE AGREEMENT FOR SELECTED MINES/SEAMS IN POLAND

Number	Mine / Seam ***	End date of the current license	Final date as per the "Agreement"
Polish Mining Group (PGG)			
KWK ROW			
1.	Ruch Marcel	2041	2046
2.	Ruch Rydułtowy	2042	2043
3.	Ruch Jankowice	2044	2049
4.	Ruch Chwałowice	2040	2049
KWK Ruda			
5.	Ruch Halemba	2045	2034
6.	Ruch Pokój	2035	2021
7.	Ruch Bielszowice	2044	2023
KWK Piast-Ziemowit			
8.	Ruch Piast	2030	2035
9.	Ruch Ziemowit	2044	2037
KWK Murcki-Wujek			
10.	Ruch Murcki-Staszic	2043	2039
11.	Ruch Wujek	2035	2021
12.	KWK Bolesław-Śmiały	2040	2028
13.	KWK Sośnica	2042	2029
14.	KWK Mysłowice-Wesoła	2043	2041
Węglokoks KRAJ			
KWK Bobrek-Piekary			
1.	Ruch Bobrek	2040	2040
Jastrzębska Spółka Węglowa (JSW)			
KWK Knurów-Szczygłowie			
1.	Ruch Knurów	2044	—
2.	Ruch Szczygłowie	2044	—
3.	KWK Budryk	2044	—
TAURON Wydobycie (TWd)			
1.	ZG Janina ⁴	2040	— ⁵
2.	ZG Sobieski ⁴	2063	— ⁵
3.	ZG Brzeszcze	2040	— ⁵
Lubelski Węgiel Bogdanka (LWB)			
1.	KWK Bogdanka	2065	—
Other (private) mines			
1.	PG Silesia	2044	—
2.	ZG Siltech	2023	—
3.	Eko-Plus	2043	—

*** *** KWK (Coal Mine), ZG (Mining Plant), PG (Mining Enterprise)

⁴ From 2022, ZG Janina and ZG Sobieski will operate as a combined mine⁵ In the proposal for a social contract sent to the government on January 19, 2021, the trade unions indicated the suggested closing dates for the TWD mine (ZG Brzeszcze: 2040; ZG Janina / Sobieski: 2049), which were ultimately not included in the Agreement

1.3 Scenarios of hard coal supply for energy purposes

Table 2 shows the volume of steam coal extraction in 2019, which is the basis for determining the supply of steam coal. Due to the reduction in production caused by the COVID-19 pandemic, the data for 2020 is not fully representative. Therefore, in order to assess the supply in the 2021-49 perspective, the average production level of individual mines in 2019 was assumed. Corrections to plans, in line with the companies' strategies, were adopted for LW Bogdanka, Jastrzębska Spółka Węglowa and the companies Węglokoks Kraj and TAURON Wydobycie.

TAB. 2. COAL MINING PER COMPANIES IN 2019

Company	Total hard coal mining [k tonnes]	Mining of steam coal [k tonnes]	Steam coal's share [%]
PGG S.A.	29 500	27 600	93,56
LW Bogdanka S.A.	9 400	9 400	100,00
JSW S.A.	14 800	4 600	31,08
Węglokoks Kraj Sp. z o.o.	2 200	2 200	100,00
TWd S.A.	3 900	3 900	100,00
Other	1 800	1 800	100,00
TOTAL	61 600	49 500	80,36
of which: coking coal	12 100		

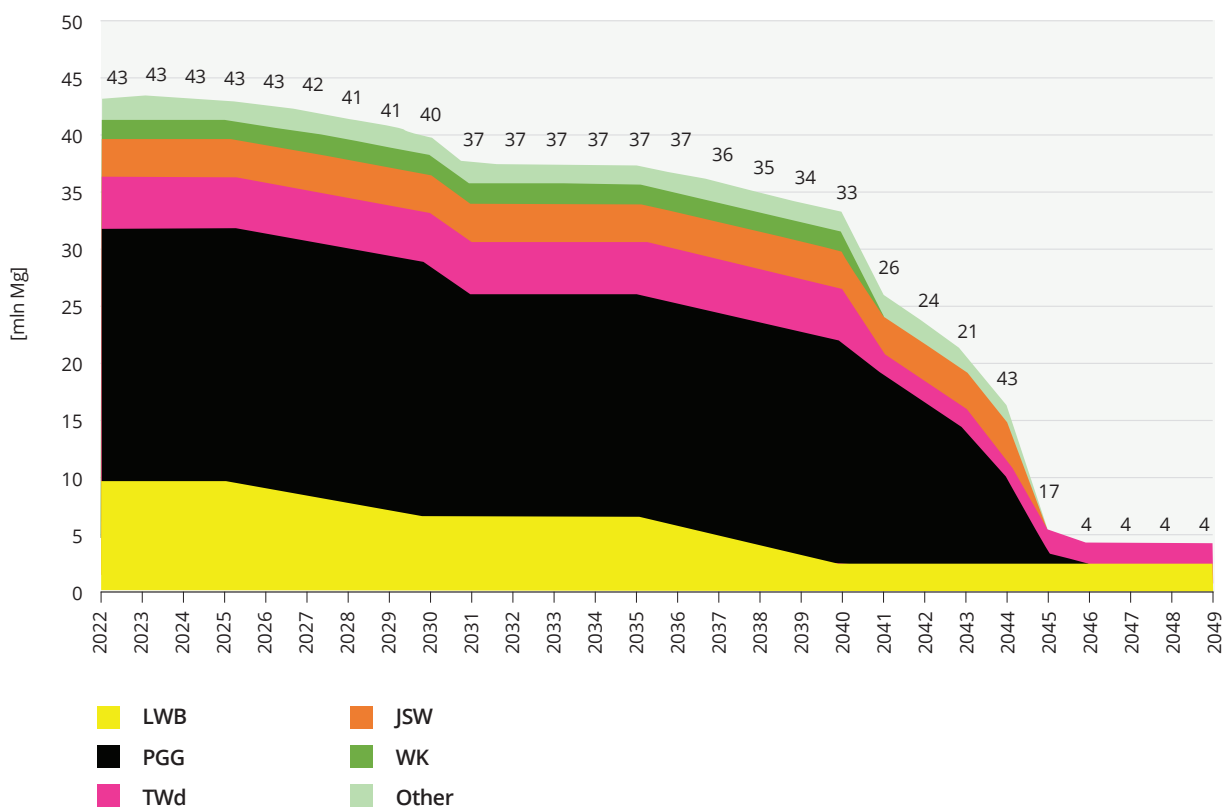
A forecast of domestic hard coal supply for energy purposes was presented in two scenarios:

- the "Concessions" (S_CON) scenario assumes exploitation in the mines in accordance with the current concession completion dates, taking into account the adequacy of resources in the exploited deposits;
- in the "Agreement" (S_AGR) scenario, the production termination dates were adopted in accordance with the signed "Agreement" social agreement; In addition, it was assumed that the term of the currently valid concession will be extended for the following mines / Ruchów: Marcel, Rydułtowy, Jankowice, Chwałowice and Piast.

The analysis of coal supply shows that in the S_CON scenario, the annual volume of the produced raw material would remain at a relatively constant level of 40 million Mg until 2030. In the years 2031-35 there would be a slight decrease in the annual production (to the value of 37 million Mg), additionally deepened in the years 2036-40 to about 33 million Mg. Only after 2041, due to the expiry of many concessions, a drastic decrease in production can be noticed, which would lead to a volume of approximately 4-5 million Mg after 2045 (Fig. 5).

The supply forecast was made assuming the production at the current level, taking into account the corrections of plans indicated by the mining companies. The current licenses enable production to be carried out in the fields exploited by LW Bogdanka and TAURON Wydobycie until 2049; the current concessions for fields exploited by other mining companies will expire slightly earlier.

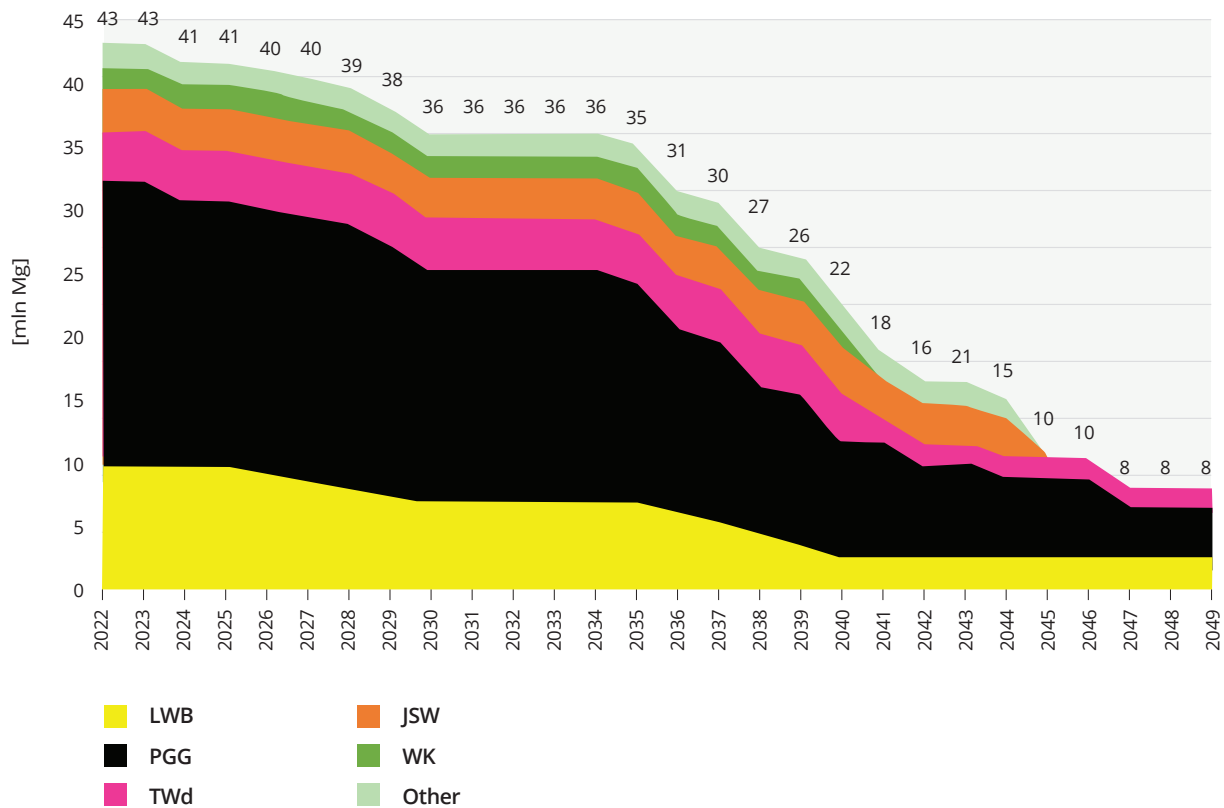
FIG. 5. STEAM COAL SUPPLY FORECAST IN THE S_KON SCENARIO
SOURCE: OWN STUDY



The S_AGR scenario results in a significant reduction in the volume of coal production after 2035. Until then, a moderate downward trend is noticeable. In the aforementioned variant, the annual coal production in 2035 would be 35 million Mg, 22 million Mg in 2040, while in 2045-49 it would be around 8-10 million Mg (Fig. 6).

As in the S_CON scenario, the main source of coal will be the deposits currently mined by the Polish Mining Group (PGG), but the mine shutdown schedule adopted in the Agreement significantly reduces the annual volumes of coal production by the PGG. Ultimately, until 2049, besides PGG, the deposits will be mined in the mines of LW Bogdanka, TAURON Wydobycie.

FIG. 6. STEAM COAL SUPPLY FORECAST IN THE S_POR SCENARIO
SOURCE: OWN STUDY

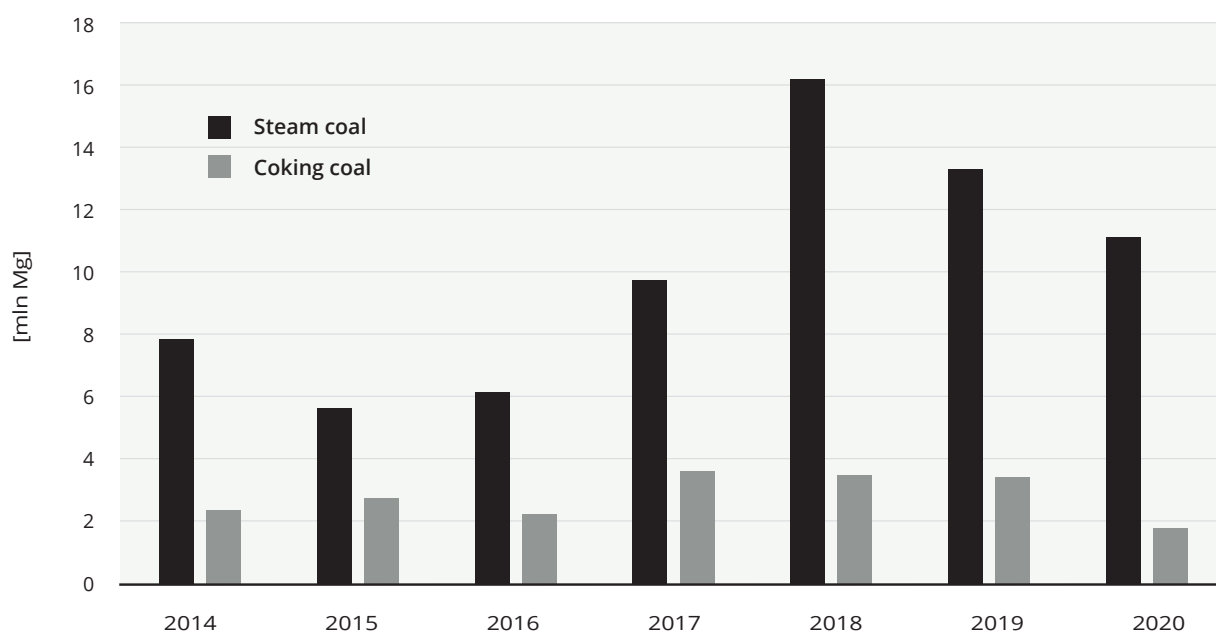




2. Import of steam coal to Poland

In the past, Poland was a significant exporter of hard coal in the international arena. In recent years, however, the volume of coal supplies imported to Poland has been higher than the volumes exported (15). Imports are made up predominantly of steam coal (Fig. 7).

FIG. 7. STEAM AND COKING COAL IMPORTS
BASED ON: [15], [16] (DATA BY THE NATIONAL REVENUE ADMINISTRATION)

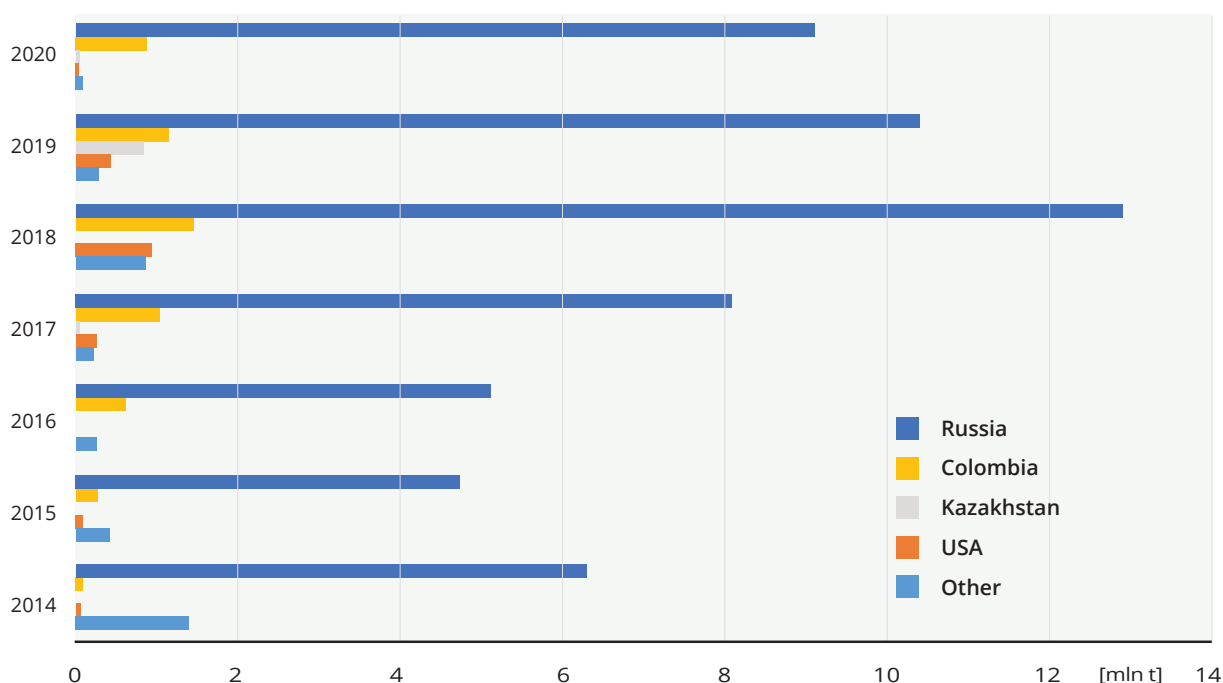


2.1 Directions of coal import for energy purposes

Power coal is currently imported to Poland mainly from Russia and Colombia. In addition, in recent years, deliveries have been made, inter alia, from the USA, Kazakhstan, the Czech Republic, Australia and Mozambique. Deliveries are made by sea and by land.

In 2020, Russia was the main import supplier of coal, from where 9.1 million Mg of this raw material was delivered to Poland (82% of supplies for energy purposes). The volume of supplies from Colombia amounted to 0.9 million Mg (8% of steam coal deliveries to Poland).

It should be noted that the structure of the share of major suppliers did not change significantly in 2020 compared to 2019, when 10.4 million Mg of steam coal from Russia (79%) and nearly 1.2 million Mg from Colombia (9%) were imported to Poland. The detailed structure of steam coal supplies to Poland in recent years is presented in Fig. 8.

FIG. 8. DELIVERIES OF STEAM COAL BY COUNTRY OF ORIGIN BETWEEN 2014-20.
BASED ON: [15], [16] (DATA BY THE NATIONAL REVENUE ADMINISTRATION)

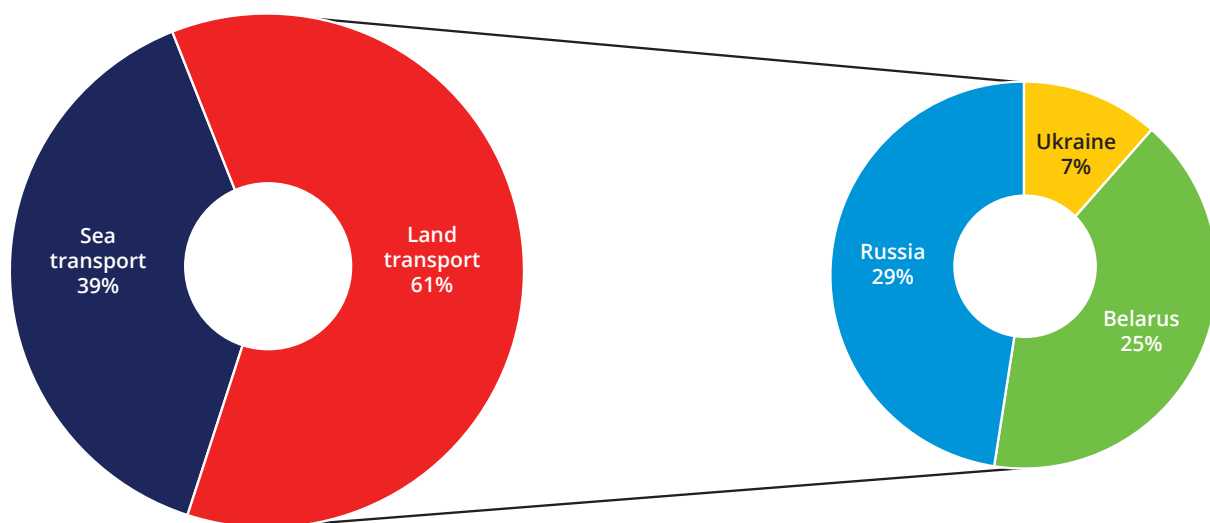
The main method of coal supply is by land. Nevertheless, there has been a noticeable increase in imports by sea in recent years. In 2014 and 2015, 20% of deliveries were seaborne, rising to 40% in the period 2018-2020 (Fig. 9).

Coal imports by sea are carried out mainly through the port of Gdańsk (26% of steam coal supplies in 2020). The ports in Gdynia and Świnoujście and, to a lesser extent, the port in Szczecin play an important role in the national hard coal transport system via this route. Deliveries of smaller volumes are also made to the ports in Elbląg and Police.

The main maritime hub dedicated to receiving hard coal supplies in Europe are the so-called ARA ports (Amsterdam, Rotterdam and Antwerp). The raw material is transported mainly by capesize ships with a deadweight tonnage (DWT) exceeding 150,000 tonnes. Mg (eg from Colombia, South Africa) and panamax, with a load capacity (DWT) in the range of 65-80 thousand. Mg (e.g. from Russia, USA, but also Colombia and South Africa).

The limitation is usually the port infrastructure and the transport route. Domestic seaports usually host panamax ships and smaller vessels. However, it should be noted that Poland also has the possibility of unloading capesize vessels (including coal deliveries from Colombia to the North Port).

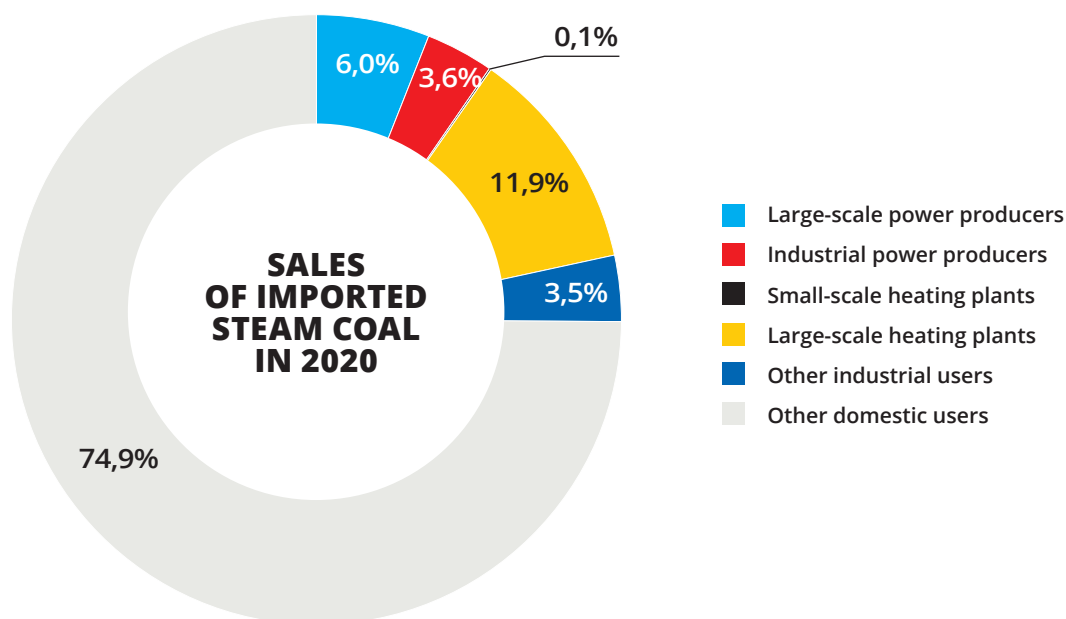
FIG. 9. STEAM COAL IMPORTS BY MODE AND COUNTRY IN 2020
BASED ON: [15]



Hard coal deliveries by land to Poland are carried out at nearly twenty border crossings. Imports are mainly carried out from the east. Due to the difference in the axis size of the railway tracks, the raw material is unloaded at border reloading terminals. The exception is the border crossing in Hrubieszów, from where the broad-gauge metallurgical line (LHS), 395 km long, runs to the terminal in Sławków (Śląskie Voivodeship). The largest amounts of imported coal are brought through the border crossing Braniewo-Mamonowo (Russia) and Terespol-Brześć, with a terminal in Małaszewicze (Belarus). In 2020, of all coal imports for energy purposes, approximately 29% went through Braniewo and approximately 13% through Terespol / Małaszewicze).

Coal imported to Poland is directed mainly to the group of the so-called 'other domestic recipients' (households, agriculture, public utility buildings). In 2020, about 75% of the sales volume was directed to this group (Fig. 10).

The remaining group of recipients - due to the low sulphur content in imported coal - are heating plants and large-scale power plants. The imported coal is also directed to industrial power plants and other industrial recipients; insignificant amounts of the raw material go to non-professional heating plants. It should be emphasized that an important reason for importing coal to Poland is also its competitive price – usually lower than the price of domestic coal.

FIG. 10. IMPORTED STEAM COAL SALES DESTINATIONS IN 2020
BASED ON: [15]

2.2 Prices of imported coal

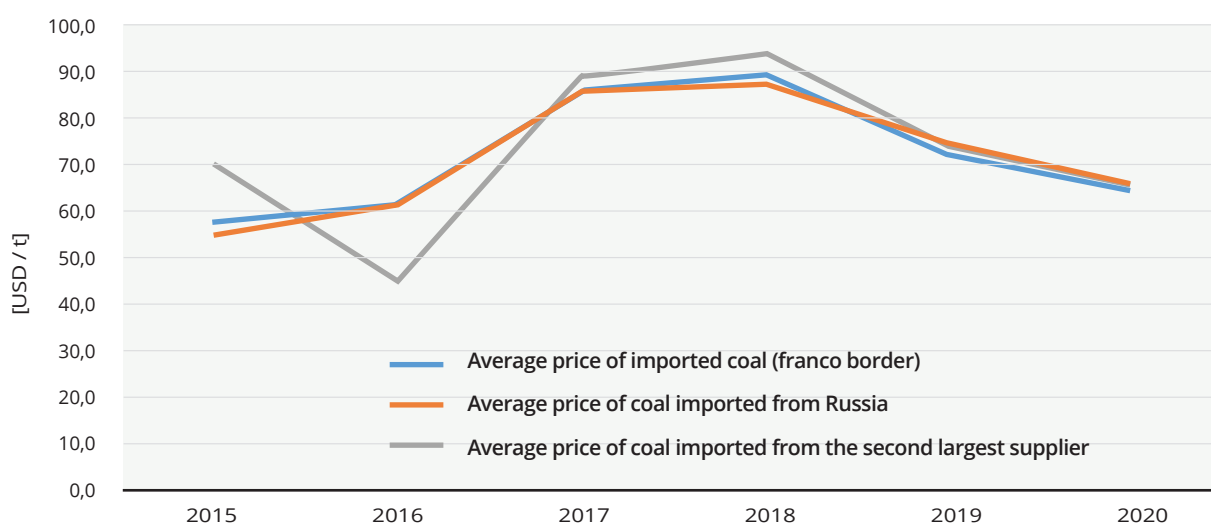
In analyses of international coal prices, the so-called price indices that refer to the standardised quality of the raw material are used. On the European market, the basic indicator is the API2 index informing about transactions carried out in the above-mentioned ARA ports (Amsterdam, Rotterdam and Antwerp) in the CIF (Cost, Insurance & Freight) formula for coal with the following parameters (17):

- calorific value in working condition: 6000 kcal / kg (about 25.1 MJ / kg),
- sulphur content: below 1%,
- ash content: 11–15%,
- moisture content: 11–15%,
- volatile matter content: 22–27%,
- graining: 0–50 mm.

A separate issue is to determine the price of coal imports from Russia - the main coal exporter to the Polish market. FOB (Free on Board) coal prices in the Baltic Sea are closely related to the CIF ARA price. The analysis of the prices of Russian coal shows that for many years they have been about 4–5% lower than the prices of steam coal traded in ARA ports. As a result of the above, suppliers from Russia gain a competitive advantage over the other major importers (Colombia, South Africa, USA). This is what makes Russia one of the main suppliers of this raw material both to ARA ports and to the Polish market, given the favorable quality of Russian coal.

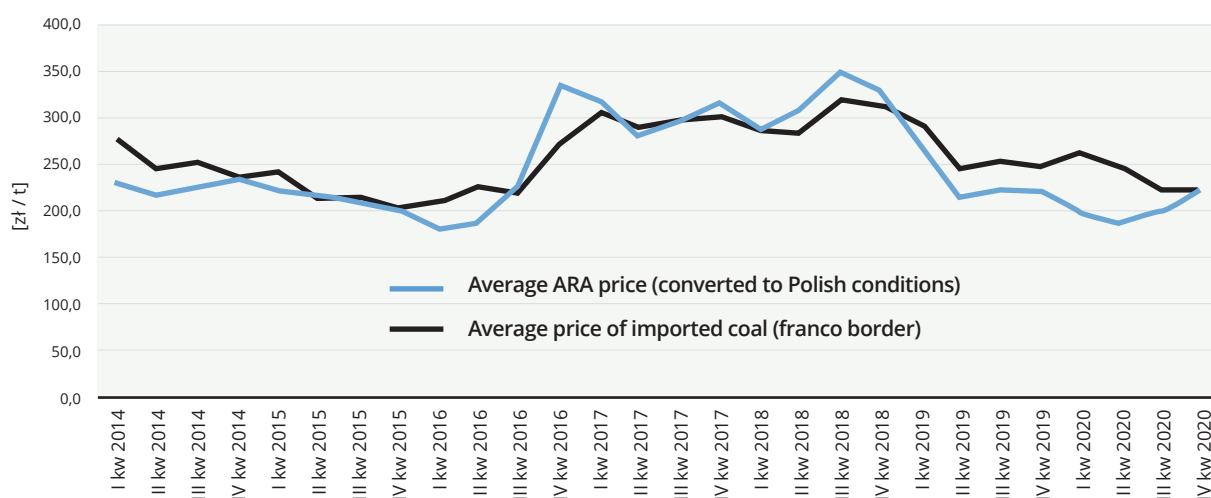
The analysis of the average prices of steam coal imported to Poland shows that they are strongly correlated with the purchase price of Russian coal (Fig. 11). For years, coal from the eastern direction has accounted for about 80% of supplies. As a result of the above, the price of Russian coal has a key impact on the average price of the raw material imported to Poland. The purchase price of this raw material from the second largest supplier in terms of share (in the analysed years they were Colombia and the Czech Republic), however, does not differ significantly.

FIG. 11. AVERAGE PRICES OF STEAM COAL IMPORTED TO POLAND (FRANCO BORDER) FROM LARGEST SUPPLIERS BETWEEN 2015-20
BASED ON: [15]



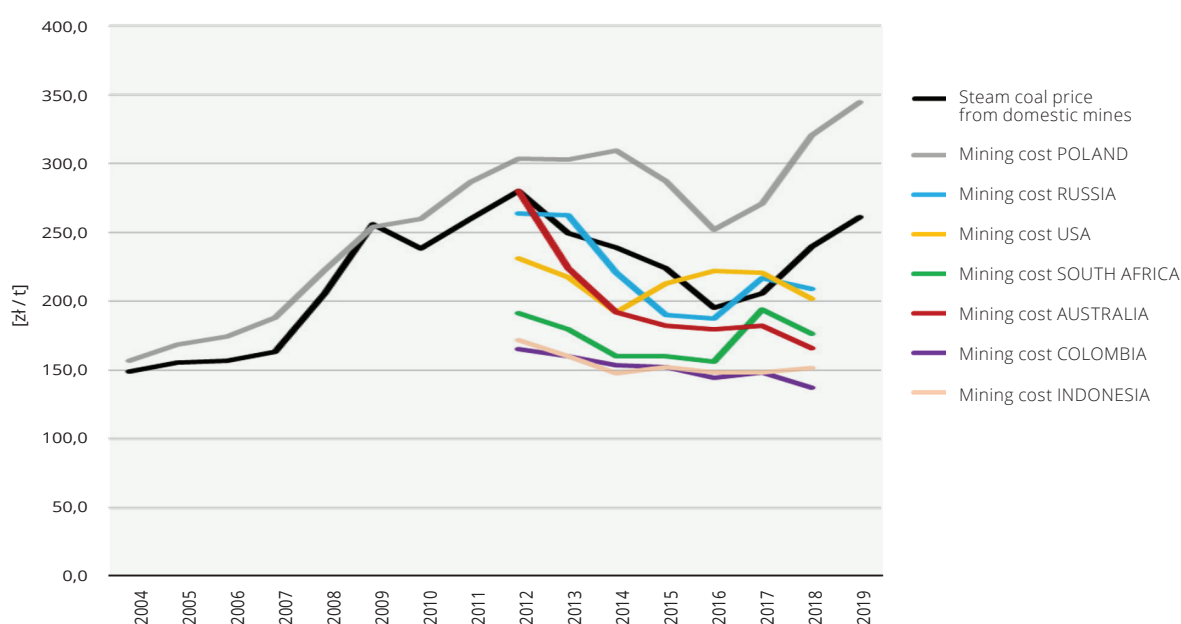
The comparison of the CIF ARA index prices and the prices of steam coal at the country border (free at the border) (Fig. 12) confirms the high competitiveness of coal from eastern directions in recent years. Russian coal prices are most often adjusted to the CIF ARA index, which is a price determinant on the European market.

FIG. 12. AVERAGE PRICES OF IMPORTED COAL (FRANCO BORDER) AND PRICES OF COAL FROM ARA PORTS (CONVERTED TO POLISH CONDITIONS) BETWEEN 2014-20
BASED ON: [15]



It needs to be noted that the price obtained from the sale of domestic coal does not cover the costs of its extraction and processing, which consequently led to a negative financial result in the domestic hard coal mining sector in recent years. The average production cost of a tonne of hard coal in Poland compared to the production costs of this raw material in selected countries (major coal exporters to world markets) is definitely unfavorable to the domestic coal sector (Fig. 13). This is due to, inter alia, the differences in the operating conditions - in Poland, mining is carried out even at depths below 1000 meters, in difficult geological and mining conditions. In other countries it is often open-pit mining or mining at lower depths, which results in significantly cheaper production costs.

FIG. 12. AVERAGE MINING COST OF ONE TONNE OF HARD COAL IN POLAND COMPARED TO OTHER COUNTRIES
BASED ON: [12], [18] - [20]





3. Scenarios of coal demand from the power and heating sectors

The scenarios of the demand for thermal coal are based on the data published in (a) Poland's Energy Policy until 2040, (b) the "Clean heat 2030" report, which is the basis for the "Strategy for district heating" currently being developed by the Ministry of Climate and Environment and (c) information from the Central Statistical Office and the Energy Market Agency on the consumption of hard coal. In the developed scenarios, the main emphasis was put on the implementation of the objectives of the Polish Energy Policy until 2040 relating to the use of hard coal.

3.1 Objectives of the Polish Energy Policy until 2040 - the role of coal

Poland's Energy Policy until 2040 was adopted on February 3, 2021. Its main goals, among other things, relate to reducing the use of hard coal as fuel for the production of electricity. The volume of electricity production from coal was predicted in two scenarios, depending on the future prices of CO₂ emission allowances (4):

- in the high scenario, where the forecast price of allowances is lower, the maximum volume of electricity production from coal (hard coal and lignite)⁶ should not exceed 56%;
- in the low scenario, which was characterized by a correspondingly higher forecast of prices of CO₂ emission allowances, this volume amounts to 37.5%.

Another element of PEP 2040 regarding the use of hard coal is the strategy of its use in the small customers sector. In PEP 2040, the goal was to move away from burning this raw material in households in cities by 2030, and in rural areas by 2040. The document also presents the goal of promoting coal from domestic hard coal mines, which was formulated as an attempt to cover the demand with own resources (4).

3.2 Scenarios of demand for steam coal

For the purposes of this study, and based on data on demand in the power and heat sectors, three scenarios of the demand for steam coal were formulated:

1. "High Demand" (S_WYS) (Fig. 14), where demand drops from 54 million Mg in 2022 to 23 million Mg in 2040
2. "Low Demand" (S_NIS) (Fig. 15), where demand drops from 51 million Mg in 2022 to 12 million Mg in 2040
3. "Minimum Demand" (S_MIN) (Fig. 16), where demand drops from 46 million Mg in 2022 to 11 million Mg in 2040.

⁶ The targets adopted in the PEP 2040 document relate to the production of electricity from hard coal and lignite jointly, only the demand for hard coal was taken into account for the calculations.

Coal for the power sector

The basis for the construction of the S_WYS and S_NIS scenarios are the projections of high and low demand for coal for electricity production, according to the assumptions of the Polish Energy Policy until 2040. In the S_WYS scenario, the consumption of hard coal for energy purposes was calculated in accordance with the adopted assumption of a maximum 56% total coal consumption. For the S_NIS scenario, consumption was calculated assuming 37% total coal consumption in 2030 and 11% in 2040 in energy production. The S_MIN scenario is the authors' own forecast of the lowest demand for coal. It assumes accelerated decommissioning of coal-fired power plant units based on the report of the Minister of Climate and Environment on the results of monitoring the security of electricity supply of July 2021 (21) and information from energy companies regarding the shutdown of coal-fired units.

Coal for the heat sector

The demand for coal for heat production was adopted in line with the forecast published in the report "Clean heat 2030. Strategy for heating" (22), based on assumptions from the PEP 2040.

In further analyses, three out of the four forecasts presented in the aforementioned report were taken into account, concerning the consumption of hard coal for heat production in the power industry, heating industry and by individual consumers. All projections of the report assume ending the combustion of hard coal in system sources by 2050 and resignation from burning hard coal in non-systemic sources, respectively in:

- by 2030 (for the minimum scenario),
- by 2035 (for the efficiency scenario) and
- by 2040 (for the decarbonisation scenario).

Assumptions presented in the Clean heat 2030 report have been implemented to scenarios prepared for this study as follows:

- S_WYS – coal phaseout from non-system sources in 2040
- S_NIS – coal phaseout from non-system sources in 2035
- S_MIN – coal phaseout from non-system sources in 2030.

Other sectors

Coal consumption in other sectors (industry, transport, agriculture) was estimated on the basis of the report "Consumption of fuels and energy carriers in 2019". Due to the COVID-19 epidemic, it was decided to adopt the baseline values for 2021 in line with the 2019 value. In the following years, a specific decrease in demand for thermal coal in these sectors was assumed. The final consumption value in 2040 is 50% lower than in the base year.

FIG. 15. STEAM COAL DEMAND FORECAST IN THE S_NIS SCENARIO

SOURCE: OWN STUDY

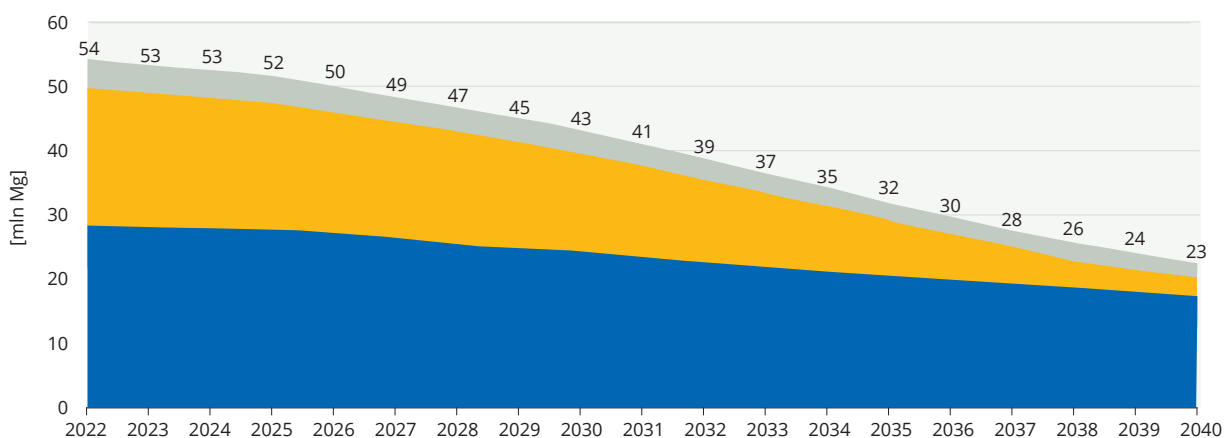


FIG. 15. STEAM COAL DEMAND FORECAST IN THE S_NIS SCENARIO

SOURCE: OWN STUDY

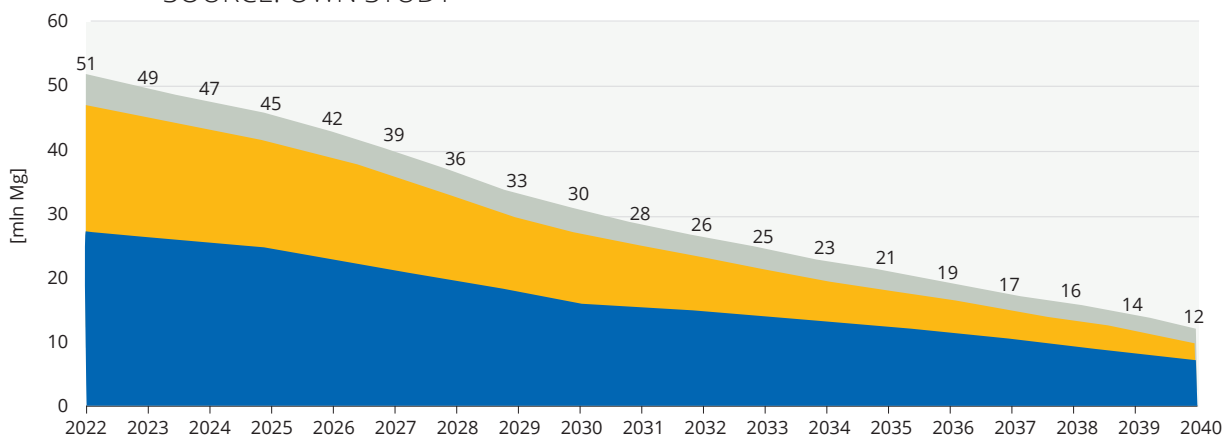
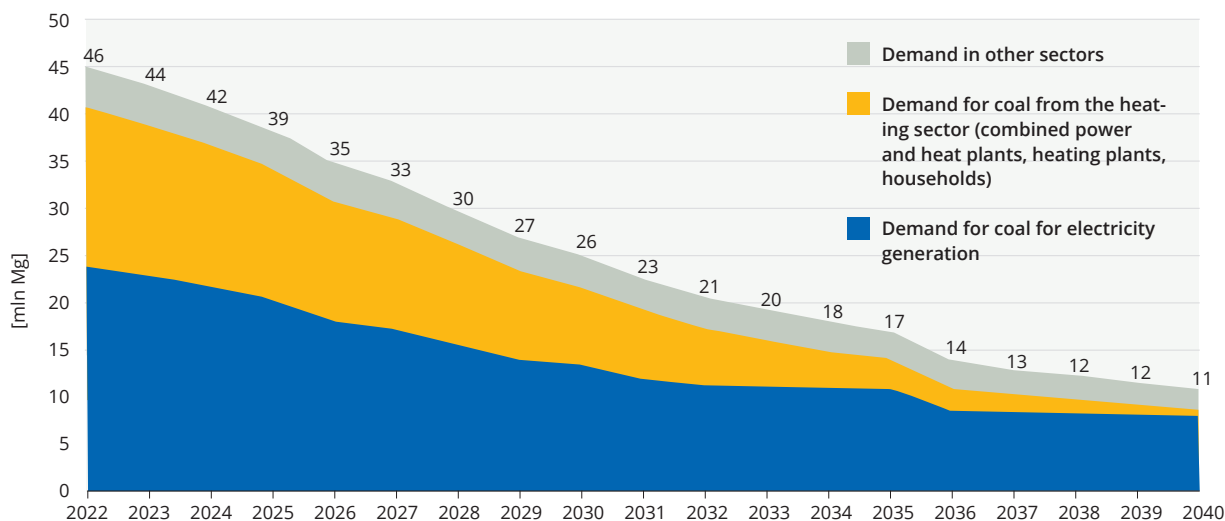


FIG. 16. STEAM COAL DEMAND FORECAST IN THE S_MIN SCENARIO

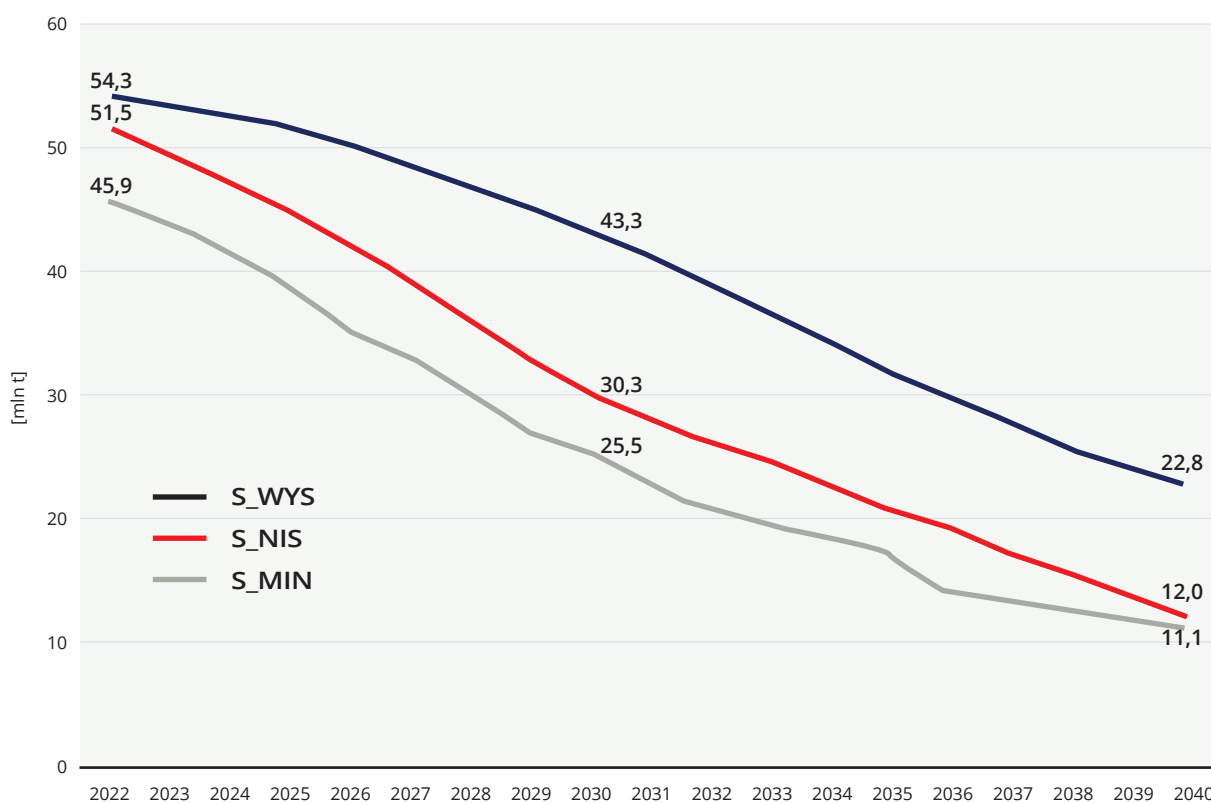
SOURCE: OWN STUDY



All scenarios assume that the final year of the forecast is 2040, which is in line with the horizon of the current Energy Policy of Poland.

Fig. 17 presents a summary of the demand in the three analyzed scenarios. In the S_WYS scenario, hard coal consumption will decrease from 54.3 million Mg in the base year (ie 2022) to 43.3 million Mg in 2030 and 22.8 million Mg in 2040. In the S_NIS scenario, the demand reduction is more dynamic. According to the forecast, in 2030 the demand will amount to 30.3 million Mg and 12 million Mg in 2040. In the S_MIN scenario, the reduction in demand in the next decade is very rapid. In 2030, the demand for energy coal should amount to 25.5 million Mg, and in 2040 only 11.1 million Mg.

FIG. 17. FORECAST STEAM COAL DEMAND IN THE ANALYSED SCENARIOS





4. Forecast of the supply and demand balance of coal for power and heating industries

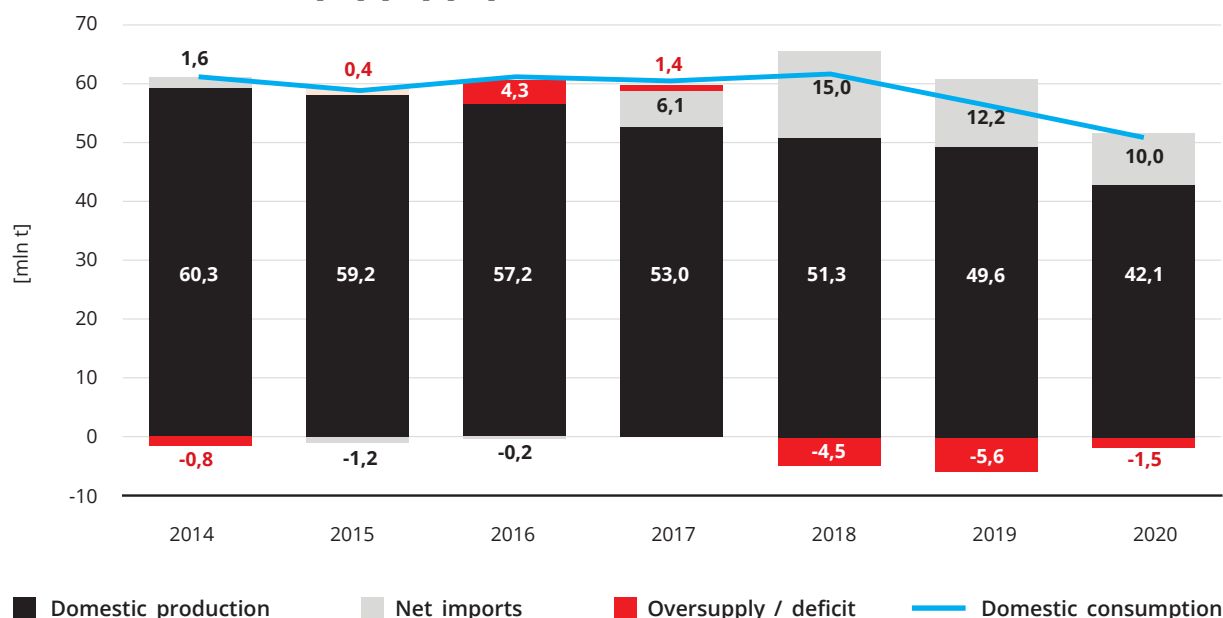
The demand and supply data used for the analysis have been presented in the previous sections of the study, in particular:

- a) domestic production projections in two scenarios, ie S_CON and S_AGR - chapter 1;
- b) data on import / export volumes - chapter 2;
- c) forecasts of domestic demand in three scenarios, ie. S_WYS, S_NIS, S_MIN - chapter 4.

Fig. 18 shows the components of the historical annual supply-demand balance between 2014 and 2018 broken down into:

- supply components, ie domestic production and net import (i.e. imports less exports);
- demand component, ie domestic consumption;
- balance⁷, ie an oversupply or deficit (increase or decrease in inventories).

FIG. 18. HISTORICAL ANNUAL HARD COAL SUPPLY-DEMAND BALANCES BETWEEN 2014-20
BASED ON: [15], [24], [25]



* Note: due to the presentation of the data in the chart, the oversupply is presented with a negative sign, the deficit with a positive sign.

⁷ Due to presentation considerations, oversupply is shown with a negative sign and a deficit is shown as a positive value.

Demand-supply balances have been prepared for the following variants:

- a) variant of domestic supply with import⁸ (W_KRAJ_IMP),
- b) domestic supply variant (without considering imports) (W_KRAJ)

Based on the above assumptions for construction of supply-demand balances, calculations were made of the volumes of the domestic hard coal oversupply or deficit for energy use in Poland, where:

- a) oversupply was defined as a situation where the supply (domestic or combined with imports) is higher than demand,
- b) deficit was defined as a situation where the supply (domestic or combined with imports) is lower than demand.

It is worth noting that despite the decline in the consumption of imported hard coal in the power sector, its consumption in Poland is still high. The standard for steam coal in international trade is grain size of 0-50 mm. Imported coal is used primarily by individual recipients. An important quality parameter that determines the maintenance of imports (mainly from eastern directions) is also low in sulphur. Such coal is mainly consumed in heating plants and combined heat and power plants.

In domestic mines, production is focused on obtaining guided fine coal assortments for large-scale energy. There is an insufficient amount of low-sulphur coal, so coal with such quality characteristic is still imported. As a result of the above, the supply variant taking into account the average net import is treated as the basic one in this analysis. However, considering that in order to achieve the goal of PEP2040 regarding the promotion of domestic resources, calculations were also performed for the option of meeting the demand for coal using only resources own, without imports.

In the W_KRAJ_IMP variant, i.e. domestic and imported coal, six scenarios of the supply-demand balance were prepared (Tab. 3). The names of the scenarios are the same as the names of the scenarios of supply and demand presented in the previous chapters. Abbreviations are also included in the list of abbreviations and symbols at the beginning of the study.

Similarly, six scenarios of the supply-demand balance were analysed for the W_KRAJ variant (domestic coal without imports) (Tab 4)

8 The base value was the average level of net imports from 2014-2020, which amounted to 6.2 million Mg.

TAB. 3. COMPARISON OF SCENARIOS IN THE DOMESTIC SUPPLY AND IMPORTS VARIANT (W_KRAJ_IMP)

Demand scenarios \ Supply scenarios	Supply	
	S_KON	S_POR
S_WYS	S_WYS_KON_KRAJ_IMP	S_WYS_POR_KRAJ_IMP
S_NIS	S_NIS_KON_KRAJ_IMP	S_NIS_POR_KRAJ_IMP
S_MIN	S_MIN_KON_KRAJ_IMP	S_MIN_POR_KRAJ_IMP

TAB. 4. COMPARISON OF SCENARIOS IN THE DOMESTIC SUPPLY AND NO IMPORTS VARIANT (W_KRAJ)

Demand scenarios \ Supply scenarios	Supply	
	S_KON	S_POR
S_WYS	S_WYS_KON_KRAJ	S_WYS_POR_KRAJ
S_NIS	S_NIS_KON_KRAJ	S_NIS_POR_KRAJ
S_MIN	S_MIN_KON_KRAJ	S_MIN_POR_KRAJ

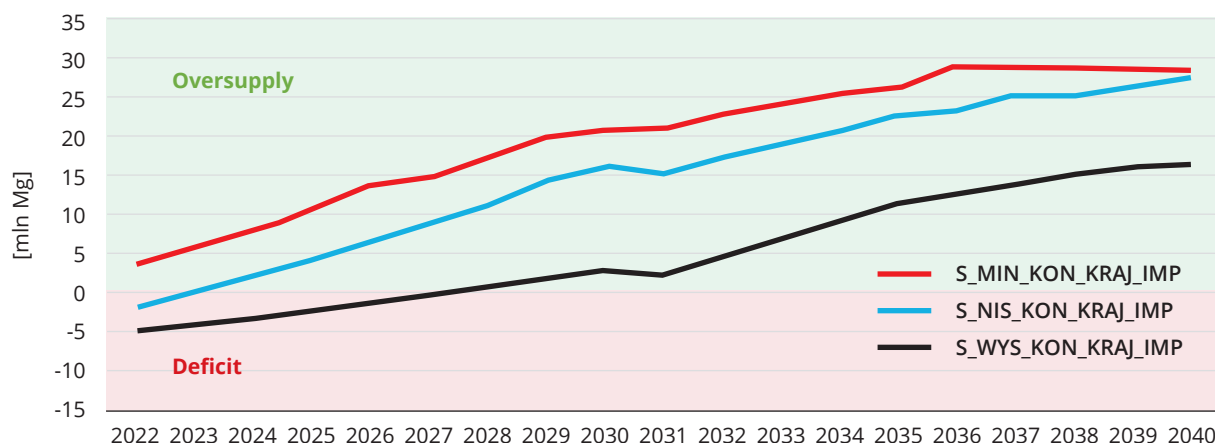
4.1. The variant with domestic supply and imports

Results of the calculations for the variant with domestic supply and imports (W_KRAJ_IMP) are presented in Fig. 19 and Fig. 20. For the scenarios in which production was assumed in accordance with the applicable concessions (Fig. 129), there risk of steam coal deficits in Poland is low. At the same time, an oversupply of coal appears in each of the analysed scenarios.

In the case of the scenario assuming high demand (S_WYS_KON_KRAJ_IMP) oversupply appears in 2028. For the remaining scenarios, oversupply starts as early as 2025 and amounts to: 4.3 million Mg (S_NIS_KON_KRAJ_IMP) and 10 million Mg (S_MIN_KON_KRAJ_IMP). In the following years (2026-30) annual oversupply is on average about 1 million Mg (S_WYS_KON_KRAJ_IMP), over 11 million Mg (S_NIS_KON_KRAJ_IMP) and 17 million Mg (S_MIN_KON_KRAJ_IMP). A rapid increase in oversupply is observed between 2031 and 2040.

In the back-end of the analysis, annual oversupply of almost 17 million Mg is observed in S_WYS_KON_KRAJ_IMP and for scenarios with respectively lower demand it amounts to 27.5 million Mg S_NIS_KON_KRAJ_IMP) and 28 million Mg (S_MIN_KON_KRAJ_IMP).

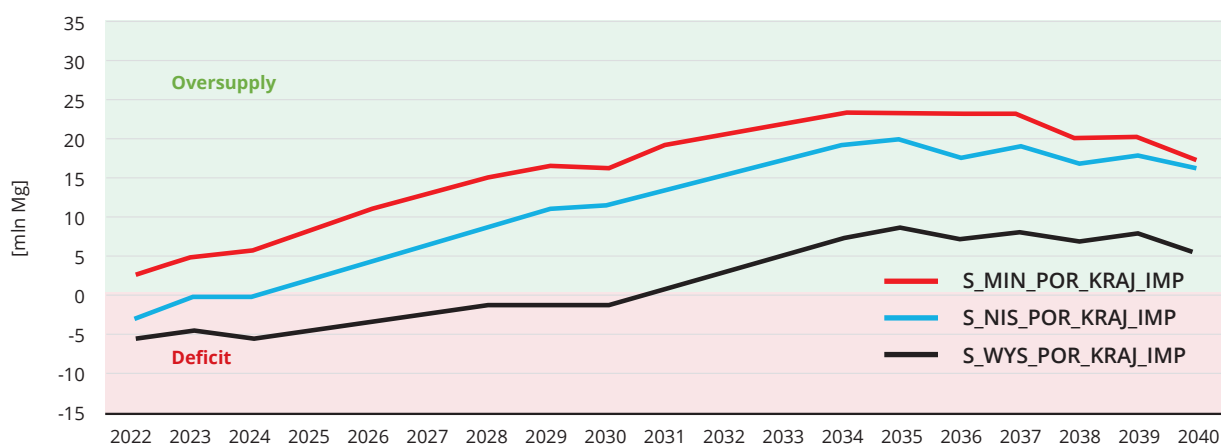
FIG 19. SUPPLY-DEMAND BALANCES FOR THE VARIANT WITH DOMESTIC SUPPLY AND IMPORTS (W_KRAJ_IMP)



Under the assumption of deposits exploitation according to the Agreement, oversupply also occurs in all analysed scenarios (Fig 20). This situation is observed from the beginning of the analysis period in S_MIN_POR_KRAJ_IMP. In the remaining scenarios, oversupply is observed in 2025 (S_NIS_POR_KRAJ_IMP) and in 2031 r. (S_WYS_POR_KRAJ_IMP).

A rapid uptake in oversupply is observed in all scenarios between 2031-35. In the entire analysis period (2022-40) the average oversupply volumes are: 1.6 million Mg / year (S_WYS_POR_KRAJ_IMP), 11.4 million Mg/year (S_NIS_POR_KRAJ_IMP) and 16.2 million Mg / year (S_MIN_POR_KRAJ_IMP).

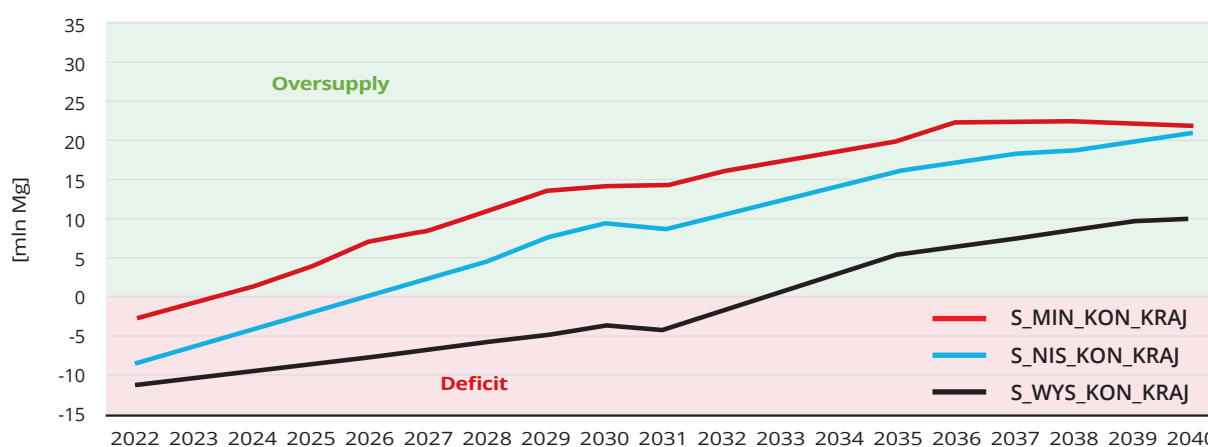
FIG. 20. SUPPLY-DEMAND BALANCES IN THE DOMESTIC SUPPLY AND IMPORTS VARIANT (W_KRAJ_IMP)



In summary, the W_KRAJ_IMP variant sees an oversupply from 2031 in every considered scenario. Depending on assumptions, in the 2040 horizon the oversupply ranges from a few to almost 30 million Mg per year. It is only in the case of high demand that consumption and supply are balanced in her first decade.

In S_WYS_KON_KRAJ_IMP and S_WYS_POR_KRAJ_IMP in the period of 2022–30 a small deficit is observed (respectively 1.2 million Mr/year and 3.3 million Mg/year on average).

FIG. 21. SUPPLY-DEMAND BALANCES IN THE DOMESTIC SUPPLY AND NO IMPORTS VARIANT (W_KRAJ)



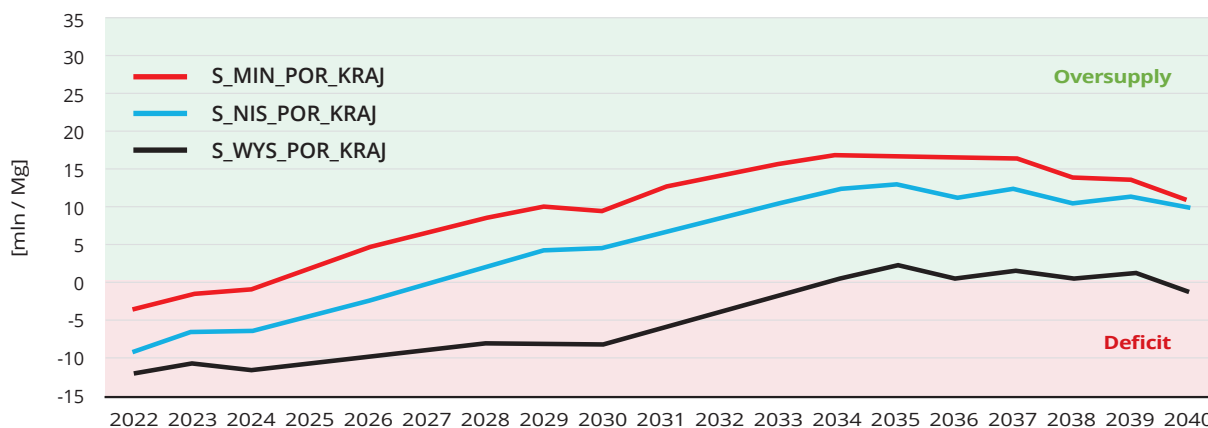
4.2. The variant with domestic supply without imports

Calculations for the variant with domestic supply (W_KRAJ) are shown in Fig 21 and Fig 22.

In all scenarios, the assessment of the availability of thermal coal in the domestic supply variant and in the case of production in accordance with the valid concessions (Fig. 21) indicates the possibility of a deficit in the initial years of the analysis.

In S_MIN_KON_KRAJ and S_NIS_KON_KRAJ oversupply in 2030 is respectively 14.4 and 9.7 million Mg, while in S_WYS_KON_KRAJ the deficit amounts to 3.3 million Mg.

Oversupply in this scenario is observed only from 2033 and gradually increases, averaging 6.7 million Mg per year in 2033–40. In S_MIN_KON_KRAJ and S_NIS_KON_KRAJ, for which a high level of oversupply is observed as early as 2030, the oversupply grows further from 2031. Between 2031–40 average annual oversupply is 20.1 million Mg (S_MIN_KON_KRAJ) and 16.1 million Mg (S_NIS_KON_KRAJ).

**FIG. 22. SUPPLY-DEMAND BALANCES IN THE DOMESTIC SUPPLY
AND NO IMPORTS VARIANT (W_KRAJ)**

Under the assumption of deposit exploitation as per the Agreement, the initial years see a deficit of the raw material (Fig 22). This persists respectively until 2024 (S_MIN_POR_KRAJ), until 2027 in S_NIS_POR_KRAJ and until 2033 in S_WYS_POR_KRAJ.

In S_MIN_POR_KRAJ and S_NIS_POR_KRAJ, after 2027 a gradual increase in annual oversupply is observed. At its peak (in 2035) oversupply reaches respectively 17.3 and 13.6 million Mg. In S_WYS_POR_KRAJ, the oversupply occurring in the second decade of the analysed period does not exceed 3 million Mg/year.

To sum up, the sole use of domestic coal results in a deficit in all scenarios in the beginning years of the analysis. In scenarios considering high demand, the deficit persists until 2032 (S_WYS_KON_KRAJ) and 2033 (S_WYS_POR_KRAJ). In the remaining scenarios, oversupply is observed from:

- 2024 in S_MIN_KON_KRAJ,
- 2025 in S_MIN_POR_KRAJ,
- 2026 in S_NIS_KON_KRAJ,
- 2027 in S_NIS_POR_KRAJ.

4.3. Summary

The conducted analysis confirms that for the adopted assumptions regarding the demand for coal for energy purposes and its supply from domestic mines and imports, long-term oversupply of this raw material occurs in every variant and scenario, and in most of them it is noticeable already in the initial years of the analysis. For the scenarios in the variant of the total supply of domestic and imported coal (W_KRAJ_IMP), where the average import volume is assumed to be maintained, in most of the scenarios considered, the oversupply reaches the value of 2 to 10 million tonnes per year as early as 2025. In 2035, oversupply occurs in all scenarios and amounts to an average of 19 million tonnes annually.

It should be emphasized that in the scenarios assuming no import, there is also an oversupply of the raw material, but only in the later years of the analysis. The average value of oversupply in the domestic supply variant (W_KRA J) is 4.8 million tonnes (in 2030) and 12.6 million tonnes (in 2035), respectively. As a consequence, it is required to take appropriate measures aimed at adjusting the supply and production plans of coal companies to the forecasted demand.

Taking into account the above calculations, it will be necessary to adjust the extraction volume to the forecasted demand and to revise the adopted dates of decommissioning of mines. The results of the analysis indicate that in the case of mining in accordance with the signed Agreement, there is a surplus of raw material after 2033 - regardless of the adopted scenario of demand for coal and the level of imports. In 2035, the oversupply may range from 2.6 to 23.5 million tonnes per year.

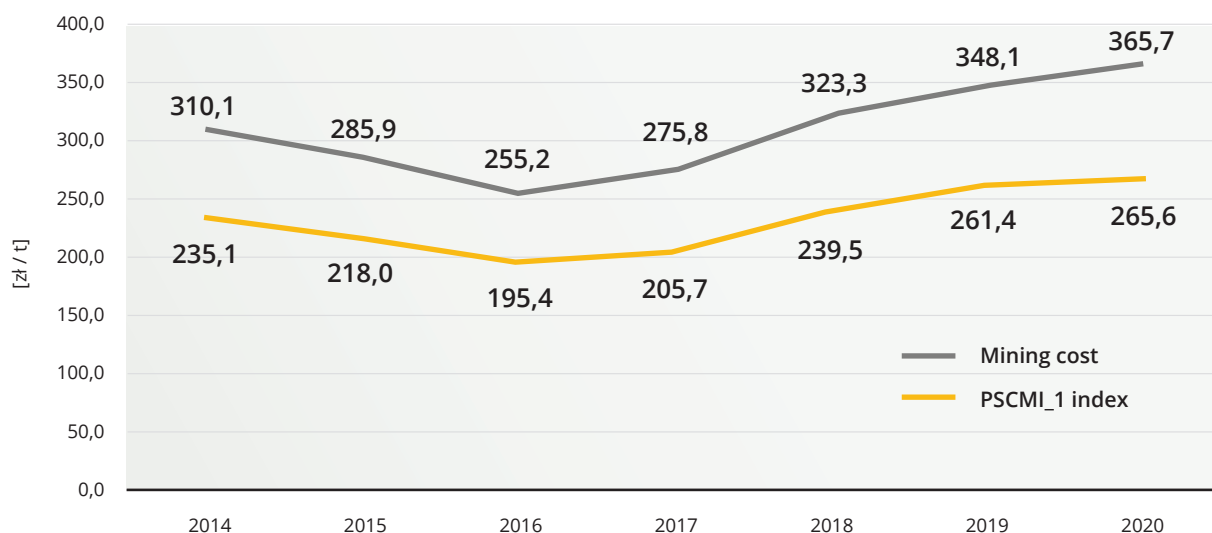


5. Analysis of domestic and imported coal prices to Poland

An appropriate indicator reflecting the price level of coal (ex-mine) sold to large-scale power and industrial power producers is the PMSCL_1 index. It reflects the prices of coal of the 20-23/1 class⁹ [26]. In the years 2014-2020, the average annual selling price of 1 Mg of thermal coal in Poland remained below the average total coal production cost¹⁰, accounting for approximately 73-77% of this cost on average.

At the same time, the PSCMI_1 index showed trends consistent with the cost of production, and both variables were characterised by a high degree of correlation (Pearson's coefficient of 99.3%). The above dependencies are presented in Fig. 23.

FIG. 23. THE PSCMI_1 INDEX AND AVERAGE HARD COAL MINING COST IN POLAND
BASED ON: [25], [27]



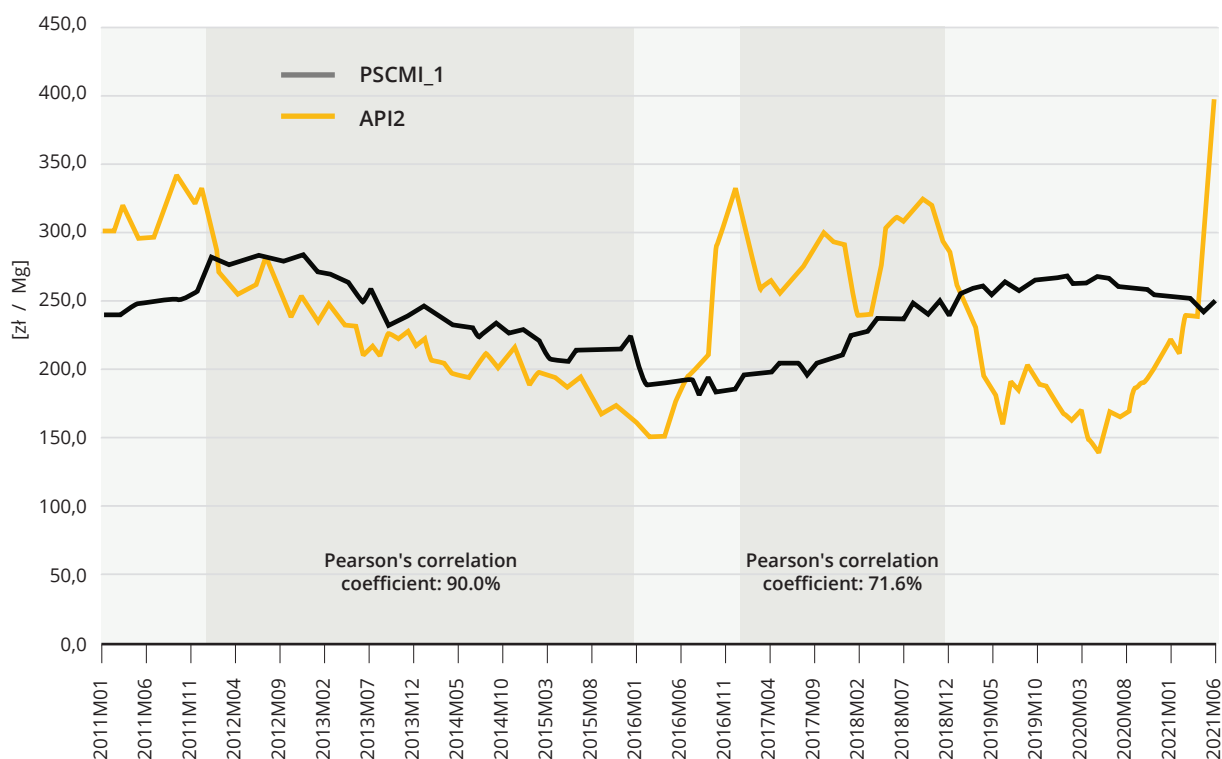
The determinant of hard coal prices on the European market is the API 2 index (CIF ARA) showing the prices in the CIF formula (Cost, Insurance and Freight) in ARA ports. The analysis of the monthly PSCMI_1 values for domestic steam coal and the API2 index [28] showing the prices of imported hard coal (API2 index converted to Polish conditions¹¹) shows that historically there have been periods of high positive correlation between the prices of domestic coal and coal imported to Poland from global markets (Fig. 24).

It should be mentioned that in the third quarter of 2021, the price of coal on the European market increased dramatically, reaching previously unlisted values. However, based on the analysis of similar events in the previous decades, it is expected that the upward trend observed in June 2021 (Fig. 24) is of a temporary nature.

⁹ <https://polskirynekwegla.pl/o-indeksie>

¹⁰ Due to the lack of data enabling differentiation, the cost of production relates to steam coal and coking coal together.

¹¹ API2 index calculated for the calorific value of the PSCMI_1 index

FIG. 24. HISTORICAL VALUES OF THE PSCMI_1 AND API_2 INDICES
BASED ON: [27], [29]

The above observations were used to construct a proprietary forecast of hard coal prices in Poland in the medium-term (until 2025) and long-term (2025-40) horizon, in accordance with the following methodology:

- in the medium term, i.e. in the horizon of 2025, it was assumed that the prices of hard coal in Poland will reflect the main trends observed in Fig. 23 - i.e. the main price factor will be production costs, which will follow the upward trend observed from 2016,
- in the long term, i.e. from 2025 to 2040, it was assumed that the prices of hard coal in Poland would show a high convergence with the development trends of steam coal prices on global markets (based on the observations presented in Fig. 24).

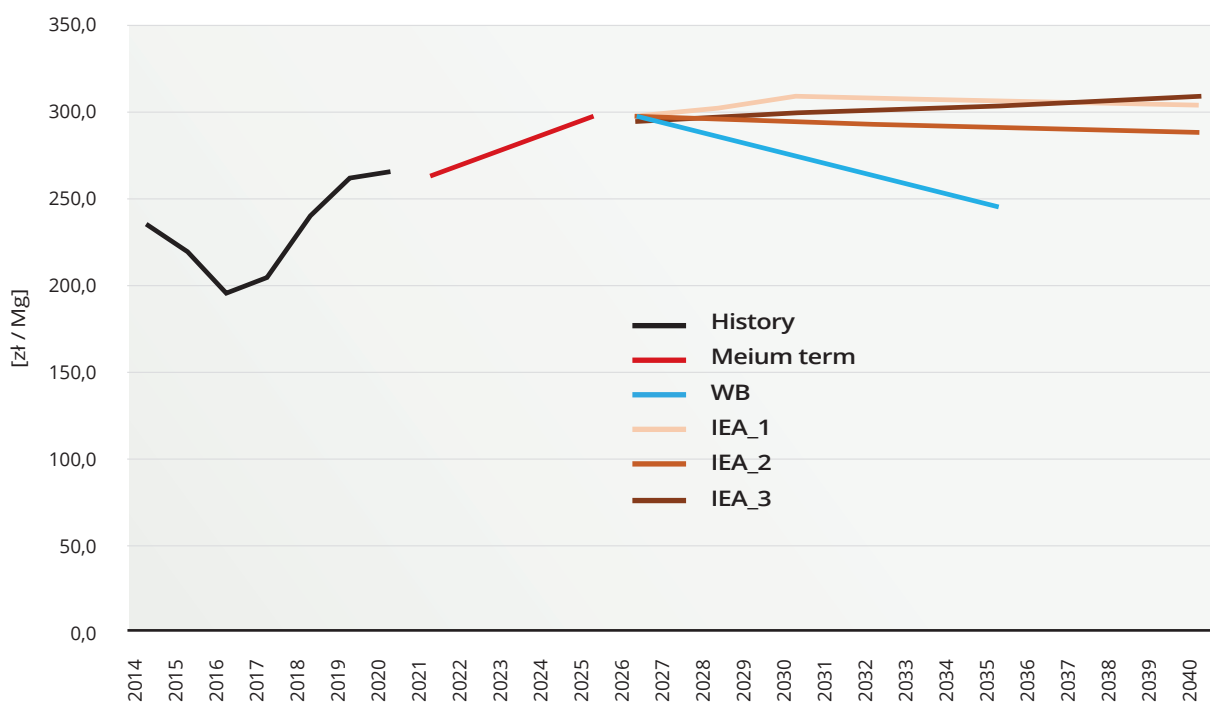
The forecast of hard coal prices in Poland in the long term was made on the basis of the latest available forecasts of hard coal prices in the world markets published by the World Bank (WB) [30] and the International Energy Agency (IEA) [31]. A summary of the WB and IEA forecasts for hard coal prices in the global markets is presented in Table 5.

**TAB. 5. STEAM COAL PRICE FORECASTS IN GLOBAL MARKETS
AS PER THE WB AND THE IEA**
BASED ON: [30], [31]

Forecast	Unit	2025	2030	2035	2040
WB (World Bank) ¹²	[USD/t]	73,5	66,5	60,4	-
IEA_1 (Stated Policies scenario)	[USD/t]	66,0	71,0	70,0	69,0
IEA_2 (Sustainable Development scenario)	[USD/t]	57,0	-	-	55,0
IEA_3 (Delayed Recovery scenario)	[USD/t]	60,0	-	-	64,0

Based on the previously presented methodology and forecasts for coal prices on global markets, a proprietary forecast of the PSCMI_1 index in the medium and long term was prepared. The long-term forecast of hard coal prices in Poland was prepared in four variants (Fig. 25).

FIG. 25. HISTORICAL AND FORECAST VALUES OF THE PSCMI_1 INDEX



Two of the four presented forecasts (WB, IEA_2) indicate the possibility of long-term downward trends in coal prices already after 2025. The above is in line with the scenarios of S_MIN_KON_KRAJ, S_NIS_KON_KRAJ as well as S_MIN_POR_KRAJ and S_NIS_POR_KRAJ, according to which oversupply of steam coal in Poland occurs in the years 2024-27 and grows steadily until 2040.

In the third projected case (MAE_1), coal price increases in Poland may continue beyond the average period (i.e. in the years 2025-30), after which a long-term downward trend is expected from 2030. The above aligns with the S_WYS_KON_KRAJ and S_WYS_POR_KRAJ scenarios in which the occurrence of an oversupply of steam coal from 2033 and 2034 respectively was estimated.

In the case of the presented forecasts of oversupply in the total supply variant (i.e. taking into account the volumes of imported coal), it can be expected that the forecast of downward trends in domestic coal prices may occur faster due to the greater forecasted scale of the oversupply of the raw material.



Summary and conclusions

The accelerating implementation of the European Union's climate and energy policy confirms that the prospect of decarbonisation by reducing coal consumption is inevitable. The role of Poland is to effectively plan the path of departure from coal and the ability to reconcile use of domestic resources with effective reduction of emissions.

The report includes a scenario analysis of the hard coal supply and demand balance in Poland until 2040. Key assumptions in compiling coal balances for energy purposes concerned:

- domestic supply of steam coal, determined on the basis of current concessions (S_KON supply scenario) and the provisions of the social agreement between the Polish government and the mining industry (S_POR supply scenario) (chapter 1),
- coal imports, assumed on the basis of historical values (chapter 2),
- the demand for coal, determined on the basis of the PEP2040 document and other publicly available documents and reports (chapter 3).

Twelve scenarios of the supply-demand balance were developed, including six scenarios in the variant of the total supply (also taking into account the import of coal) and six scenarios in the variant of the domestic supply (excluding imports). The results of the analysis show that the coal oversupply occurs in each of the analysed scenarios. In the case of the total supply variant (i.e. taking into account imports), in four out of six analysed scenarios, the oversupply of coal occurs from 2025 (except for the scenarios taking into account the high demand for coal, where the oversupply occurs after 2027 and 2030). In the case of the domestic supply variant (excluding imports), in three out of six analysed scenarios, oversupply occurs after 2025; in one case, an oversupply occurs from 2027, and in two cases after 2032. The results of the calculations also show that only in the case of „high demand” and no imports, a long-term deficit of domestic coal may persist in the coming years.

Despite the goal included in the Polish Energy Policy until 2040 to promote domestic resources, it can be expected that the import of steam coal will continue. It is influenced both by lower prices of imported coal compared to domestic coal prices and the continuing demand for coal with qualitative parameters and grain size favourable for selected consumer groups.

The results of the volumetric analysis of coal supply and demand balances in Poland indicate that in order to ensure an effective path of departure from coal, it will be necessary to adjust the level of coal production to the domestic demand by limiting production or revising the adopted dates of mine closures. In this context, the demand for coal from the power industry, heating industry and individual customers will be of key importance.

The report also includes forecasts of steam coal prices on the European market. Assuming that price changes in Poland in the long run will follow price changes in world markets, these forecasts indicate the possibility of a long-term downward trend in coal prices after 2025. The current price situation on European fuel markets, with record coal and natural gas prices, is not expected to significantly affect the long-term trend in the price of steam coal. If the forecasts of domestic coal oversupply materialise, it can be expected that downward trends in domestic coal prices may occur earlier, due to the growing oversupply of the raw material.

Due to the high fixed costs of domestic coal mining, the forecast scale of oversupply will negatively affect the gap between the price of coal and the costs of its production. In the event of a failure to adjust the extraction of mines to the domestic demand for coal, the problem of covering production costs with sales revenues will become more pronounced.



Literature

- [1] Komisja Europejska, „Komunikat Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego i Komitetu Regionów: Ambitniejszy cel klimatyczny Europy do 2030 r. Inwestowanie w przyszłość neutralną dla klimatu z korzyścią dla obywateli,” 2020. [Online]. <https://eur-lex.europa.eu/legal-content/PL/TXT/PDF/?uri=CELEX:52020DC0562&from=DA>. [Dostęp 29.09.2021].
- [2] Komisja Europejska, „Ocena wpływu Komunikatu Komisji do Parlamentu Europejskiego, Rady, Europejskiego Komitetu Ekonomiczno-Społecznego i Komitetu Regionów: Ambitniejszy cel klimatyczny Europy do 2030 r. Inwestowanie w przyszłość neutralną dla klimatu z korzyścią dla obywateli,” 2020. [Online]. https://ec.europa.eu/clima/sites/clima/files/eu-climate-action/docs/impact_en.pdf. [Dostęp 29.09.2021].
- [3] Komisja Europejska, „Propozycja nowelizacji Dyrektywy w sprawie propomowania stosowania energii ze źródeł odnawialnych,” 2021. [Online]. https://ec.europa.eu/info/sites/default/files/amendment-renewable-energy-directive-2030-climate-target-with-annexes_en.pdf. [Dostęp 29.09.2021].
- [4] Ministerstwo Klimatu i Środowiska, „Polityka Energetyczna Polski do 2040 roku,” 2021. [Online]. <https://www.dziennikustaw.gov.pl/M2021000026401.pdf>. [Dostęp 29.09.2021].
- [5] Dz. U. 2011 Nr 163 poz. 981 ze zm., „Ustawa z dnia 9 czerwca 2011 r. - Prawo geologiczne i górnicze,” 2020. [Online]. <http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20111630981/U/D20110981Lj.pdf>. [Dostęp 29.09.2021].
- [6] Dz.U. 2015 poz. 987, „Rozporządzenie Ministra Środowiska z dnia 1 lipca 2015 r. w sprawie dokumentacji geologicznej złoża kopaliny, z wyłączeniem złoża węglowodorów,” 2015. [Online]. <http://isap.sejm.gov.pl/isap.nsf/download.xsp/WDU20150000987/O/D20150987.pdf>. [Dostęp 29.09.2021].
- [7] M. Nieć and E. Salamon, „Zmiany zasobów złóż paliw kopalnych (kopalin energetycznych) w Polsce w ostatnim półwieczu,” Zesz. Nauk. Inst. Gospod. Surowcami Miner. i Energią PAN, no. 96, p. 201, 2016.
- [8] P. W. Saługa, E. J. Sobczyk, and J. Kicki, “Wykazywanie zasobów węgla kamiennego w Polsce zgodnie z JORC Code,” Gospod. Surowcami Miner. - Miner. Resour. Manag., vol. 31, no. 2, pp. 5–30, 2015.
- [9] J. Mucha, M. Nieć, P. W. Saługa, E. J. Sobczyk, and M. Wasilewski, „Ryzyko inwestycji w górnictwie węgla kamiennego jako funkcja dokładności oszacowań parametrów złożowych,” Gospod. Surowcami Miner. - Miner. Resour. Manag., vol. 2, no. 24, pp. 161–174, 208AD.
- [10] PIG-PIB, „Bilans zasobów złóż kopalin w Polsce wg stanu na 31 XII 2020,” 2021. [Online]. http://geoportal.pgi.gov.pl/css/surowce/images/2020/bilans_2020.pdf. [Dostęp 29.09.2021].

- [11] Otwarte Dane: Serwis RP, „Zestawienie złóż eksploatowanych na podstawie decyzji inwestycyjnej, w ramach fazy wydobywania koncesji na poszukiwanie i rozpoznawanie złóż węglowodorów oraz wydobywanie węglowodorów ze złóż (stan na dzień 30.07.2021 r.),” 2021. [Online]. <https://dane.gov.pl/pl/dataset/221/resource/31655,zestawienie-zoz-eksploatowanych-na-podstawie-decyzji-inwestycyjnej-w-ramach-fazy-wydobywania-koncesji-na-poszukiwanie-i-rozpoznawanie-zoz-weglowodorow-oraz-wydobywanie-weglowodorow-ze-zoz-stand-na-dzien-300>. [Dostęp 29.09.2021].
- [12] Agencja Rozwoju Przemysłu: Oddział Katowice, „Ceny zbytu i wielkość sprzedaży sortymentów grubych, średnich i drobnych oraz miałow do wybranych odbiorców krajowych w latach 2014-20.”
- [13] Ministerstwo Aktywów Państwowych, „Krajowy plan na rzecz energii i klimatu na lata 2021-2030: Założenia i cele oraz polityki i działania,” 2019. [Online]. <https://www.gov.pl/attachment/df8c4c37-808c-44ff-9278-676fb94add88>. [Dostęp 29.09.2021].
- [14] Ministerstwo Aktywów Państwowych, „Umowa Społeczna będąca wynikiem porozumienia Międzyzwiązkowego Komitetu Protestacyjno-Strajkowego oraz delegacji rządowej w sprawie zasad i tempa transformacji górnictwa z września 2020,” 2021. [Online]. <https://www.gov.pl/web/aktywa-panstwowe/umowa-spoeczna-dla-gornictwa-podpisana>. [Dostęp 29.09.2021].
- [15] Agencja Rozwoju Przemysłu: Oddział Katowice, „Import i przywóz (nabycie wewnętrzne) węgla kamiennego w latach 2014-20.”
- [16] Agencja Rozwoju Przemysłu: Oddział Katowice, „Podstawowe informacje o rynku oraz sektorze węgla kamiennego w Polsce w latach 2014-20.”
- [17] PolskiWegiel.pl, „Indeks cen węgla CIF ARA,” 2021. [Online]. <http://polski-wegiel.pl/indeksy-cen-wegla/>. [Dostęp 29.09.2021].
- [18] NIK, „Funkcjonowanie górnictwa węgla kamiennego w latach 2007-2015 na tle założeń programu rządowego,” 2016. [Online]. https://www.nik.gov.pl/kontrola/wyniki-kontroli-nik/pobierz,lka~p_15_074_201606210708251466492905~02,typ,kk.pdf.
- [19] WysokieNapięcie.pl, „Ogromna strata górnictwa, choć węgiel nie najdroższy w historii,” 2020. [Online]. <https://wysokienapiecie.pl/27457-ogromna-strata-gornictwa-choc-wegiel-mamy-naj-drozszy-w-historii/>. [Dostęp 29.09.2021].
- [20] Australia Minerals, „Presentation on coal market in New South Wales,” 2018. [Online]. http://mric.jogmec.go.jp/wp-content/uploads/2017/10/seminars2017_0929_03_en.pdf. [Dostęp 29.09.2021].
- [21] Minister Klimatu i Środowiska, „Sprawozdanie z wyników monitorowania bezpieczeństwa dostaw energii elektrycznej,” 2021. [Online]. <https://www.gov.pl/attachment/4b7aba2d-b8de-4a02-91c4-033c805b2f93>. [Dostęp 29.09.2021].
- [22] Forum Energii, „Czyste ciepło 2030: Strategia dla ciepłownictwa,” 2019. [Online]. https://forum-energii.eu/public/upload/articles/files/strategia_dla_cieplownictwa_pl_net.pdf. [Dostęp 29.09.2021].
- [23] GUS, „Zużycie paliw i nośników energii w 2019 roku,” 2020. [Online]. <https://stat.gov.pl/obszary-tematyczne/srodowisko-energia/energia/zuzycie-paliw-i-nosnikow-energii-w-2019-roku,6,14.html>. [Dostęp 29.09.2021].

- [24] Eurostat, „Supply, transformation and consumption of solid fossil fuels,” 2021. [Online]. https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_cb_sff&lang=en. [Dostęp 29.09.2021].
- [25] Agencja Rozwoju Przemysłu: Oddział Katowice, „Wyniki techniczno-ekonomiczne działalności oraz inwestycje w górnictwie węgla kamiennego w Polsce. Dane przetworzone na podstawie wyników badania statystycznego statystyki publicznej ‘Górnictwo węgla kamiennego i brunat
- [26] PolskiRynekWęgla.pl, „Polski Indeks Rynku Węgla Energetycznego,” 2021. [Online]. <https://polskiirynekwegla.pl/o-indeksie>. [Dostęp 29.09.2021].
- [27] PolskiRynekWęgla.pl, „Indeks PSCMI 1: Ceny miesięczne,” 2021. [Online]. <https://polskiirynekwegla.pl/indeks-pscmi-1-kolejna-publicacja-w-dniu-2-listopada-o-godzinie-1200>. [Dostęp 29.09.2021].
- [28] ArgusMedia.com, „Coal: API 2 price assessment,” 2021. [Online]. <https://www.argusmedia.com/en/methodology/key-prices/api-2-coal>. [Dostęp 29.09.2021].
- [29] Investing.com, „API2: ceny miesięczne,” 2021. [Online]. [https://www.investing.com/commodities/coal-\(api2\)-cif-ara-futures-historical-data](https://www.investing.com/commodities/coal-(api2)-cif-ara-futures-historical-data). [Dostęp 29.09.2021].
- [30] The World Bank, „Commodity Markets,” 2021. [Online]. <https://www.worldbank.org/en/research/commodity-markets>. [Dostęp 29.09.2021].
- [31] IAE, „World Energy Outlook 2020,” 2021. [Online]. <https://www.iea.org/reports/world-energy-outlook-2020>. [Dostęp 29.09.2021].

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