# Coal Industry Global Transformations: Analysis and Projections

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***Abstract* — The paper explores the current global trends in coal production, exports, imports, and consumption with focus on China, India, and Russia up to the year 2050. Russia's coal production in 2022 is shown to rise to 443.6 million tons due to an increase in domestic coal consumption, which made it possible to compensate for a slight decrease in coal exports. At the same time, the growth in domestic coal consumption was 6.1% compared to the level of 2021. Of this, 23% was utilized by the electric power industry, 10.4% for coking, 6.9% for residential, industrial and agricultural consumers, and the remaining 6.8% of coal supplies were delivered to other consumers within the domestic market. In 2023–2024, Russia may see a slight decrease in coal production and export volumes, which is associated with sanctions, a decline in demand of European consumers, and a reduction in the use of this type of fuel or refusal from it in some Asian countries. The possibility of reorienting Russian coal supplies from West to East is limited by the plans of the Asia-Pacific countries along with commissioning new coal capacities in the near future to actively develop wind farms and solar power plants and adopt national hydrogen strategies. These factors, in turn, may lead to a decrease in Russian coal production and exports by 2050. However, it is too early to talk about the end of the "era of coal," at least until 2030.**

***Index Terms* — coal mining, coal exports, coal imports, coal consumption, coal market, China, India, Russia.**

## I. Introduction

Currently, the situation with coal is ambiguous. On the one hand, the decarbonization of the economy, ensuring low-carbon development and carbon neutrality, contributes to the use of renewable energy in many countries of the world, which, in turn, displace gas and coal in the power industry structure.

The growth of climate requirements is a catalyst for current and future fundamental changes in the energy sector, including the coal industry. Discussions about the future of the coal industry are getting increasingly more intense in the world community. The plans of individual countries to reduce the use of this type of minerals and the emerging trend towards a decrease in investment in the coal industry suggest the inevitable end of the coal era.

However, on the other hand, there are good reasons to believe that we are witnessing a deep transformation rather than a "decline" in the coal industry.

Furthermore, the changes that occur in the coal industry under the influence of accelerated energy transition policies and the activation of the climate agenda are likely to both continue and intensify.

In this regard, let us consider current trends in the production, exports, imports and consumption of coal in the major countries of the world, including Russia.

## II. Modern Global Trends in Coal Production

In 2021, according to the IEA [1, 2], the global coal production amounted to 7.7 billion tons with

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approximately 60% being mined in China and India. It is worth noting that both countries are actively expanding the production of natural gas and renewable energy sources (RES) [3].

China accounts for 48.7% of the world's coal production, with India following at 10.7%, Indonesia at 7.4%, Australia at 6.0%, the USA at 6.8%, and Russia at 5.7%.

Currently, according to BP, 36% of the world's electricity is generated using coal as a fuel.

Coal-fired generation saw a remarkable surge between 2001 and 2021: in China by 4.7 times, in India by 3 times, in Indonesia by 5 times, and in Vietnam by 35 times. However, in Europe, it has reduced by half over the past 10 years. Newly commissioned generating capacities in Asian countries (Thailand, Malaysia, and others) are also mainly based on coal. In Russia, the share of coal in the structure of electricity generation is currently about 18% [4].

In 2022, according to preliminary data, coal production increased compared to the previous year: to 862 million tons in India, to 4.5 billion tons in China, and to 546 million tons in the EU countries. This surge marks the highest global coal production since 1982. Coal experienced a renaissance.

In Russia, coal production in 2022 increased to 443.6 million tons due to a rise in domestic coal consumption, which made it possible to compensate for a slight decrease in coal exports [5, 6]. About 5.0 million tons of coal in 2022 was mined in the Donbass (in 2021 – 7.5 million tons).

In recent years, a steady trend in the spatial development of the coal industry has emerged in Russia: the production of thermal coal has shifted away from the European and some eastern regions of the country, becoming increasingly more concentrated in the Kuznetsk basin. Coking coals are now moving towards the eastern borders of Russia, approaching the Asian markets.

In 2022, domestic coal consumption in Russia increased by 6.1% and reached 261.5 million tons, compared to 2021. At the same time, the electric power industry accounted for 23% of coal consumption, followed by coking with 10.4%. The remaining coal supply to the domestic market was allocated as follows: 6.9% for the needs of the population, utility and agro-industrial complex, and 6.8% for the other consumers in the domestic market.

Projections suggested that global coal production might surpass 8.3 billion tons, including about 4.9 billion tons in China, and about 950 million tons in India.

In 2023-2024, Russia may see some decrease in coal production, which is associated with the embargo and other factors.

The question arises: what is the situation with coal exports?

## III. Coal Exports from the Major Countries of the World

In 2021, the total coal exports from the major countries of the world reached 1.3 billion tons. The shares of the main coal exporting countries at the end of 2021were as follows: Indonesia at 33.2%, Australia at 27.7%, Russia at 16.4% (3rd globally), the USA at 5.9%, South Africa at 4.8%, Colombia at 3.7%, Canada at 2.4%, Kazakhstan at 1.8%, and Mongolia at 0.9%. In 2021, according to coal companies, Russia exported 215 million tons of coal.

Indonesia maintained its leading position in 2022, shipping 494 million tons of coal for export.

On August 10, 2022, an embargo went into effect as part of the EU countries and the UK's 5th package of sanctions. This embargo restricts the purchase, import, or transit transportation of coal from Russia. Additionally, it prohibits the provision of services related to coal, including shipping insurance. As a result:

– Deliveries of Russian coal to the EU countries stopped (their volume amounted to more than 22% of all fuel exports), which, according to the Ember center, increased coal supplies from Kazakhstan (where, Russian coal is delivered according to parallel export schemes), as well as Indonesia, Colombia, and South Africa [7].

– Supplies of Russian coal to Japan, South Korea, Great Britain, and other countries reduced or completely halted.

Against this background, in 2022, the Russian coal exports, according to coal companies, decreased by 6.2%, i.e., to 201.7 million tons. Nevertheless, Russian coal exporters managed to maintain or increase their market share in areas where sanctions do not apply, in particular, in China, India, Turkey, and Malaysia.

Thus, in 2022, the volume of Russia's coal exports to China increased to 45.3 million tons (+65.7% by 2021), to Turkey to 24.5 million tons (+64.5% by 2021), and to India to 13.6 million tons (2.7 times higher than in 2021). At the same time, deliveries of Russian coal to Japan fell by 46.3%, to 13.9 million tons, and deliveries to Germany decreased by 66.3%, to 1.3 million tons.

Due to the sanctions, Russian companies became heavily dependent on their coal supplies to China, and had to sell their coal at a significant discount in 2022.

China offers Russia to build a cross-border railway corridor from Kuzbass Tashtagol to Urumqi (People's Republic of China (PRC)) on a concession basis, after which the export of Russian coal to China may increase.

However, it is important to take into account two points: firstly, the primary coal suppliers to the PRC are and, most likely, will continue to be: Indonesia, Mongolia, and Australia; and secondly, China is actively developing renewable energy sources and other alternative energy sources. Therefore, our projections suggest that China will increase the volume of coal exports until 2030 at the most.

In 2022, commercial production of coking coal began at the Syradasai coal deposit in Taimyr and its delivery to the PRC (100 thousand tons). In addition, it is possible to supply coal from the Syradasai deposit to Turkey and the countries of North Africa.

In general, in 2023, the Ministry of Energy of Russia predicted the stabilization of the Russian coal export [8] and the growth of Russian coal supply to the East.

However, it is worth noting that there may be a decrease in coal exports due to the Special Military Operation. At the same time, the delivery of coal from Siberia to Asia through the ports of the South and North-West is already reaching the threshold of profitability. The primary issue lies in the escalating costs of coal transportation to Asian markets, in particular, the expenses related to chartering ships and acquiring insurance services. There is a significant dependence on the imported foreign mining equipment and the depreciation of existing equipment.

In addition, the possibility of reorienting Russian coal supply from West to East is also limited by the fact that the Asia-Pacific countries, in addition to commissioning new coal capacities in the near future, are planning to actively develop wind and solar power plants, and are implementing national hydrogen strategies. Factors that may pose risks to suppliers of Russian coal for export include:

– the instability of world prices for primary energy resources and their dependence on both economic and political factors;

– the aggravation of competition among energy sources in the world market;

– the transition to a carbon-free economy and the prospect of introducing a "carbon" tax, leading to a decrease in the share of electricity generated from coal;

– the transition of the world economy to energy-saving technologies and the gradual displacement of coal from the energy balance, etc.

According to the IEA, the reduction in thermal coal exports from Russia will continue, and by 2025 the drop may be 4.3% compared to 2022 (up to 150 million tons).

## IV. Current Trends and Structure of Coal Imports

The main coal importing countries in 2021 were: China – 332 million tons (24.2% of the global volume of imported coal), India – 199 million tons (14.5%), Japan – 173 million tons (12 .7%), South Korea – 89.7 million tons (5%), Taiwan – 69.8 million tons (5.1%), Vietnam – 43.9 million tons (3.2%), Germany – 38.4 million tons 2.8%), and Russia – 20.7 million tons (1.6%).

In 2022, the Russian Federation imported 19.7 million tons of coal, of which almost all (more than 99%) was supplied from Kazakhstan.

It is possible to substitute Kazakh thermal coal with Russian Kuznetsk coal through the modernization of the equipment of Russian power plants (primarily in the Urals).

In January-May 2023, coal supply from Kazakhstan to Russia decreased by 16%. In turn, Kazakhstan increased coal exports to Europe, Turkey, and the countries of Central Asia [9].

In 2022, China imported about 290 million tons of coal, of which the share of Russian coal delivered to China was only 15.6%.

India is another major coal importer, and Russia has high hopes for supplying its coal to the Indian market.

Although Russia managed to increase coal imports to India by 2.7 times in 2022 compared to the level of 2021 (up to 13.6 million tons), the share of Russian coal supplied to this country still remains insignificant. Furthermore, it is important to consider the following:

1) The main coal exporter to India is Australia;

2) In order to ensure India's energy security, the country's leadership intends to halt coal imports by the 2024-2025 financial year, commencing in April 2024, and increase domestic production;

3) Despite the projected increase in the demand for coal in the domestic market of India to 1.5 billion tons by 2030,

the country has adopted the program "Self-sufficient India," aiming to build new mines in the country and enhance coal production at existing domestic coal enterprises to meet the growing needs.

This situation will greatly complicate the supply of Russian coal to China and India, which are currently the primary importers of Russian coal.

## V. Current Trends in Global Coal Consumption

Coal consumption worldwide reached approximately 8 billion tons in 2021.

China ranks first (53%), followed by India in a second place with 13.7%; the USA comes in third with 6.2%; Russia holds the fourth position (3.1%) and Japan ranks fifths with 2.2%. South Africa and Germany both have a share of 2.1% ranking sixths and sevenths respectively. Indonesia rounds off the rankings in the eighths place with a share of 1.8%.

China and India currently account for about 67% of all coal consumed globally. In subsequent years, this figure may exceed 70%.

Nevertheless, it is worth noting that China has recently announced their commitment to achieve carbon neutrality by 2060 [9], while India aims to achieve the same goal by 2050 [10, 11]. Russia has set a target of achieving carbon neutrality by 2060.

In 2021, there was a 6% increase in coal consumption in the world compared to the level of 2020, which is associated with the recovery of the world economy from the coronavirus pandemic and the collective determination to reduce reliance on gas imports from Russia.

In 2022, global coal demand witnessed a significant surge, according to the IEA, surpassing 8.3 billion tons. This growth was observed not only in the EU and India, with an 8% increase compared to 2021, but also in China, where the demand rose by 7%, in Indonesia by 36%, and in Finland by 10%.

In contrast, coal consumption in the US decreased by 7% reaching 457 million tons. In addition, coal consumption in Vietnam decreased by 4.2% [11].

In September 2022, China initiated the construction of an additional 165 GW coal-fired generating capacity, planning to increase this figure to 270 GW by 2025.

The increase in coal consumption in China was mainly due to a growth in demand for coal for non-energy purposes, i.e., the production of GTL, plastics, and fertilizers.

New generation capacities in other Asian countries (Thailand, Malaysia, and Vietnam) are also mainly based on coal.

Russia ranks 4th in terms of coal consumption (with a share of 3.1% in 2021). Compared to 2000, the volume of coal consumption in Russia remained practically unchanged, however, the share decreased from 5.3 to 3.1% [4].

The volume of coal consumption in Japan, which ranks 5th in the world, increased by approximately 20 million tons in 2021 against 2000, while its share compared to all countries decreased from 3.3 to 2.2%.

It is important to note that South Africa is going to completely abandon coal and switch to renewable energy sources [12].

In 2023, according to the IEA, coal consumption worldwide was expected to slightly surpass 8.3 billion tons, the level of 2022, although in the first half of 2023 there was a 1.5% increase compared to the same period in 2022.

An increase in coal consumption in 2023 was expected primarily in India (by 6.8%, to 1.1 billion tons) and in the EU countries (by 5.7%, to 685 million tons). This surge was a result of the temporary shift back to coal due to soaring natural gas prices, decreased hydropower generation, and the closure of nuclear power plants.

In 2024, the global coal consumption may reach approximately 8.4 billion tons, according to the IEA projections.

## VI. Coal Consumption Projections

In the context of the emerging innovation and technological landscape, driven by the implementation of the Industry 4.0 program, we have developed a model enabling projections of coal consumption both on a global scale and in individual countries.

The coal consumption projections made using this model factor in changes in the coal consumption in the energy sector and metallurgy; world coal reserves; spatial development of coal mining in certain countries of the world; prices of coal, oil and gas; coal intensity of GDP; and other macroeconomic indicators [13–15].

The projections relied on three options for the development of the world economy:

Option I – low rates of decarbonization of the world

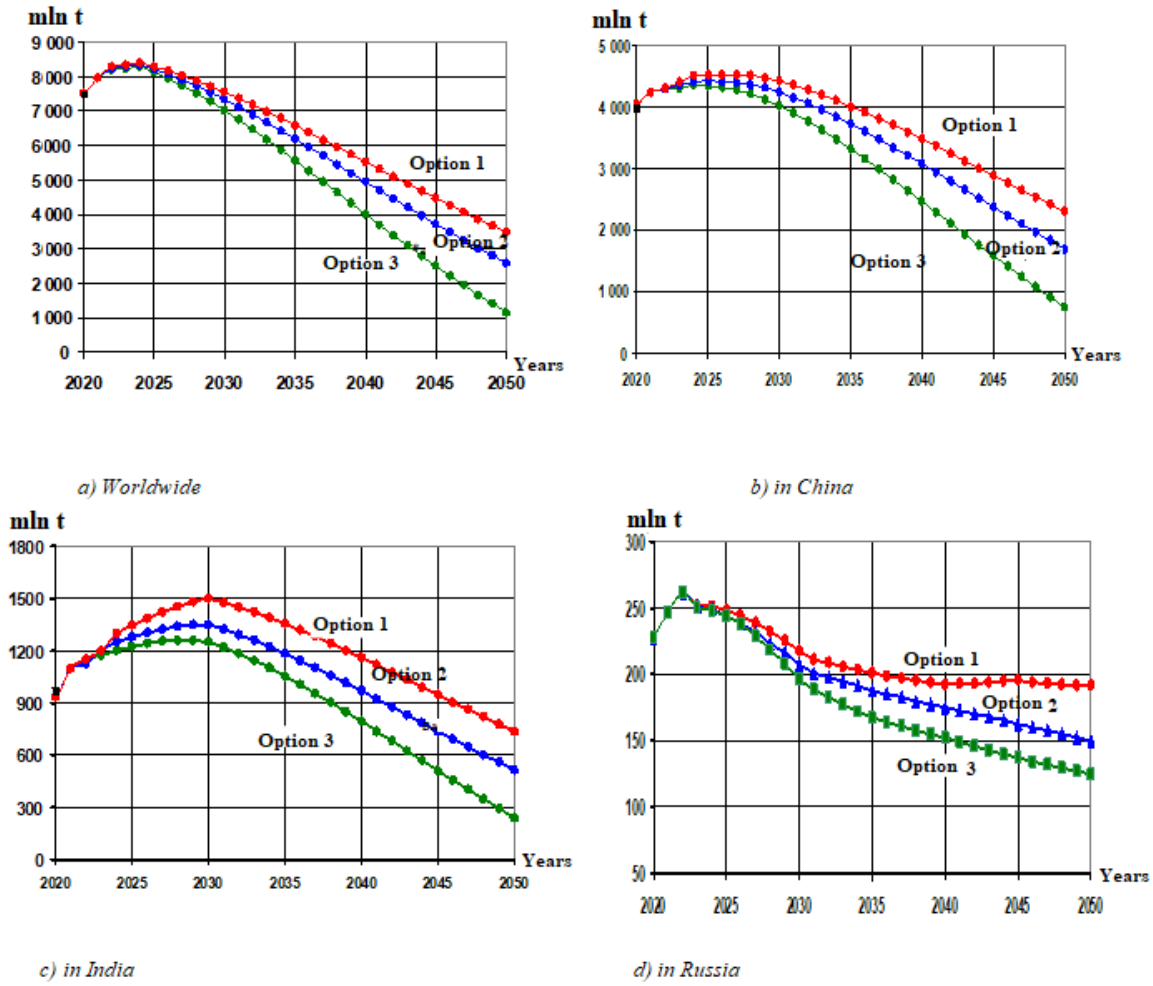


***Fig. 1. Projections of coal consumption worldwide and in major countries until 2050.***

economy, assuming decarbonization ends before the 1970s, and there is no embargo on Russian coal supply to the EU countries;

Option II – moderate rates of decarbonization of the world economy, assuming decarbonization ends before the 2060s and there is partial enforcement of the embargo on Russian coal supply to the EU countries;

Option III – high rates of decarbonization of the world economy, assuming decarbonization ends before the 2050s and there is strict enforcement of the embargo on Russian coal supply to the EU countries.

The projections of coal consumption in the major countries of the world and Russia, following the accepted options, are shown in Fig. 1.

Projections of the Russian coal production and exports according to the three scenarios are shown in Fig. 2.

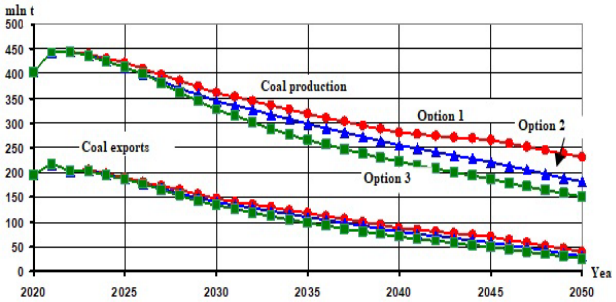


***Fig. 2. Projections of Russian coal production and exports until 2050.***

## VII. Conclusion

The global coal industry has experienced rapid growth in recent years. However, with the global push for decarbonization of the economy and the pursuit of carbon

neutrality by most countries of the world, a shift from the use of coal in energy and other industries has begun. This shift is expected to curb the growth rate of coal consumption in the future. The speed of this decline will depend on the scenarios for the development of the world economy: under favorable scenarios, the world anticipates a rapid abandonment of coal, whereas under unfavorable scenarios, the trend is expected to be the opposite. The reduction in global coal trade is likely to happen much faster, as it will be more economically profitable for importing countries to switch to the use of renewable energy sources and hydrogen.

The sanctions, restrictions, and embargo imposed on Russian coal will result in a decline in the production of Russian coal. This is due to the decreased demand from European consumers and reduced or discontinued imports by some Asian countries. Furthermore, some coal companies are currently facing the threat of bankruptcy.

A decrease in the volume of the Russian export coal market may result in the reduction in a large number of coal mining enterprises and personnel engaged in coal extraction and processing by the year 2050. Nevertheless, it is still too early to talk about the end of the "coal era," at least until 2030.

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**Liudmila S. Plakitkina**, Head of the Research Center for Coal Industry in Russia and in the World, Ph.D., Corresponding Member of the Russian Academy of Natural Sciences. The main interests are: systematic research to assess the development parameters of the Russian coal industry taking into account the development of its resource base and the achieved results of its work in domestic and global energy markets; analysis and forecasts of the development of the coal industry of the world, individual regions and countries of the world and Russia in the context of the implementation of low-carbon energy trends and strengthening of sanctions restrictions.