Coal

2024

Analysis and forecast to 2027

INTERNATIONAL ENERGY AGENCY

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Abstract

Coal is often considered a fuel of the past, but global consumption of it has doubled in the past three decades. At the height of lockdowns related to the Covid-19 pandemic in 2020, demand declined significantly. Yet the rebound from those lows, underpinned by high gas prices in the aftermath of Russia's full-scale invasion of Ukraine, has resulted in record global coal production, consumption, trade and coal-fired power generation in recent years.

Now, questions about the forecast loom. That period also saw a formidable expansion of renewable power capacity, which is now threatening coal's century-long supremacy in electricity generation. At the same time, accelerating demand for electricity around the world could give coal another boost.

Many competing factors are at play. How quickly will coal use decline in developed economies as they become more electrified? When will coal use peak in China, the world's largest producer and consumer? How will India fuel its economic growth? When will coal be replaced in the industrial sector? And what might different regional trajectories mean on a global level?

Using the latest data, *Coal 2024* presents recent trends and a three-year forecast for coal demand, supply and trade by grade and by region. It is essential reading for anyone interested in understanding global energy.

Acknowledgements, contributors and credits

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The individuals and organisations that contributed to this report are not responsible for any opinion or judgement it contains. Any error or omission is the sole responsibility of the IEA.

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Table of contents

Executive summary

Global coal demand is set to reach a new all-time high in 2024…

Global coal demand is expected to grow by 1% in 2024 to an all-time high of 8.77 billion tonnes (Bt). This represents a considerable slowdown in growth from previous years: global coal consumption rose by 7.7% in 2021 as it rebounded from the Covid shock the year before, by 4.7% in 2022 and by 2.4% in 2023. Although industrial consumption also increased over that period, the power sector has been the main driver of coal demand growth, with electricity generation from coal set to reach an all-time high of 10 700 terawatt-hours (TWh) in 2024.

At the regional level, coal demand in China is expected to grow by 1% in 2024 to reach 4.9 Bt, another record. India is poised to see demand growth of over 5% to 1.3 Bt, a level that only China has reached previously. In the European Union and the United States, coal demand continues to fall, but at a significantly slower pace. It is on track to decline by 12% and 5% respectively this year, compared with 23% and 17% in 2023.

… but demand could plateau through 2027, depending on China

After having grown by more than 1.2 billion tonnes since 2020, global coal demand is set to plateau in the next three years, reaching around 8.87 billion tonnes by 2027. Given the slow progress of deploying carbon capture, utilisation and storage (CCUS) technologies in the sector, carbon dioxide emissions from coal are not expected to decline in that period, based on today's policy settings and market trends. While coal demand in advanced economies continues to shrink, this decline is expected to be offset by growth in a few emerging and developing economies, such as India, Indonesia and Viet Nam, where the additional energy demand associated with economic growth is set to be met with a variety of sources, including coal. Despite increasing renewable electricity generation, India is expected to see the largest increase in coal use in the coming years, driven by consumption from the power sector and industry. Still, as has been the case for 25 years, China, which consumes 30% more coal than the rest of the world put together, will continue to define global trends.

Faster growth in electricity use in China is pushing up coal demand there

A third of all the coal consumed worldwide is burned in power plants in China, making the country's electricity sector the main driver of global coal markets. In 2024, China has maintained its focus on diversifying its power sources, continuing to build out nuclear plants and accelerating its massive expansion of solar PV and

wind capacity. The country's hydro sector also experienced a rebound after several years of underperformance. However, electricity demand in China is increasing strongly, growing at a faster rate on average than GDP since 2021. Two major drivers are underpinning power demand growth in China: the electrification of services previously provided by other fuels, such as mobility and industrial heat, and emerging industries such as data centres and AI.

Weather-driven fluctuations overshadow structural changes in the short term

In this report's forecast, the year-to-year changes in global coal demand through 2027 are relatively small, coming in at less than 50 million tonnes (Mt). In India, the country poised to see the largest increase in coal demand, it rises by just over 100 Mt through 2027. In the European Union, coal demand declines by 68 Mt in the same period. In China, analysis of potential variation in coal demand based on weather conditions and their impact on renewable generation indicates demand could be about 140 Mt higher or lower than the base case during the forecast period. This underscores that weather variations are increasingly defining short-term trends, even as structural changes take place at both the regional and global level. Given China's dominant role in world coal markets, weather variations there can be particularly impactful – both at the country level and the global level.

Coal demand is set to continue to shrink in most advanced economies through 2027

Coal demand in most advanced economies peaked a few years ago and is falling, although the trajectory can vary depending on the region or country. In Europe and North America, where coal use has dropped over the past decade, the rate of decline is now slowing. Demand for power from the electricity sector could further slow declines in these regions in the years ahead. Even so, by 2025, the coal consumed in the European Union and the United States combined will be less than half the amount used in India. The closure of the last coal power plant in the United Kingdom in September 2024 was an important symbolic moment for a country where coal had powered the industrial revolution.

Global coal production is also expected to flatten through 2027

In 2024, global coal production is expected to reach an all-time high, surpassing 9 Bt for the first time. The three largest producers – China, India and Indonesia – reached new records for output. China, which accounts for half of global production, is set to see output grow by 1% in 2024, despite declines in the first half of this year amid a safety campaign in Shanxi, the largest producing province. In India, the government is incentivising production from public companies, mainly Coal India, as well as captive and commercial producers. As a result, output is set to rise by over 7%. Indonesian producers, which benefited from strong domestic

coal demand and sustained demand from international markets, are expected to surpass 800 Mt for the first time.

Looking ahead, production in China is set to ease, given abundant stocks and a lack of substantial demand growth. By contrast, production in India is expected to continue to grow, spurred by robust coal demand and government policies to reduce imports. In Indonesia, despite continued strong domestic demand, production is poised to shrink due to weaker international markets for thermal coal. Overall, we expect annual global coal production of close to 9 Bt through 2027. Australia is set to become the fourth largest producer by 2027, surpassing the United States and Russia. Producers in Russia are struggling amid international sanctions, low profitability and infrastructure bottlenecks.

Trade volumes set to reach all-time high in 2024 before receding

International trade of coal by volume is expected to reach a new all-time high in 2024, at 1.55 Bt. All categories are on course to set new records in terms of both growth and overall volume, namely seaborne thermal coal, total thermal coal, seaborne metallurgical coal and total metallurgical coal. In China, despite abundant stocks and lukewarm demand, imports are expected to surpass 500 Mt in 2024. In India, strong demand has kept imports at similar levels as in 2023, despite the country's production push. Viet Nam has surpassed Chinese Taipei as the world's fifth largest importer. Looking ahead, in light of these trends, our models show trade volumes shrinking, with trade in thermal coal seeing the biggest decline. That said, Chinese imports have repeatedly come in higher than expected in recent years.

Reshuffle of trade flows continues as shift to Asia accelerates

More than two years after the European Union banned Russian coal imports and Russian producers shifted exports eastwards, the reshuffle of trade flows continues. It is difficult to know the effect of the extension of US sanctions to some Russian producers, which are also grappling with rail bottlenecks to eastern markets, higher rail tariffs, export duties, and new import duties in some countries such as China. Other factors reshaping trade flows include a resumption of Australian exports into China and security risks to some shipping routes. On top of that, the market's centre of gravity continues to shift increasingly to Asia amid the collapse of demand in Europe. Indonesia has proven again to be the most flexible exporter. After rising above 500 Mt in 2023, Indonesian exports are expected to surpass 550 Mt in 2024. Mongolia has become the second largest metallurgical coal exporter after Australia, although its role in global trade is limited, since all of its exports go to China.

Coal remains profitable as prices stay above pre-crisis levels

The pandemic and associated drop in demand for coal sent prices plunging in 2020, but they subsequently rebounded to record highs – first in October 2021, and then again after Russia's invasion of Ukraine in 2022. Prices have receded since then, but they are still 50% higher than the average during the 2017-19 period. As of November 2024, the price of imported thermal coal in Europe was around USD 120 per tonne, compared with an average of USD 80 per tonne in 2017-19. For Australian thermal coal, the price today is around USD 140 per tonne, versus USD 90 on average at the end of the last decade.

Coal exporters are making solid profits overall. Russian producers are the main exception. After earning substantial profits in 2022, and to a lesser extent in 2023, many producers have tipped into losses because of increased rail tariffs and other duties, which come on top of the discount at which they must sell their coal due to Western sanctions.

The ownership of export-oriented coal mining capacity is changing

A change in the ownership of export-oriented mines competing in international markets is observable in the last few years. On one hand, some companies which want to reduce their carbon footprint or improve their Environmental, Social and Governance (ESG) credentials are selling coal assets in order to focus on other commodities. On the other hand, a number of companies which have generated significant cash due to large profits since 2021 are doubling down on coal. A recent major move was the acquisition of Elk Valley Resources by Glencore, the largest thermal coal exporter, which also became a major metallurgical coal exporter after the acquisition.

Demand

After a small increase in 2024 to an all-time high, global coal demand is set to flatten through to 2027

In 2023 global coal demand increased to a record 8 687 Mt, marking a 2.5% y-o-y increase. This rise was primarily driven by countries heavily reliant on coal, such as China and India. Additionally, low hydropower output fuelled the demand for coal in power generation, which climbed by 2.5% to 5 855 Mt. Non-power coal use grew by 2.3%, reaching 2 833 Mt.

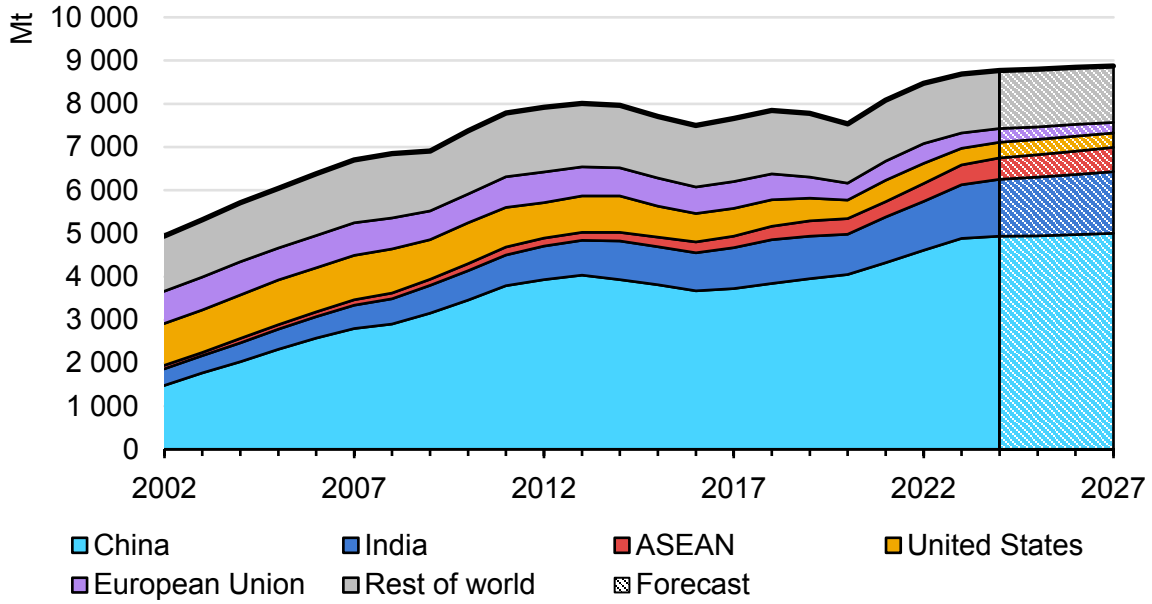
China, the world's largest coal consumer, accounted for over 56% of global demand in 2023. The country's coal consumption increased by 6% to 4 883 Mt, with the power sector accounting for 63% of its coal demand. India, the second-largest consumer, saw a 10% rise in coal demand, reaching a total of 1 245 Mt.

For 2024 global coal demand is projected to grow by 1.0%, setting a new all-time high of 8 771 Mt. The slower coal demand growth in Asia, partially offset by falling demand in advanced economies, results in slower global growth. Global coal demand continues its shift eastward, with China, India and ASEAN countries expected to consume three-quarters of total demand in 2024, a significant increase from around 35% at the start of the century.

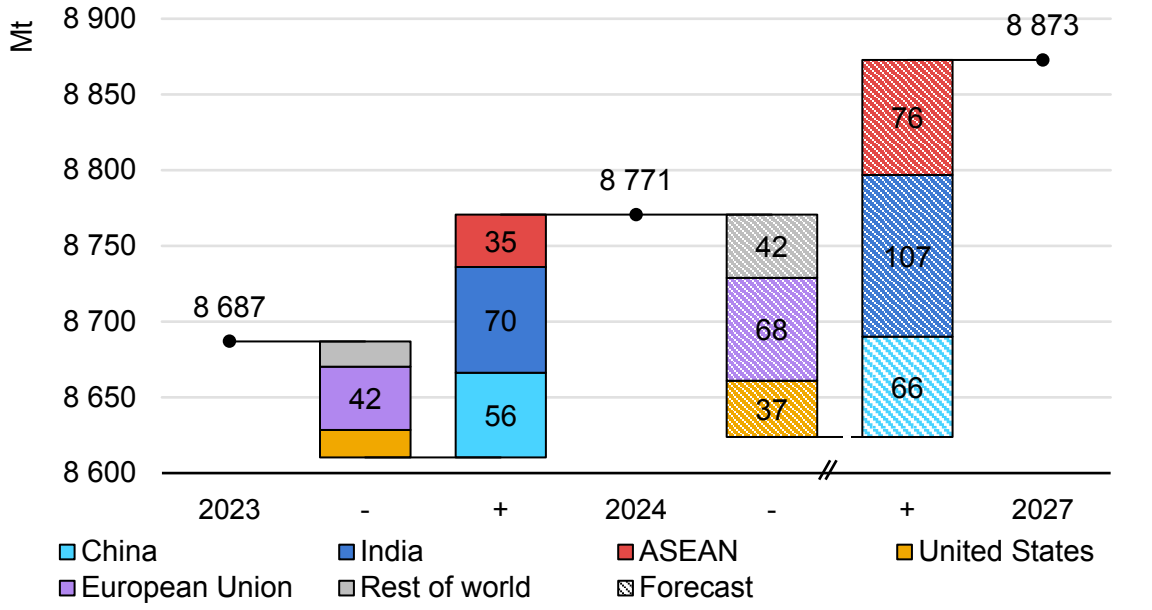
In absolute terms, the most significant increases in 2024 are anticipated to have been in India (up 70 Mt, or 6%) and China (up 56 Mt, or 1.1%), together with others like Indonesia and Viet Nam. Conversely, the largest declines are expected to have taken place in the European Union (down 42 Mt, or 12%) and the United States (down 18 Mt, or 5%), with the electricity generating sector the main driver. Forecasts for the Russian Federation (hereafter "Russia"), the fourth-largest coal consumer, remain uncertain due to the ongoing war in Ukraine, which also makes Ukraine's coal outlook unclear.

For our forecast period up to 2027 we anticipate coal demand to move in a narrow range. While growth in India and ASEAN countries counterbalance declines in the European Union and the United States, China continues to be the major determinant of global coal demand. In the electricity sector, despite the formidable expansion of renewables, strong electricity demand is expected to keep coal-fired power generation at similar levels to 2024.

Global coal consumption, 2002-2027



Change in global coal consumption, 2023-2027

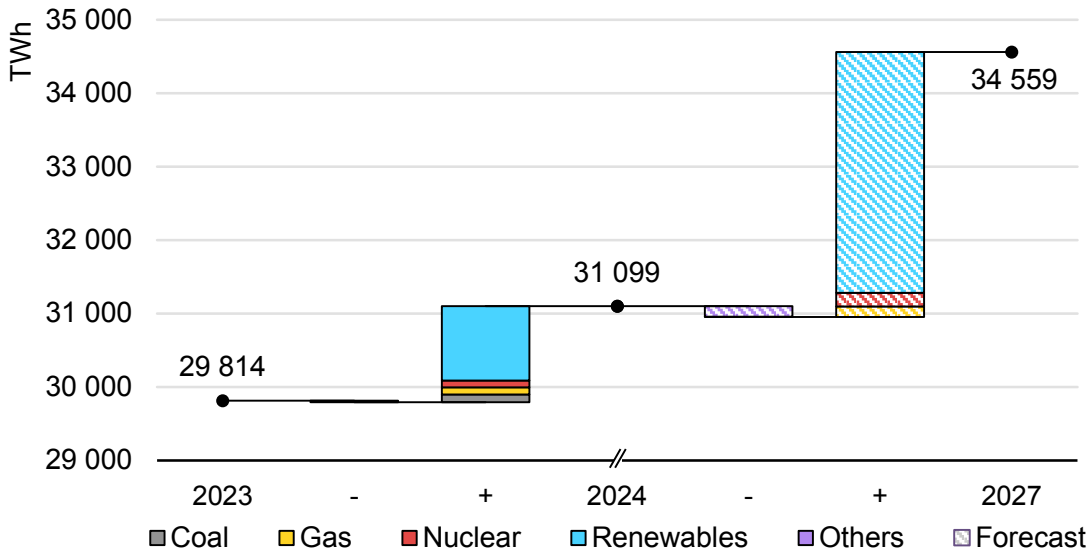


Coal-fired power generation reaches an all-time high in 2024, then plateaus

In 2023 global coal-fired electricity generation grew by 1.7%, or 175 TWh, corresponding to 192 Mt of coal demand in the power sector.[1] Despite significant growth in renewable generation in 2023 (up 426 TWh), coal-fired power generation remained the largest source of electricity, accounting for over 35% of the total. Regionally, the United States (down 169 TWh) and the European Union (down 133 TWh) recorded the biggest declines in coal-fired power generation in 2023, although this was more than offset by gains in China (up 347 TWh) and India (up 125 TWh). Globally, total power generation grew by 2.4%, reaching a total of 29 898 TWh.

Global electricity generation is expected to have grown by 4.4% in 2024, reaching 31 099 TWh. China and India have once again led the growth in electricity demand. While China is expected to have met this increase primarily through the expansion of renewables, India is forecast to have relied mostly on coal for its additional electricity due to low hydropower availability in the first half of the year. Despite the expansion of renewables, coal-fired power generation in China is expected to record moderate growth of 1.7% for 2024. Global coal-fired power generation is projected to have grown by 1.0%, or 104 TWh.

Change in global electricity generation by source, 2023-2027



[1] The rate of growth in coal consumption in the power sector differs from the change in electricity generation for a number of reasons. First, different plants consume coal of different calorific value (CV) at different efficiencies. Second, around one-quarter of coal plants are combined heat and power (CHP) and, therefore, heat provision also plays a role in coal demand. Third, coal-fired power generation includes power generated by coal by-products such as metallurgical gases from steel works, and this is not included in the coal demand for power generation.

For our forecast period through to 2027, we expect global coal demand for power generation to remain stable at around 6 000 Mt. The rapid deployment of low-cost solar PV bolsters the rise in renewable power generation. Nuclear power and gas-fired generation are also projected to see moderate growth, particularly in China and India. The anticipated growth in renewable energy sources, nuclear power and natural gas is expected to align with the projected increase in electricity demand. Consequently, no decline in coal-fired power generation is foreseen.

Given these factors, we anticipate coal-fired power generation to remain at levels similar to 2023 during the 2024-2027 period. Nevertheless, by that time, coal's share of the global electricity mix is expected to drop to just over 31%, the lowest level recorded by the IEA.

No increase in non-power thermal coal and lignite expected through to 2027

Beyond power generation, thermal coal and lignite are used in various activities, such as cement manufacturing and providing heat for industrial and residential purposes. For the analysis in this report, heat supplied by CHP units or central district heating is included in the power sector. In 2023 non-power thermal coal and lignite consumption increased by 2.5%, reaching 1 736 Mt. This accounted for 23% of total thermal coal and lignite consumption for that year.

The majority of this increase was driven by China, where consumption rose to 1 094 Mt, with continuous growth in the coal conversion sector, which aims to reduce oil and gas import dependence. While still a fraction of China's level of consumption, ASEAN countries saw a higher percentage increase, with consumption rising by 13% from 76 Mt to 87 Mt. This exceptional growth was primarily driven by Indonesia, which saw an increase of 9 Mt. Indonesia is strategically boosting its nickel production to meet the global demand for this critical mineral used in battery manufacturing. Since most Indonesian nickel is produced using the rotary kiln-electric furnace (RKEF) process, which relies on coal as both a reductant and an energy source, nickel production is driving the growth of thermal coal consumption in Indonesia. Additionally, coal used for electricity in the process (included in the power sector) and the use of coke (included in the met coal demand) further contribute to the carbon footprint of nickel production.

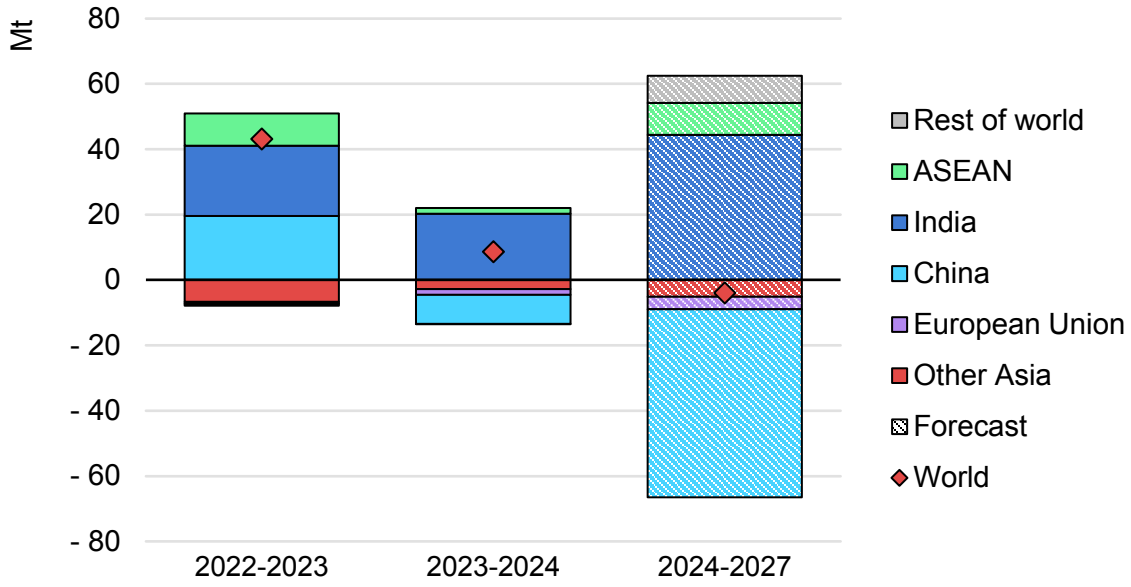
We anticipate a slight increase in the aggregated non-power use of thermal coal and lignite in 2024, driven by gains in India, which are expected to offset declines in other Asian countries and the European Union. In China, efforts to reduce coal consumption for residential heating and small industry, along with weak infrastructure investment affecting cement demand, are likely to dampen non-power coal consumption. However, the coal conversion sector continues to show

significant potential for coal use. Overall, we expect a pronounced decline of 58 Mt in China's thermal non-power coal demand through to the end of 2027.

India's non-power thermal coal and lignite consumption is projected to continue its upward trend, with industrial activity expected to grow by nearly 6% annually over the next three years. We estimate India's consumption increasing by 44 Mt by 2027, and an additional 10 Mt expected from ASEAN countries.

In summary, we project global consumption of thermal coal and lignite for non-power purposes to remain stable, with a slight decline of 4 Mt, or 0.2%, by 2027.

Change in thermal coal and lignite consumption for non-power purposes by region, 2022-2027

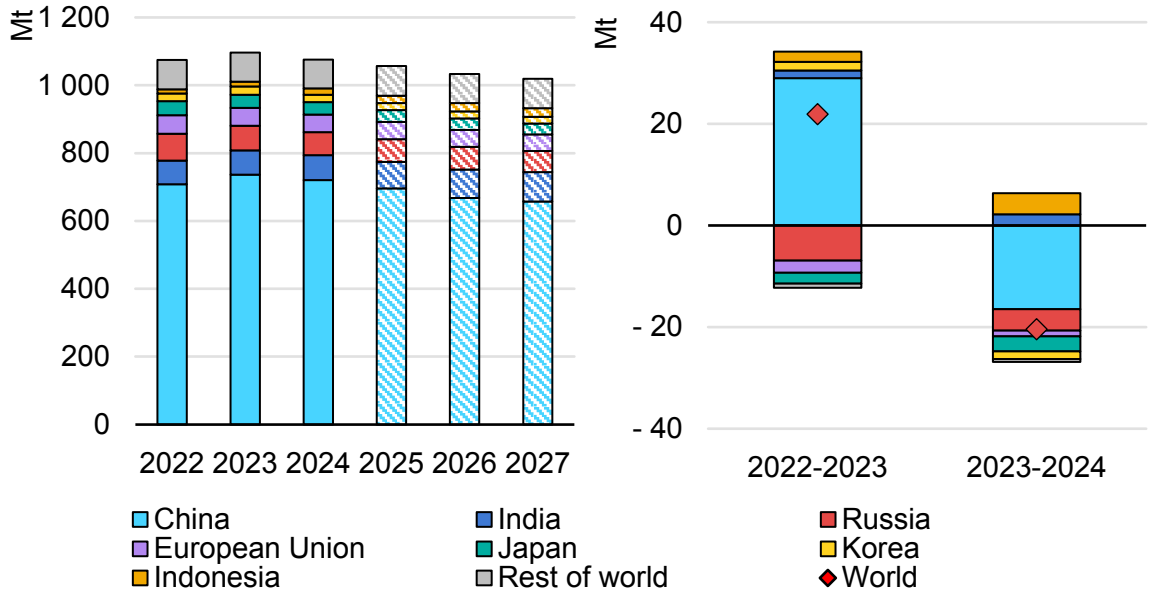


Met coal demand declines through to 2027

Metallurgical (met) coal is essential for steelmaking. It includes coking coal (hard, medium and semi-soft) and coal for pulverised coal injection (PCI). Coke, produced by heating coking coal in a coke oven without oxygen, is also used in the manufacture of carbides, ferroalloys and other chemical compounds. Our forecast for met coal demand is primarily based on steel production forecasts from organisations such as the World Steel Association, together with expected GDP growth and industrial activity, taking into account the increasing rates of scrap utilisation. In the period until 2027 the adoption of hydrogen and other innovative processes to produce steel without coke is expected to remain limited.

In 2023 global met coal consumption increased by just 2%, or 22 Mt, to 1 097 Mt. The most significant uplift was seen in China, where met coal demand increased by 4.1%, or 29 Mt, to 737 Mt.

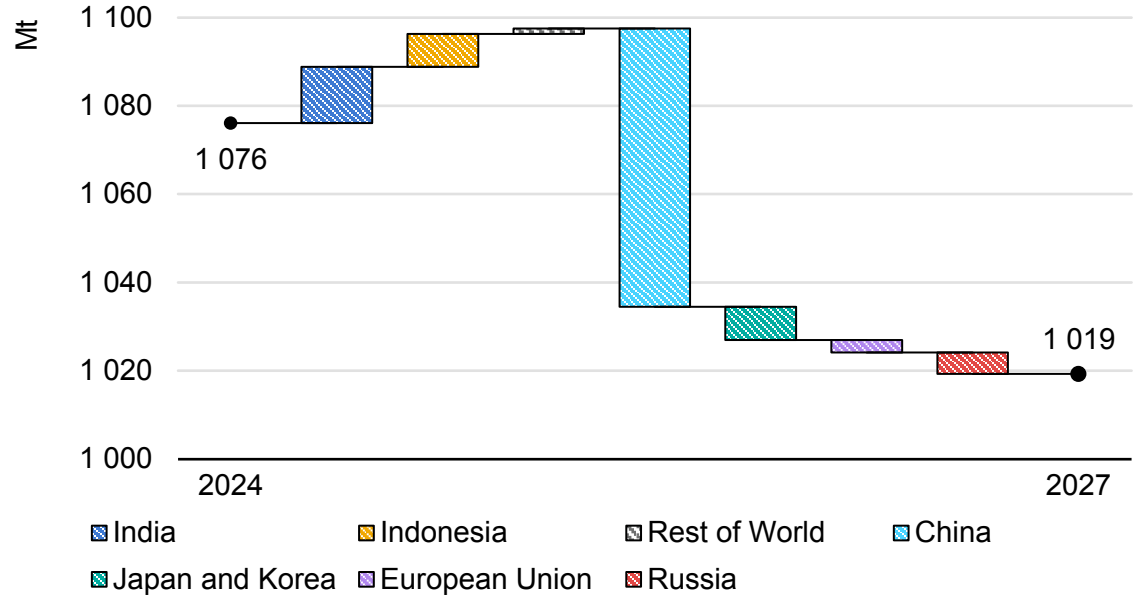
Met coal consumption and annual change by region, 2022-2027



In 2024 we anticipate a 1.9% overall reduction in met coal consumption, bringing the total to 1 076 Mt. While China was the main driver of the increase in 2023, it is now expected to lead the decline in 2024 due to lower industrial activity. Although India and Indonesia are projected to consume more coal, their increased demand will not be enough to counterbalance the decrease in China. Indonesia is increasing its coking coal consumption to feed new export-oriented coke ovens. The situation In Russia remains uncertain due to the ongoing war in Ukraine.

Over the next three years we do not anticipate significant changes in met coal consumption, mainly determined by steel demand in line with the economic outlook. Consequently, we forecast a decrease in overall met coal consumption of 47 Mt, standing at 1 019 Mt in 2027 at the end of the three years, with India and Indonesia the only major contributors to growth. India's expected increase of 13 Mt is expected to be offset by a drop of 63 Mt in China over the next three years. Similarly, Indonesia's demand is projected to grow by 8 Mt, while Japan, Korea and the European Union are expected to see a combined decrease of 10 Mt. Additionally, Russia's demand is projected to decline yet further.

Forecast change in met coal consumption by region, 2024-2027



Weather uncertainty spills over into the coal demand forecast

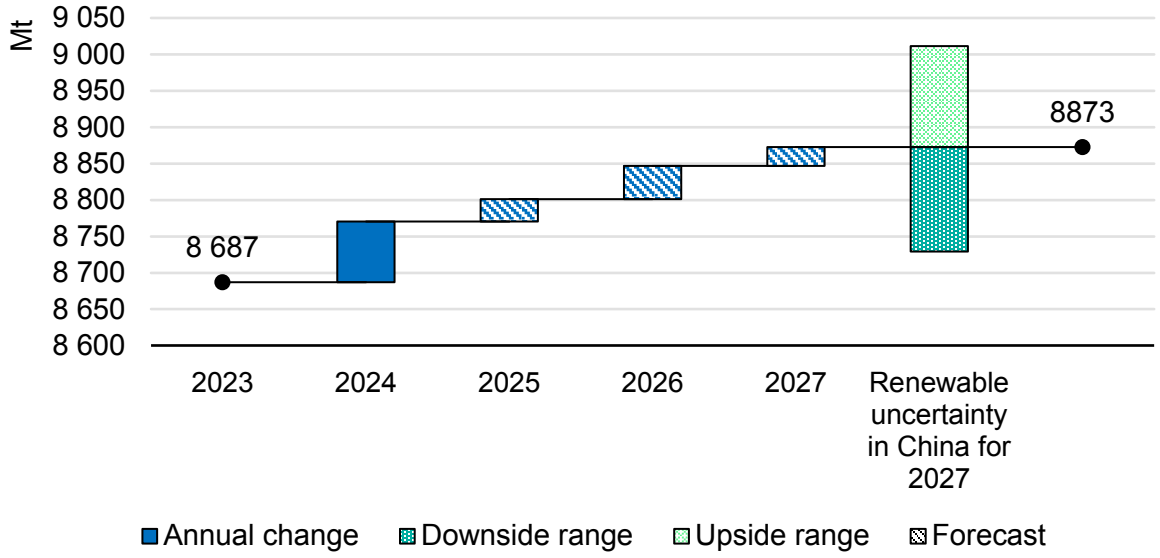
The shift towards renewable energy sources, principally wind and solar PV, introduces short-term uncertainty when forecasting coal demand. The output from wind, solar PV and hydroelectric generation fluctuates with varying weather conditions. In many regions, coal remains the primary power source to balance these fluctuations, resulting in variable coal generation output.

In China, which boasts the world's largest clean energy capacity, the absolute deviations in output may be substantial. As the capacity of wind and solar PV continues to expand rapidly, so the scale of the impact of weather variability on the renewable power generation is expected to increase, leading to greater fluctuations in coal demand.

In the section on China, we analyse the uncertainty of coal demand from the impact of weather conditions on renewable generation. Analysing historical records, we conclude that with the continuing expansion of renewables in China, coal as the main balancing source could see its demand moving in a range of 282 Mt (143 Mt up or 139 Mt down) by 2027 if weather conditions change the capacity factor of wind, PV solar and hydro from those considered in the forecast. This range of 282 Mt uncertainty represents 3.2% of the forecast global demand of 8 873 Mt. Of course, coal is not the only potential provider of additional electricity in China, but given its scale compared with other available sources of additional electricity, the simplification is valid. Moreover, this only considers

uncertainty on the electricity supply side – weather also has a major impact on electricity and/or heat demand, which can further drive coal demand. Given the magnitude of this range of uncertainty, we observe that the impact on global coal demand of weather variations in China has the ability to surpass structural developments in other regions for any given year. A similar analysis can be conducted for India, where weather conditions also have an impact on coal consumption, but the scale of China's coal consumption is unmatched by any other country.

Forecast change in global coal consumption, 2024-2027, and uncertainty range due to Chinese renewable generation



China

Coal demand in China remains strong through to 2027

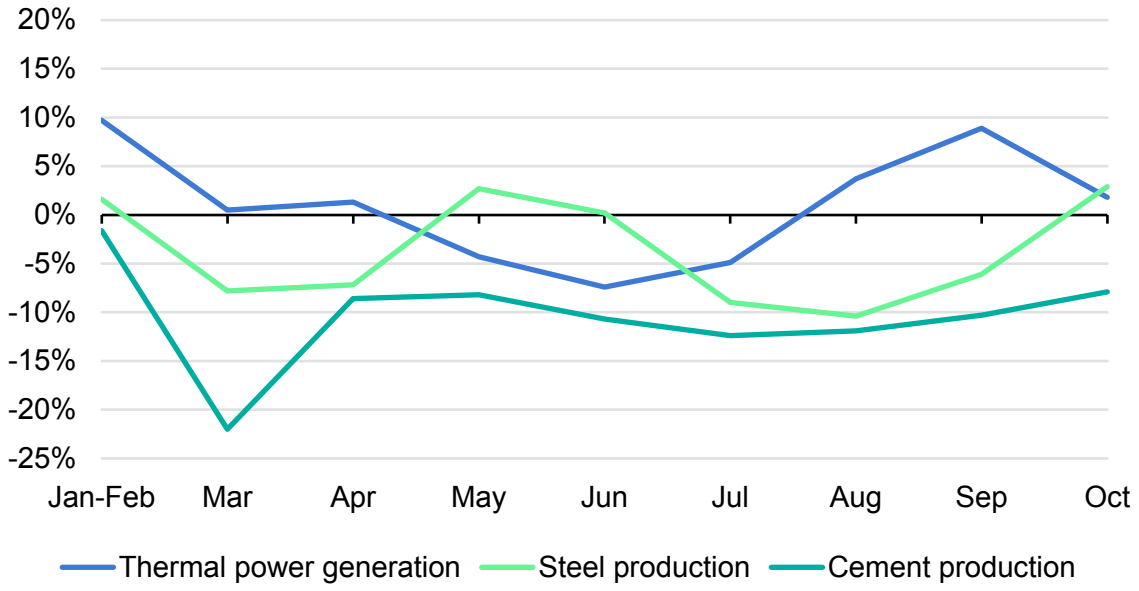
China, the world's largest coal consumer, used 4 883 Mt of coal in 2023, marking a 6% y-o-y increase and accounting for 56% of global coal consumption. The majority (85%) of this consumption was thermal coal, amounting to 4 146 Mt, primarily used for power generation. The remaining 737 Mt was met coal.

The power sector is the primary driver of China's coal consumption. We anticipate demand from coal-fired power plants to have increased by 2.7% in 2024. With non-power thermal coal consumption declining slightly, we estimate 1.7% growth in total thermal coal consumption in China, reaching 4 219 Mt in 2024.

After stable economic performance in 2023, China is encountering economic challenges due to weak consumer demand and the ongoing real estate crisis. The IMF projects GDP growth of 4.8% in 2024, which is 0.4 percentage points lower than the previous year. Met coal consumption is anticipated to decline, with steel production falling by 3.7% year-on-year in the first ten months of 2024. This downturn is attributed to sluggish construction activity, as the housing market faces challenges. For 2024 we estimate a 2.2% decrease in met coal consumption to 720 Mt.

These anticipated changes in demand mean that China is once again on track to set a record for total coal consumption, with an estimated usage of 4 939 Mt in 2024.

Y-o-y percentage change in three economic indicators, China, January-October 2024



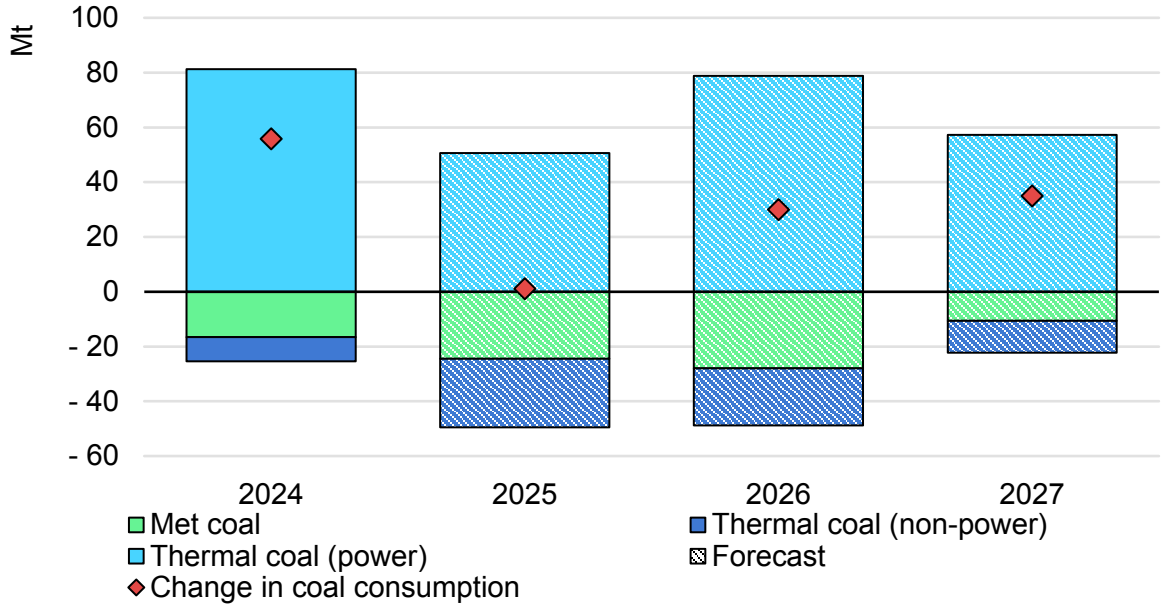
Source: IEA analysis based on National Bureau of Statistics of China (2024), Statistical Database.

Our forecast for China's coal consumption over the next three years is closely linked to developments in the power sector, which is the country's largest coal consumer and accounts for one-third of global coal demand. In a country where more than half of primary energy comes from coal, overall economic growth and industrial production are also significant factors. Our estimate centres on the expected increase in electricity demand. Increased renewable generation is projected to cover this additional demand, primarily driven by accelerated solar PV deployment and a rebound in precipitation towards the historical average in 2024, boosting hydropower generation. Our forecast assumes that hydropower production aligns with historical data.

Despite the push for renewables, coal will continue to satisfy most of the existing demand, as increases in renewable electricity generation primarily address additional electricity demand. We anticipate coal-fired power generation to slightly increase between 2024 and 2027, with strong growth of electricity demand (6% per year on average) during the period. For 2027 the consumption of steam coal for electricity and heat production is estimated at 3 321 Mt, which corresponds to an annual growth below 2% through to 2027.

At the same time, met coal consumption is projected to decrease between 2024 and 2027. Furthermore, the outlook for thermal coal used outside power generation is expected to deteriorate, with industrial declines overshadowing growth in the conversion sector. The coal conversion sector in China operates on a much larger scale compared to other regions and will be pivotal in shaping future coal trends. As a result, we project a very slight growth in Chinese coal consumption (below 0.5% per year on average), totalling 5 005 Mt by 2027. The coal conversion sector is fraught with uncertainty but holds considerable upside potential.

Annual change in coal consumption by grade and use in China, 2024-2027



Robust electricity demand supports strong coal-fired power generation in China for longer

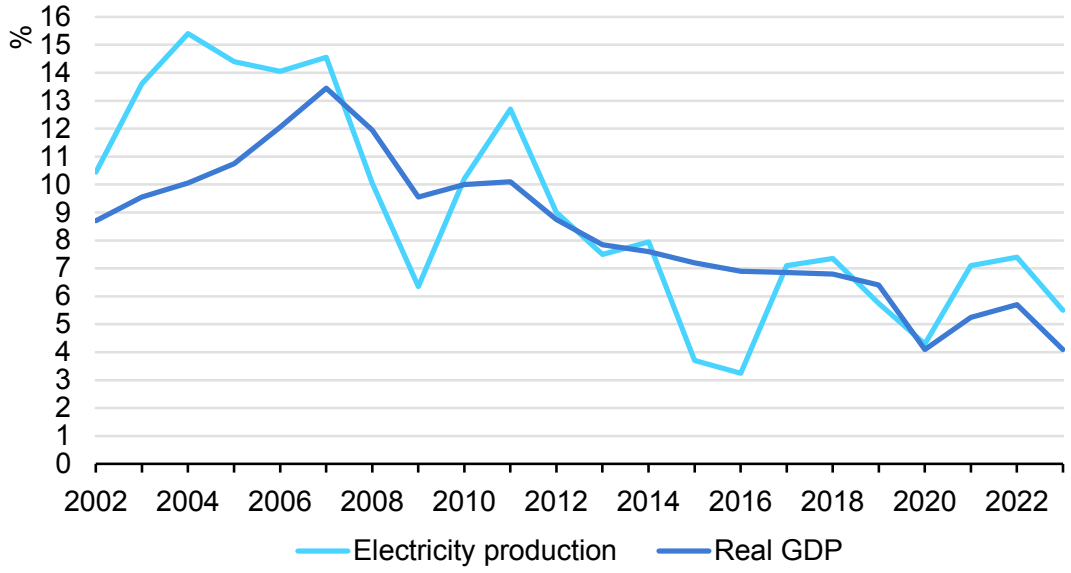
In 2023 coal maintained its dominance as the primary energy source for electricity generation in China, with an installed capacity of approximately 1 170 GW generating 5 884 TWh. Power plants accounted for about 74% of China's thermal coal demand

and roughly 63% of its total coal demand. Therefore, the Chinese electricity sector is the main driver of China's coal demand and consequently global coal demand.

Historically, electricity production and real GDP growth have moved in tandem, primarily driven by industrial activity. However, significant construction activity prior to the 2008 financial crisis caused deviations, as this sector is more energy and electricity intensive than the average for all economic activity. Consequently, during 2000-2007 average electricity growth rates exceeded real GDP growth rates. From 2008 until 2020 the service sector gained share, resulting in less electricity-intensive economic growth. Since 2021 electricity demand has outpaced real GDP growth again, fuelled by rising demand from a variety of sectors, including clean energy manufacturing, mobility and heating electrification, AI and data centres. Additionally, residential consumption has also been growing faster than the average rate, in particular demand for cooling.

In the past, diversification from coal in the electricity sector focused on hydro and nuclear. More recently, wind and especially solar PV have been surging at a rapid pace. However, despite the rapid growth of renewables, coal-fired power generation remains resilient, supported by the strong demand for electricity. In addition, coal is considered a pillar of electricity security, as confirmed by the response to past power shortages caused by a combination of coal supply issues, insufficient generation capacity and inefficient dispatch incentives. In 2021-2022 a large share of China's coal capacity was retrofitted: 150 GW was retrofitted to increase efficiency, 190 GW was retrofitted to increase flexibility and improve management of the system with increasing variable renewables, and 145 GW was retrofitted to improve the provision of heat.

Two-year moving average of growth in real GDP and in electricity production, 2002-2023



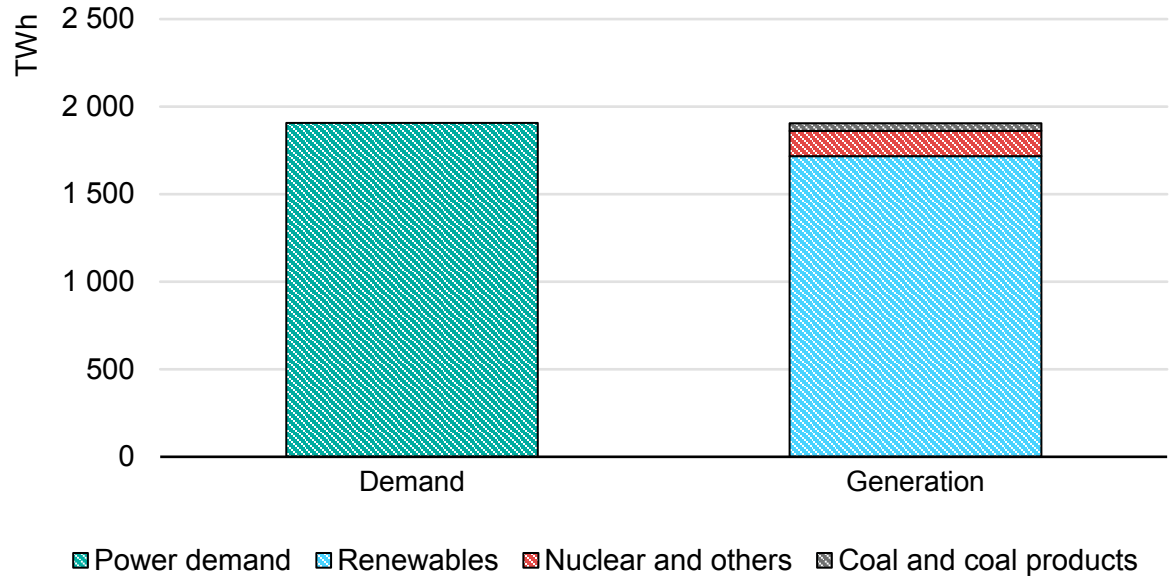
Alongside the push for renewables, with 216 GW of solar PV and 76 GW of wind capacity added in 2023, China has been expanding its coal-fired power plant fleet to ensure resource adequacy. During 2022-2023 China approved around 220 GW of new coal-fired power capacity. Acting on this, it began construction of 70 GW in 2023 and an additional 41 GW in the first half of 2024. However, in the first half of 2024 China approved only 9 GW of new coal capacity, signalling the end of the rush for new approvals. At the same time, the surge in renewable energy is expected to reduce the average utilisation rate of coal-fired power plants. To address this, in 2023 the Chinese government announced capacity payments for coal-fired power plants to ensure capital recovery regardless of their load factor.

We expect growth in China's coal-fired power generation to have slowed in 2024 compared to 2023, when severe droughts in the first half of the year significantly affected hydropower availability, thus boosting coal-fired power output. We estimate electricity demand to have surged by 7.2% in 2024, surpassing 10 295 TWh, and coal-fired power generation to have increased by 1.7% to 5 984 TWh. That corresponds to increased thermal coal consumption of 2.7%, reaching 3 134 Mt in 2024. Roughly half of the coal fleet is CHP and therefore coal demand is not totally determined by electricity generation as heat provision also plays a role. The surge in electricity demand can be partially attributed to significant growth in the residential sector, spurred by heatwaves in August and September, which were the most intensive since 1961. There are other drivers, such as the clean energy manufacturing sector – which saw a substantial year-on-year increase of 36.2% in the first three quarters – as well as data centres and AI.

For the period to 2027 we assume that hydro availability will remain at the 2024 level after several years of underperformance, and the accelerating growth in wind and solar capacity will yield significant results. Additionally, we expect steady increases in nuclear generation. Together these meet most of the new demand anticipated until 2027, leaving the remainder for coal. We estimate coal volumes for electricity and heat generation in coal plants to grow slightly between 2025 and 2027, to 3 321 Mt in 2027. In July 2024 the government issued the "Action Plan for Low-Carbon Transformation of Coal-fired Power Generation (2024-2027)" in order to reduce emissions from coal-fired power generation through biomass or ammonia co-firing or carbon capture, utilisation and storage (CCUS). There is no detail yet on how much capacity will be retrofitted, but given the size of China's coal fleet and the government's commitment to CO_2 emissions peaking before 2030, we expect the plan to mobilise significant resources. Consequently, coal demand for power generation may be subject to change. At this stage, it is difficult to make an assessment of the plan's impact on coal demand. CCUS retrofits would increase coal consumption given the energy losses associated with the process of capture and storage. By contrast, ammonia and biomass co-firing would decrease coal consumption in the plants opting for that solution. In any case, an assessment of the impact will be possible only when detailed plans are

announced. Retrofitting works are likely to start by the second half of 2025, and therefore their impact should be noted from 2027.

Forecast change in electricity demand and generation, China, 2024-2027



Uncertainty about short-term coal demand increases as renewable generation grows

The recent acceleration in electricity consumption in China and the installation rate of renewable capacity are key factors in determining the structural evolution of coal demand for power generation. In the short term, however, fluctuations in renewable generation significantly affect coal-fired power generation and, consequently, coal demand. As renewable energy sources replace coal, it is important to note that our calculations for load factors are based on representative weather conditions. Fluctuations in factors such as precipitation, wind speed and solar irradiation will have an increasing impact on the balance of energy production as the share of renewables grows. In addition, demand remains also weather-dependent due to events such as cold snaps and heatwaves. All of these factors influence the utilisation of coal-fired power plants, which typically act as the default electricity supplier in China.

To illustrate the impact of weather-driven variability in renewable generation on coal consumption in China, we have examined the variation in historical load factors for renewables (left graph below) driven by weather conditions, and translate this into the hypothetical coal consumption needed to offset the higher or lower electricity generation (right graph below). Hydropower, solar PV and wind

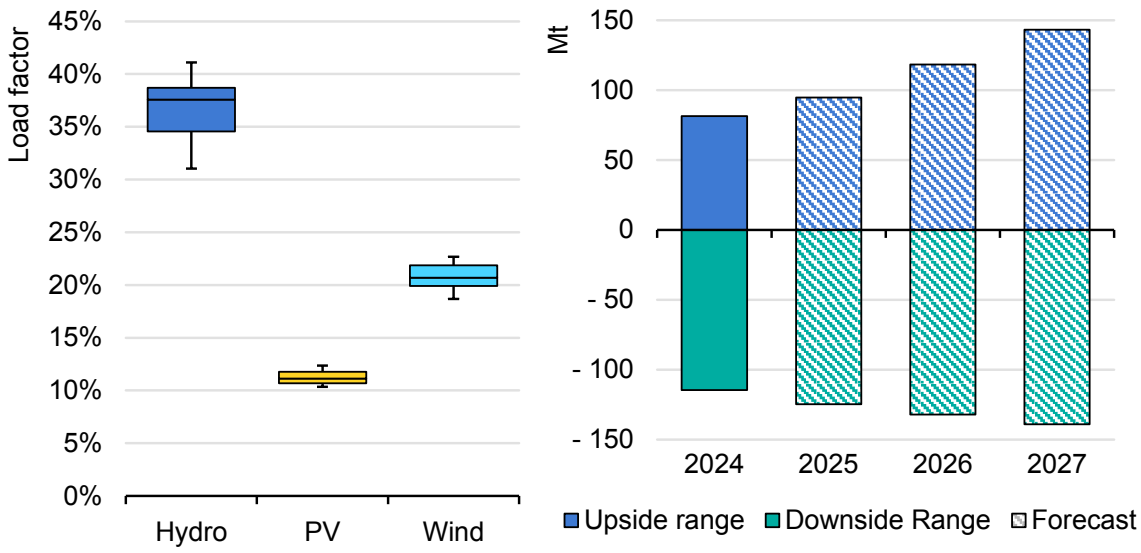
power all show fluctuations in their annual historical load factors. Over the past 20 to 30 years, observations indicate that in China hydro has a spread of 10 percentage points between its minimum and maximum load factors; for wind and solar, we have normalised historical data using plus and minus 1 percentage point for solar PV and plus and minus 2 percentage points for wind.

When renewable load factors are lower than average, other energy sources, almost entirely coal in China, must compensate. Given China's substantial renewable capacity, these fluctuations significantly affect coal consumption. In our subsequent analysis, we assume that coal-fired power plants will balance different hypothetical load factors, based on the renewable capacity assumed for 2024-2027.

The findings indicate that under the weakest combined performance of hydro, wind and solar observed since 2000, coal consumption for power generation could be over 143 Mt higher in 2027 compared with our forecast. Conversely, the maximum load factor for renewables observed in those years could result in around 139 Mt less coal use than in our forecast.[2]

The analysis highlights the significant uncertainty that weather effects impose on coal consumption in a given year. Note that the analysis only considers the supply side of electricity; the weather's impact on electricity demand is another crucial factor influencing coal consumption.

Load factor of renewables and hypothetical effect on coal consumption in China



Notes: (left) Hydro load factor based on 1990-2023 data; PV and wind load factors based on 2000-2023 data. The top and bottom edges of the boxes represent the 75th and 25th percentiles, respectively. The lines inside the boxes represent the medians; (right): Hypothetical coal use represents volumes that would be consumed if minimum and maximum levels of combined load factors of renewables apply. We assume coal consumption of 0.44 Mt per TWh of electricity.

[2] Our analysis shows that the weakest renewables performance would occur if the meteorological conditions of 2011 were to be repeated, while the strongest output would happen under 2001 conditions.

After seeing growth in 2023, China's thermal non-power demand declines slightly

In 2023 China's thermal coal consumption for non-power uses increased by 1.8% y-o-y to 1 094 Mt, representing 22% of the country's total coal consumption. Coal consumption in sectors beyond power and steel remains substantial in China despite an over decade-long effort to shift from coal to alternative energy sources, such as gas and electricity, to reduce air pollution from small, inefficient and outdated coal boilers. The country continues to use coal across various industries, including food, textiles and paper. Nevertheless, we expect coal use in small industry and residential heating to continue declining in the coming years as the shift away from coal progresses.

Switching to alternative fuels in cement production is challenging due to fuel accounting for a high proportion of total production costs. Consuming over 200 Mt of coal annually, it is the largest industrial consumer of thermal coal. Cement production in China appears to have peaked in 2020 at 2.4 billion tonnes and has declined significantly since then. In 2024 production is set to fall below 2 billion tonnes for the first time since 2010. In the first three quarters of 2024 production fell by 10.7% y-o-y. The contraction of China's construction sector is likely to further affect cement production and its demand for coal throughout the forecast period, as this trend seems structural.

The coal conversion sector has remained a significant driver of growth in thermal non-power applications in 2024. Given these developments, we estimate thermal non-power coal consumption to have narrowly decreased to 1 085 Mt in 2024. Looking ahead to 2027 we expect declines in industrial and heating applications to more than offset growth in the coal conversion sector, leading to a 5% reduction in thermal non-power coal consumption, down to 1 027 Mt.

Strong but uncertain growth is expected in China's coal conversion sector

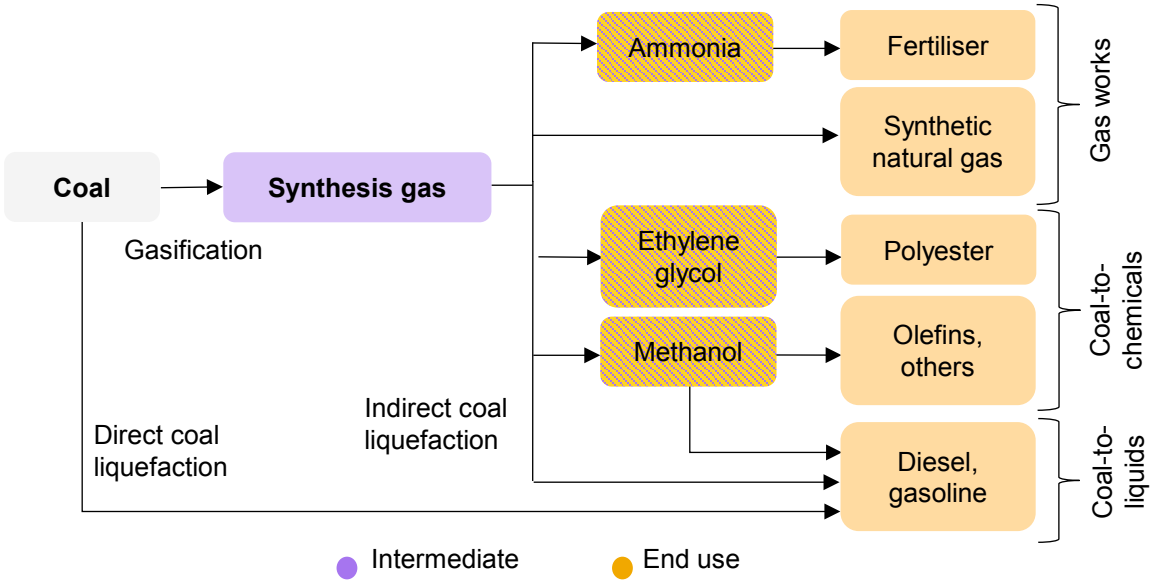
Coal conversion involves using coal as the basis to produce other commodities, typically through coal gasification. This process is usually categorised into coal-to-liquids, gas works and coal-to-chemicals. For more than a decade China has considered coal conversion a strategy to reduce dependence on overseas energy sources amid increasing oil and gas imports. This approach also supports domestic coal assets, particularly those stranded due to quality or location, and promotes local employment. However, these processes are typically energy inefficient, water- and CO_2-intensive, and their profitability is highly volatile, depending on the price of competing fuels like oil and gas. Nonetheless, there has been significant technological progress in these processes over the past decade.

Coal-to-liquids (CTL) involves producing liquid fuels like diesel or gasoline from coal, either through direct liquefaction by hydrogenation or indirect liquefaction[3] via synthesis gas and the Fischer-Tropsch process. In 2022 China used 40 Mt of coal to produce approximately 11 Mt of oil products. Further CTL projects are in the pipeline, although their progress is unclear. In October 2024 China Energy Investment (CHN Energy) initiated the construction of a CTL project in Hami city, Xinjiang, with an investment of around USD 24.1 billion. The first phase is slated for completion and operation by the end of 2027. Upon completion, the project has a target capacity of 4 Mtpa of CTL products, comprising 3.2 Mt from direct liquefaction and 0.8 Mt from indirect liquefaction, in total using around 16 Mt of coal per year.

Gas works primarily produce synthetic natural gas (SNG) and fertilisers. In China ammonia for fertilisers is mainly produced using synthesis gas from coal gasification, unlike in other countries. In 2022 it is estimated that China produced 48 Mt of ammonia from coal. New projects announced in Xinjiang and Inner Mongolia could consume an additional 85 Mt per year if they are completed.

Coal-to-chemicals (CTX) is the most dynamic sector, involving the gasification of coal to synthesis gas, which is then processed into products like methanol or ethylene glycol. In 2022 it is estimated that 80 Mt of methanol was produced. It is often converted into olefins for plastics production, while ethylene glycol is used for polyester and other materials.

Key process routes of the coal conversion sector in China



[3] Smaller volumes of liquid fuels are produced with other technologies, such as coal tar hydrogenation.

China’s met coal demand has been hit by the real estate crisis

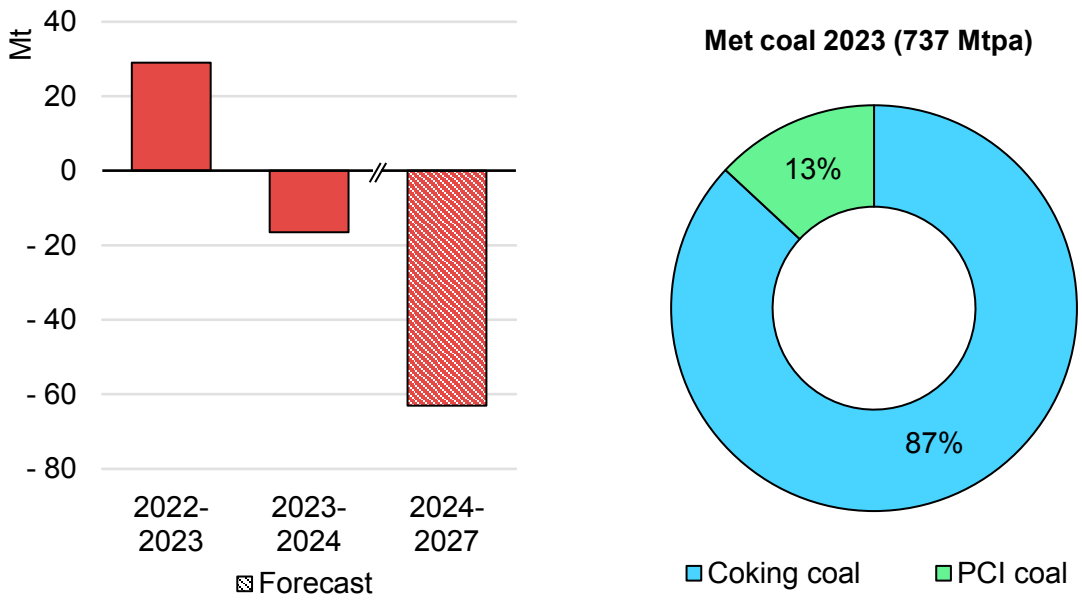
China’s met coal consumption reached 737 Mt in 2023, an increase of 4.1% y-o-y. This amounts to about two-thirds of global met coal consumption and 15% of China’s total coal consumption. The majority of this met coal (87%) is coking coal, primarily converted to coke for use in the blast furnace process for pig iron production and other industrial applications. Pig iron is a key ingredient in steelmaking in the basic oxygen furnace (BOF) route. Most of the remaining 13% of met coal is PCI coal, used in blast furnaces to reduce coke consumption.[4]

While pig iron production increased by 1% in 2023, supporting met coal consumption, the outlook has deteriorated. Over 80% of coke in China is utilised for pig iron production. With an anticipated decline in pig iron production, which will subsequently reduce coke demand, we project a 2.2% decrease in met coal consumption for 2024, at 720 Mt.

Looking ahead, we expect steel demand to remain subdued due to the ongoing real estate crisis. However, steel demand in China is slowly shifting from infrastructure and construction – which accounted for over half of steel demand a decade ago and only 40% in 2023 – to machinery manufacturing and other applications. The decoupling of cement and steel demand is a result of that trend. The share of production using an electric arc furnace (EAF), which uses scrap and does not require coke, is expected to grow at the expense of BOF production. However, this is limited by scrap availability and price. Given these factors, we forecast a 9% decline in met coal consumption until 2027, bringing it down to 657 Mt.

[4] This is an estimate as Chinese statistics do not report PCI coal as a separate category.

Change in met coal consumption in China, 2022-2027, and share of met coal grades, 2023



India

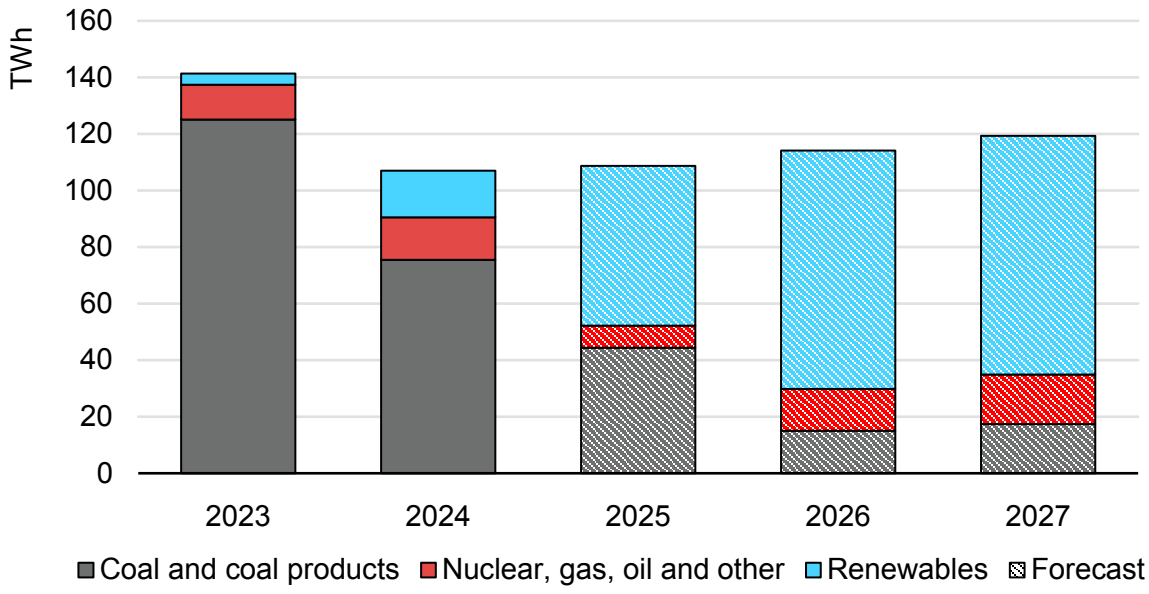
Demand for coal continues to grow in India

India is poised to be the primary driver of global coal demand growth in 2024, with a y-o-y increase of 70 Mt to 1 315 Mt. We project India maintaining this position through to 2027, despite China's undisputed position as the world's largest coal market. Indian coal demand is expected to grow by 2.6% annually, reaching 1 421 Mt by 2027, with growth across all coal grades.

We anticipate India to have used 990 Mt, or 75% of its total coal consumption, for power generation in 2024. In August 2024 India's total installed power generation capacity amounted to 451 GW, of which 218 GW was coal-fired, 89 GW was solar PV and 47 GW was wind. In November 2023 the Minister of Power stated that India plans to add 30 GW of new coal-fired capacity in addition to the 50 GW currently under construction. This does not contradict the target of achieving 500 GW of renewable generation capacity by 2030, but it indicates that coal will continue to play a significant role in India's electricity system for years to come. With the ongoing expansion of renewable generation in line with government goals, coal's share of the electricity mix is projected to be 74% in 2024, decreasing to 66% by 2027. During this period, electricity generation from renewable energy sources is expected to increase by 16% annually. Given this increase and with forecast growth in electricity demand of 5.4% annually, the system requires an

annual increase in coal consumption for electricity generation of 1.7% over the next three years. Consequently, we assume a moderate increase in coal consumption for electricity generation of 50 Mt to a total of 1 039 Mt in 2027.

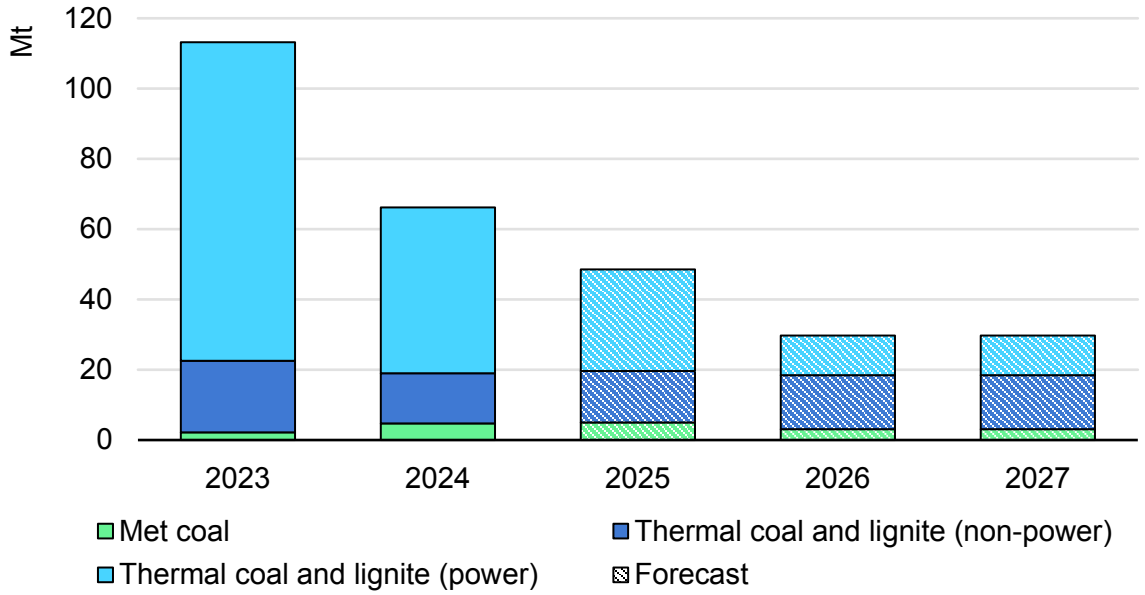
Annual change in power generation by source, India, 2023-2027



Non-power coal demand is projected to rise significantly, driven by a 6% annual increase in industrial production from 2024 to 2027. Infrastructure development will boost cement production, a key driver of non-power thermal coal and lignite demand. India, the world's second-largest cement market after China, has an installed cement production capacity of 550 Mt per year. Industry estimates suggest up to 9% annual growth in cement demand over the next five years, leading to higher plant utilisation. In India, a large share of steel production is from coal-based direct iron reduction, with significant capacity of around 50 Mtpa. This process uses thermal coal instead of the met coal used in blast furnaces. As steel and cement demand rise, we estimate non-power coal consumption reaching 382 Mt by 2027, an 18% increase over three years

India aims to gasify 100 Mt of coal annually by 2030, thereby reducing reliance on imported fuels. The government has approved USD 1 billion in financial incentives for coal gasification projects. While some initial projects have received approval and various joint ventures have been established to produce synthetic natural gas and ammonium nitrate, these are expected to be completed only after 2027.

Annual change in coal consumption by coal grade in India, 2023-2027

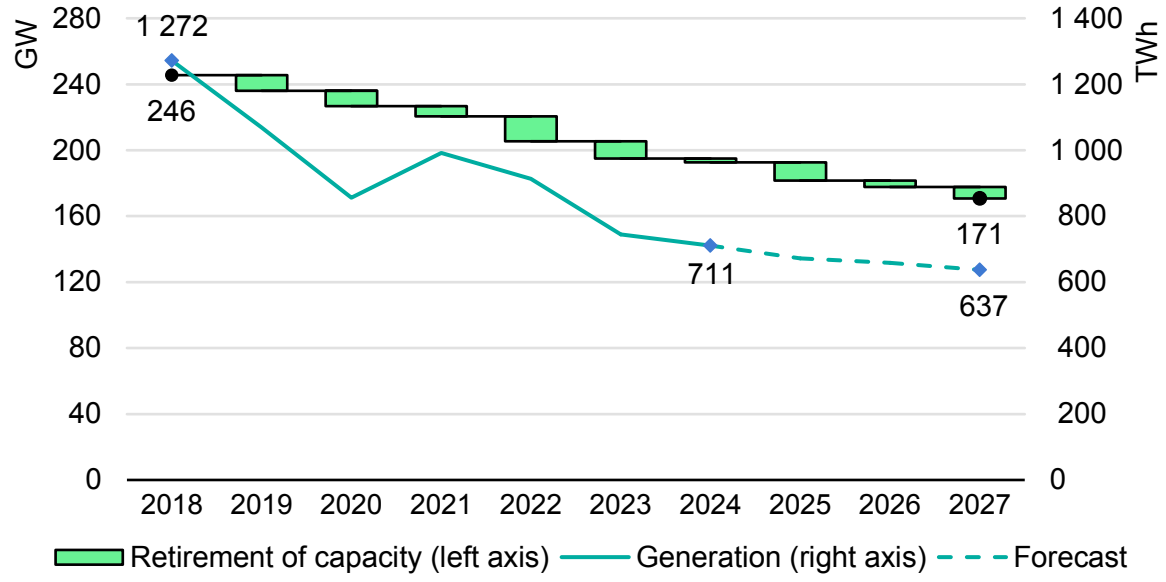


North America

The decline in coal consumption slows in the United States

In the United States overall coal consumption is expected to have decreased from 386 Mt in 2023 to 368 Mt in 2024, a decline of 5%, slower than the 17% (or 81 Mt) fall seen in 2023. Coal demand is predominantly driven by power generation, which accounts for well over 90% of total coal consumption. After nearly a decade of decline, coal-fired power generation experienced a brief resurgence in 2021 due to the recovery from the Covid-19 pandemic and high gas prices. However, this uptick was short-lived due to increased renewable generation and a growing share of gas-fired generation. Coal-fired generation is expected to fall down to 711 TWh in 2024. This corresponds to 16% of the power mix and the consumption of 335 Mt of coal.

Coal-fired capacity and generation, United States, 2018-2027

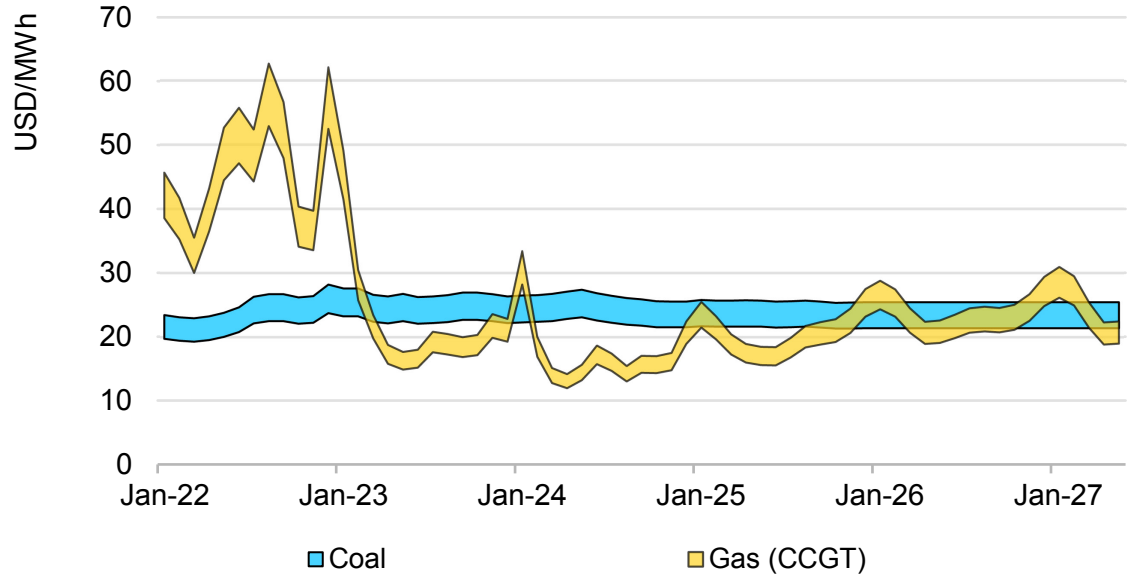


Notes: Capacity values for 2024 to 2027 are based on announced retirements. 2018 aggregated capacity is based on operational capacity in 2023 and retirements and commissions between 2018 and 2023. Retirements after 2023 are planned retirements.

Sources: IEA analysis based on EIA (2024), Electric Power Monthly, EIA (2024), Coal Data and IEA estimates.

The US Energy Information Administration (EIA) projects planned retirements of coal-fired capacity being around 2.3 GW in 2024. This trend is expected to accelerate in 2025, with operators planning to retire 11.2 GW, followed by an additional 10.7 GW over the subsequent two years. In the last few months domestic gas futures have been higher than spot prices, thereby improving the expectations of coal's cost competitiveness for power generation compared to gas. Consequently, we anticipate the decline in coal's share of the electricity mix slowing down, falling to a level of around 13%. This slowdown is projected to result in coal consumption of 300 Mt by 2027, to produce 637 TWh of electricity.

Electricity generation costs in the United States, 2022-2027



Notes: CCGT = combined-cycle gas turbine. CCGT net efficiency = 49-58%. Coal net efficiency = 35-46%.
Sources: IEA analysis based on Argus Media group (all rights reserved) and IEA estimates.

With non-power coal demand declining over the next three years, total coal consumption in the United States is projected to be 331 Mt in 2027, declining by 2.1% per year.

Several projects utilising innovative technologies have been announced in the United States, for example a project to produce graphite and hydrogen from coal in West Virginia, a new power plant using supercritical CO_2 in Wyoming, and a modular CTL project. The long-term potential of those technologies is uncertain; in any case, they are not expected to have any significant impact by 2027.

Alberta, once the largest coal-consuming province of Canada, closed its last coal-fired power plant in June 2024, in line with the goal of phasing out unabated coal-fired power generation in the country by 2030.

Europe

EU coal demand continues its unstoppable decline

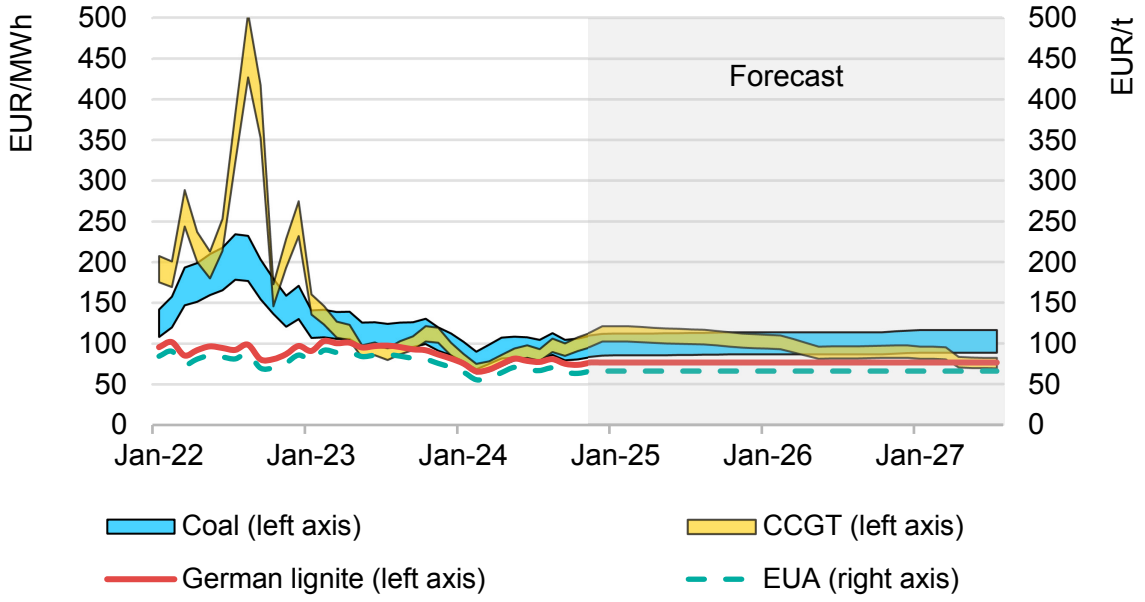
Following a brief upturn in 2022, triggered by the energy crisis resulting from Russia's full-scale invasion of Ukraine, EU coal demand declined significantly in 2023, particularly in electricity generation.

The European Union's power demand is projected to have reached 2 815 TWh in 2024, marking a 2.2% increase compared to 2023. Coal-fired power generation is expected to have declined by 16% to supply 10% of that demand.

Since 2023 energy prices have eased substantially and coal phase-out plans remain largely in place. In Germany 5.8 GW of coal-fired capacity left the market in 2024 and it is due to see a further reduction of another 1.4 GW by 2027, the national regulator has said.

Given the price of TTF gas and EUA futures in the third quarter of 2024, competition between coal- and gas-fired generation units is anticipated to be close through to 2027. However, the accelerated deployment of renewables, especially solar PV, is anticipated to further drive the decline in coal-fired generation. Therefore, coal's share of the European Union's power mix is expected to decline to 7% by 2027, corresponding to 163 Mt, with lignite comprising 124 Mt of this amount.

Electricity generation costs in the European Union, 2022-2027



Notes: EUA = European Union Allowance. CCGT = combined-cycle gas turbine. CCGT net efficiency = 49-58%. Coal net efficiency = 35-46%. Lignite net efficiency = 39%.

Sources: IEA analysis based on Argus Media group (all rights reserved) and IEA estimates.

Coal consumption in the European Union's non-power sector is projected to be 88 Mt in 2024, a 3.2% decrease from 2023, and is expected to decline slightly to 81 Mt by 2027. Therefore, mainly driven by power market developments, total coal consumption in the European Union is projected to decrease from 312 Mt in 2024 to 244 Mt in 2027.

In 2023, the Republic of Türkiye surpassed Germany and Poland to become the largest consumer of coal in Europe. Its total coal consumption in 2024 is expected to rise by 2.8% from the 2023 level to 129 Mt. By 2027 our model forecasts a decline in its coal demand to 110 Mt, as renewable energy production increasingly replaces coal-fired generation in the Turkish power mix, and Akkuyu, the first nuclear power plant in Türkiye, is commissioned.

In September 2024 the United Kingdom's last coal-fired power plant, Ratcliffe-on-Soar in Nottinghamshire, ceased operations, marking the end of 142 years of coal-fired power production in the country. Although anticipated for several years and having minimal impact on coal markets due to the small volumes consumed by the UK power sector, the closure of the last coal plant in the United Kingdom is highly symbolic: the world's first coal-fired utility power plant began generating in the country in 1882. By 2027 UK coal consumption is set to decline further to just 2 Mt, used solely for non-power purposes.

Other Asia Pacific

Strong demand for coal in Southeast Asia is being driven by Indonesia and Viet Nam

Coal consumption in ASEAN countries reached 457 Mt in 2023, marking a 10% increase from the previous year. Of this consumption, 76% was attributable to electricity generation. Indonesia accounted for nearly half (48%) of ASEAN countries' coal use, followed by Viet Nam (21%), the Philippines (9%) and Malaysia (8%).

For 2024 we anticipate ASEAN coal consumption to have risen to 491 Mt (up 8%). As in previous years, increased demand in Indonesia is the main reason for this uplift. The region continues to have robust economic growth prospects, accompanied by numerous coal-fired power plants currently under construction. We expect demand for coal in ASEAN countries to grow by 5% annually and reach 567 Mt by 2027. Indonesia accounts for two-thirds of this growth.

Growing coal consumption in Indonesia is mainly fuelled by power generation, but also by nickel production. In 2023 Indonesia produced 1.9 Mt of nickel, over half of global output. With rising demand for electric vehicles and batteries for other uses, investment in Indonesia's nickel production capacity is increasing. Nickel's high melting point and corrosion resistance make it a valuable component in processed materials. Around 70% of primary nickel production is used in steel, while 11% is used in batteries. Nickel is classified into Class 1 (nickel content > 99.8%), used in batteries, and Class 2 (nickel content < 99.8%), primarily used

in steel production. Indonesia is a major producer of Class 2 nickel. It is expanding its Class 1 capacity to meet growing demand from global battery manufacturers.

Both the rotary kiln-electric furnace (RKEF) and the high-pressure acid leach (HPAL) nickel production processes are used in Indonesia, although RKEF accounts for the majority of production. The RKEF process produces ferronickel (FeNi) or nickel pig iron (NPI), both Class 2 nickel, which can be used in steel production or converted into nickel matte for Class 1 production. Coal is used directly in this process, together with some coke. In addition, electricity for the necessary power is often provided by captive coal-fired power plants. The HPAL process produces mixed hydroxide precipitate (MHP) or mixed sulphide precipitate (MSP), which can be processed into Class 1 nickel. Coal is sometimes used to produce steam and often to supply power generation in captive plants in this process. Indonesia is also expanding aluminium production in order to export aluminium rather than bauxite. A new industrial park in North Kalimantan is due to result in the country's aluminium production growing to 2.5 Mtpa, increasing electricity demand by around 30 TWh. In November 2024 the Indonesian president announced plans to phase out coal power generation by 2040. While this sends a very strong signal for long-term developments, the impact by 2027 is expected to be very limited.

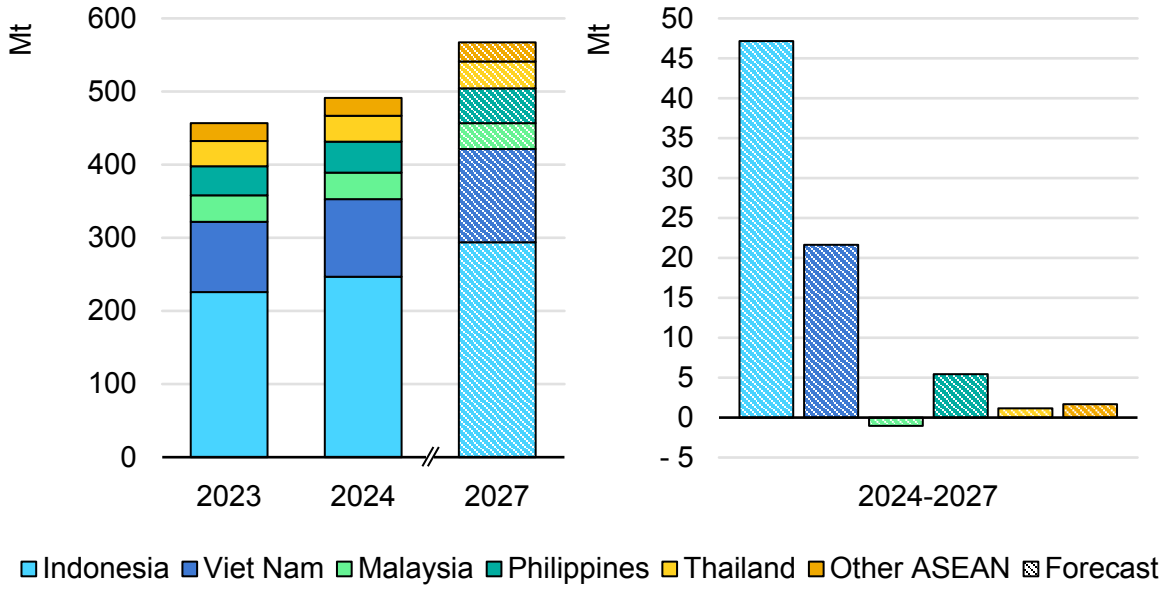
Overall, we expect Indonesia's coal consumption to have risen by 9% in 2024 to 247 Mt. The surge in nickel demand is expected to continue in the coming years, as is the requirement for coal-fired power generation injected into the grid, leading to an estimated total coal demand of 294 Mt by 2027 in Indonesia. The country, with the world's fourth-largest population, is set to become the fourth-largest coal consumer as well.

In Viet Nam coal demand in 2024 is expected to have surged significantly to 106 Mt due to recurring heatwaves, with temperatures exceeding 44 °C in April driving up cooling needs. Additionally, reduced hydropower generation in the first half of the year further boosted coal consumption. Annual electricity demand is projected to rise by 58 TWh to 375 TWh in Viet Nam by 2027. While renewable generation will meet most of this additional demand, coal consumption in coal-fired power plants is also expected to contribute, as coal-fired power generation capacity continues to grow. Combined with growth in non-power uses, we estimate coal consumption reaching 128 Mt by 2027.

In the Philippines coal consumption is projected to have risen slightly from 40 Mt in 2023 to 42 Mt in 2024. Power generation primarily drives coal consumption, with most coal imported from Indonesia. Given the strong economic outlook, we expect coal consumption to reach 47 Mt in the next three years. Although we anticipate significant growth in renewable energy generation, it will be outpaced by the increase in electricity demand.

In Malaysia coal demand is expected to remain at 37 Mt in 2024. With the expansion of renewable and gas-fired generation, the demand for thermal coal is projected to decrease by 3% to 35 Mt by 2027.

Coal consumption and forecast change in coal consumption in ASEAN countries, 2023-2027



A slow but steady decline in coal demand in mature Asia Pacific economies

Coal consumption in advanced economies of the Asia Pacific region is primarily driven by power generation, with Japan, Korea, Australia and Chinese Taipei collectively using an estimated 420 Mt in 2024.

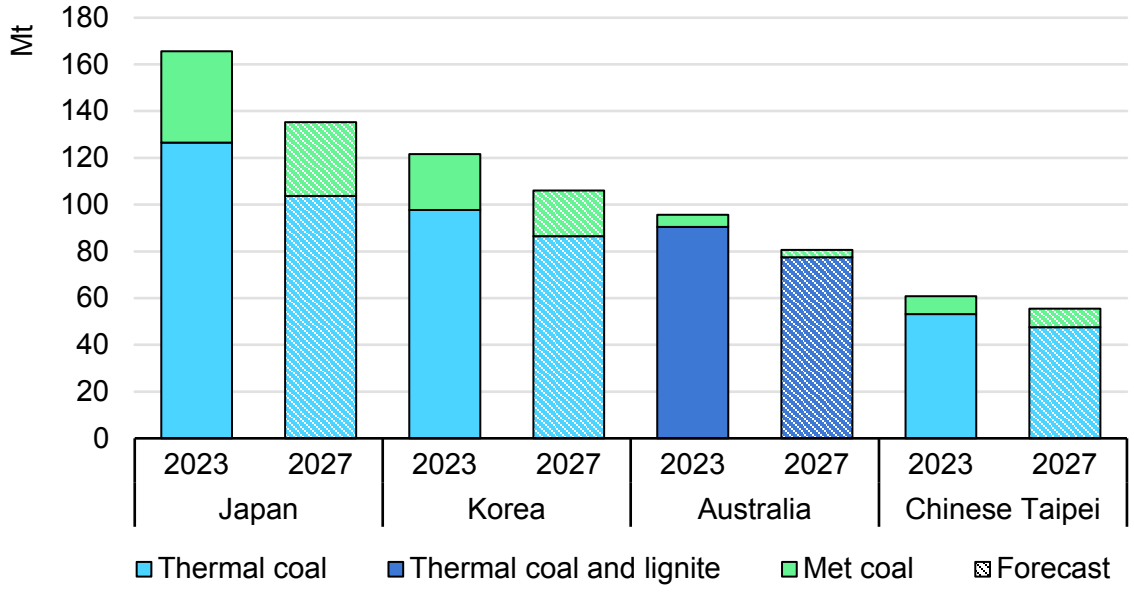
In Japan coal consumption is expected to have fallen y-o-y during 2024, bringing total consumption to 155 Mt. This decline is mostly due to the reduction in coal consumption in the electricity sector and, to a lesser extent, in steel production. Japan has set itself the goal of phasing out inefficient coal-fired power plants by 2030 and has committed to end unabated coal-fired power plants in the 2030s. Currently, inefficient coal-fired power plants with an efficiency of less than 40% account for around 20% of Japan's total power plant fleet. The government has announced plans to restart more nuclear reactors to meet the demand for electricity. With electricity demand projected to remain flat, gas- and coal-fired generation are expected to fall during the next three years assuming over 40 TWh increase in nuclear production and ongoing renewable energy deployment. Consequently, we anticipate Japanese coal consumption decreasing by 13% to 135 Mt by 2027.

In 2024 coal consumption in Korea is projected to have declined by 7 Mt, falling to a total of 114 Mt. One driver for this reduction is the addition of 2.8 GW of nuclear power capacity, which is displacing coal-fired generation. An additional 1.4 GW of nuclear capacity is expected to come online in 2025. In May 2024 the government announced increased investment in renewable energy and combined CCGTs. A slower decline is expected for coking coal demand, driven by the dynamics of the steel sector. Consequently, coal consumption is estimated to decrease to 106 Mt by 2027.

Australia's coal consumption is expected to have recovered slightly from 91 Mt in 2023 to 92 Mt in 2024. A decrease in hydropower output, combined with the lack of growth in wind generation, has driven the slightly stronger demand for coal-fired power generation. Looking ahead to 2027, coal-fired power generation is expected to decline as increasing renewables push some coal generation out of the market. We forecast a decrease in coal consumption to 78 Mt by 2027.

In Chinese Taipei coal consumption was 61 Mt in 2023, with 47 Mt used for power generation. In 2024 coal consumption is expected to have declined by 2.1% to 59 Mt. In the last quarter of 2024 Chinese Taipei is due to have retired 1.1 GW of coal-fired capacity and add 3.1 GW of gas-fired capacity. The country also plans to fully phase out nuclear power by May 2025 while boosting the share of renewables in its energy mix, which has some uncertainty. We expect total coal consumption to decrease slightly to 56 Mt by 2027.

Coal consumption by grade in select mature Asia Pacific economies, 2023 and 2027



Rising coal-fired generation capacity is driving up coal demand in South Asia

Emerging economies such as Pakistan and Bangladesh, which have a combined population of 413 million, were heavily affected by the high energy prices of 2022, resulting in energy shortages as they struggled to secure adequate supplies of primary energy such as gas and coal. Despite a subsequent easing of prices, these countries remain significantly more sensitive to price fluctuations than other major demand centres.

In Pakistan coal demand is expected to have stayed at 24 Mt in 2024, the same as in 2023. Coal prices are still too high to guarantee the profitability of coal-fired capacity relying on imported coal. Total coal-fired capacity will total over 8 GW after the commissioning of the new 660 MW unit at the Jamshoro plant. This is designed to use a blend of 80% imported coal and 20% domestic lignite. The high energy costs are also affecting industrial demand, particularly in the cement sector. The country's economic situation continues to be difficult, with double-digit inflation rates in 2024, albeit lower than in previous years, and the depreciation of the Pakistani rupee making energy imports such as LNG and coal costly for Pakistani buyers. To address power demand growth, Pakistan is increasing coal-fired power production using domestically mined coal. The government has also engaged with China, which financed most of the country's coal-fired power plants, to repurpose these plants to use domestic lignite instead of imported seaborne coal. Infrastructure to transport coal from the domestic Thar field could be operational by late 2025. However, given the lower calorific value (CV) of Thar lignite compared to the imported coal, the absolute total of tonnes consumed will increase. Consequently, we project coal consumption increasing from 24 Mt in 2024 to 27 Mt by 2027.

In Bangladesh over 4 GW of coal-fired power generation capacity has been commissioned in recent years, with an additional 4 GW under construction. As power demand is poised to rise further, we expect coal demand from power generation to double through to 2027. Additionally, a positive economic outlook is expected to support growth in non-power uses, albeit at a lower level. Consequently, we project Bangladesh's coal consumption to reach 18 Mt by 2027.

Africa

South Africa's coal sector is at a crossroads

In 2024 we expect coal consumption in Africa to have increased by 6 Mt to a total of 191 Mt, driven mainly by the improved performance of coal-fired assets operated by Eskom, the state-owned power utility of South Africa. The country accounted for 86% of Africa's coal consumption in 2023 and is expected to have increased its coal consumption to 165 Mt in 2024. Economic activity in South Africa has seen a slight improvement, and a reduction in load shedding is expected to increase coal demand.

Despite a projected increase of over 50% in nuclear generation and a doubling of renewable generation, strong electricity demand growth is expected to create room for an additional 14 TWh of coal-fired generation in South Africa in the next three years. The country continues to run three coal-fired power plants of 4.5 GW capacity that were previously set for closure. The lifetime of the three plants will be extended until 2030. Consequently, we project South Africa's coal consumption for power generation to rise to 124 Mt by 2027. The future of coal demand in South Africa will be shaped by policy makers' decisions regarding the coal-fired power fleet, either to invest in their maintenance to keep them running for longer or to phase them out.

Morocco, the continent's second-largest coal consumer, uses coal exclusively for power generation. Its coal demand is projected to have declined slightly by 3.3% to 9.7 Mt in 2024. The addition of 6 TWh of renewable generation by 2027, when overall electricity demand grows by 4 TWh, is set to reduce coal demand modestly to 9.0 Mt during the period to 2027.

In March 2024 a steel plant operated by China's Tsingshan Group began commercial operations in Zimbabwe. The initial output is 0.6 Mt of steel per year. The long-term goal is to reach a production capacity of 5 Mt, positioning Zimbabwe as the continent's leading steel producer. This will increase annual coking coal demand by 0.4 Mt with a further potential of up to 4 Mt. In August 2024 a new 335 MW unit at the Hwange power plant was commissioned, increasing annual steam coal consumption by around 1 Mt once at full capacity.

In Zambia two new coal-fired units have received approval after the power cuts following the droughts suffered in the country during 2024. However, we do not expect their commissioning by 2027.

Based on these developments, we forecast modest growth in total coal demand in Africa, which is expected to increase to 203 Mt in 2027.

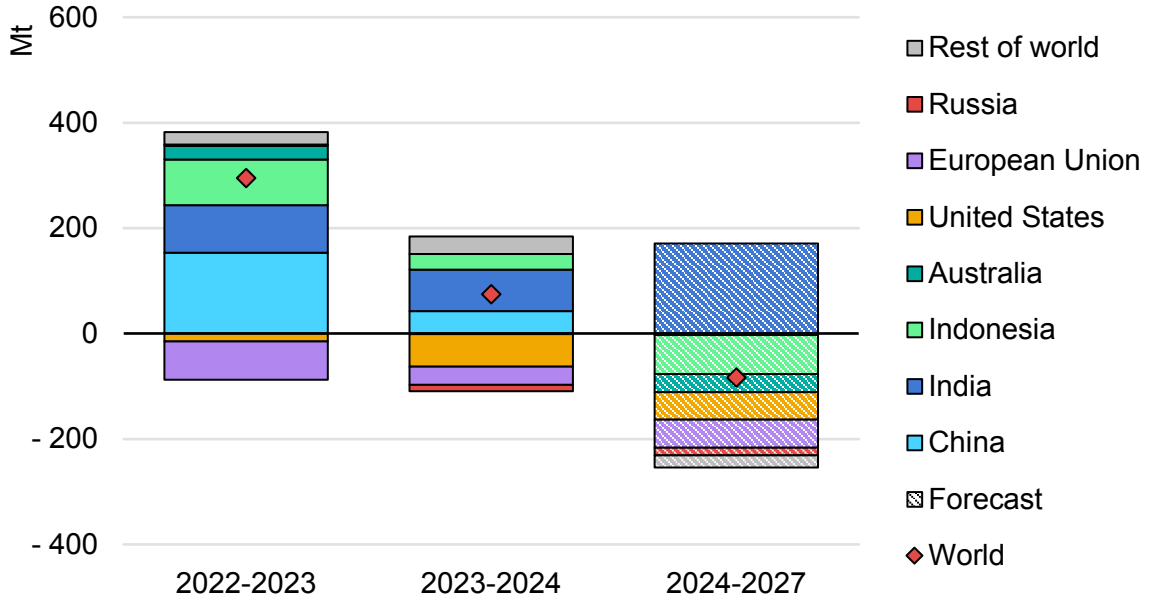
Supply

Global coal production grew to new highs in 2023, with slight growth expected for 2024

Global coal production saw another year of growth in 2023, increasing by 3.4% y-o-y to a total of 8 993 Mt. China once again led the increase in production, aiming to prevent the coal shortages experienced before 2022. However, the growth rate in 2023 was slower than in 2022. Indonesia and India each ramped up coal production by more than 85 Mt. Indonesian growth is being driven by increased seaborne demand for thermal coal from international markets and rising domestic demand. In contrast, India's growth focuses on securing supply for domestic consumers, in particular power plants, while reducing reliance on imports.

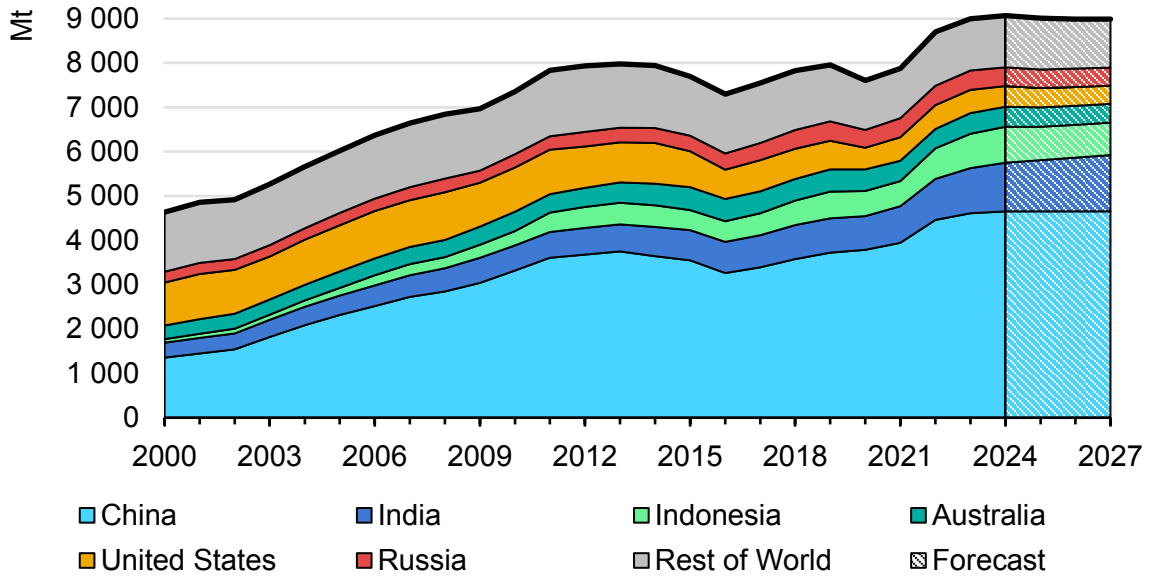
In 2024 global coal production is forecast to have increased slightly, in line with the slower growth in coal demand, but enough to reach a new all-time high and surpass 9 bt for the first time. India is expected to be the largest contributor to global coal production growth. However, these additional volumes are expected to be partially offset by significant reduction in the United States and moderate declines in the European Union and Russia. As a result, 2024 should mark the first year without notable growth in coal production since the Covid-19 pandemic.

Change in global coal production, 2022-2027



During the forecast period we anticipate a very slight decline in global coal production, aligning with expectation of a very weak global coal demand growth and current abundant coal inventories. Declines in the United States and the European Union are expected to be accompanied by reduced production volumes in Indonesia, as Chinese demand for seaborne thermal coal is expected to decrease. India remains the last stronghold of significant production growth, driven by its power sector's increasing demand. However, our model predicts that declines in other countries will narrowly offset this growth, leading to a global production total of 8 984 Mt by 2027.

Global coal production, 2000-2027



China

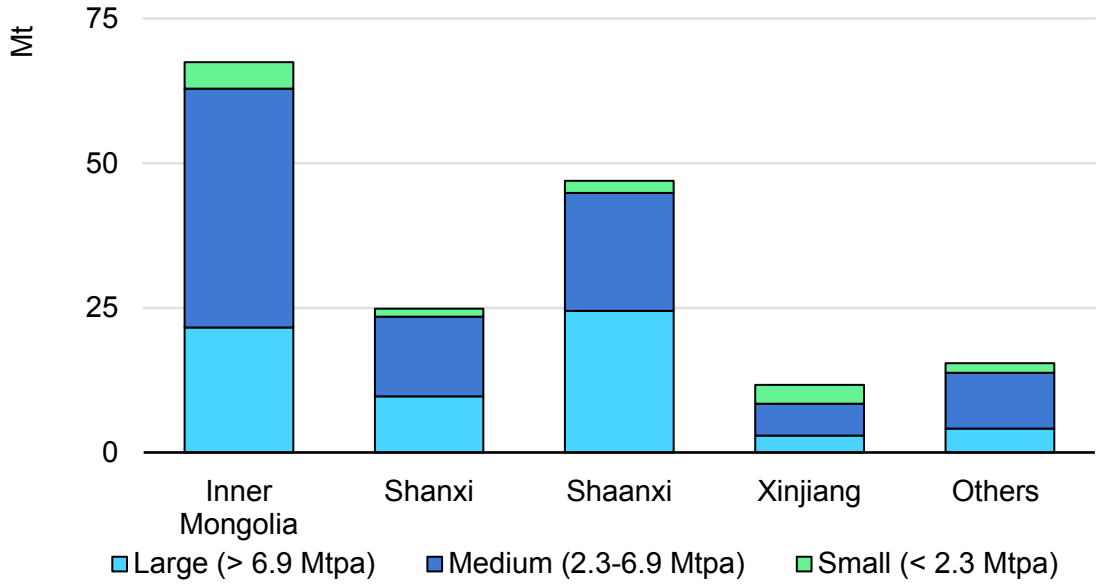
China's coal production continued to grow in 2023 following the boost in 2022

In 2023 coal production in China grew by 3.4% y-o-y to 4 610 Mt, reaching another all-time high. Following coal shortages in 2021, China implemented policies to boost coal production in the autumn of that year and achieved significant production growth during 2022. However, the average quality of the coal output deteriorated. Production continued growing during 2023, but at a slower rate. Several mining accidents caused temporary mine closures, with subsequent safety checks affecting coal production. In response to these accidents, a regulation was adopted in September 2023 imposing a ban on the construction of new mines below a capacity of 0.9 Mtpa, which often face a higher risk of

accidents. After first surpassing the 400 Mt production mark in a single month in December 2022, the following year saw three months surpassing this mark – March, November and December.

More than four-fifths of China's coal production is thermal coal and about 83% of this thermal coal is produced in just four regions.[5] These regions and their corresponding share of thermal coal production are Inner Mongolia (34%), Shaanxi (23%), Shanxi (20%) and Xinjiang (6%). Inner Mongolia recorded the highest increase in production in 2023, growing by more than 5%. The four largest producing regions export a big share of their production to other regions, posing challenges for transport infrastructure. The analysis of 2023's output increases by mine size shows a significant contribution from medium-sized mines (up 91 Mt) and large mines (up 63 Mt) mines, while small mines (up 13 Mt) showed little growth compared to 2022's output.

Change in thermal coal production in China's major producing regions by mine size, 2022-2023



Source: Adapted from CRU (2024), Thermal Cost Model (database).

China's coal production growth slows in 2024

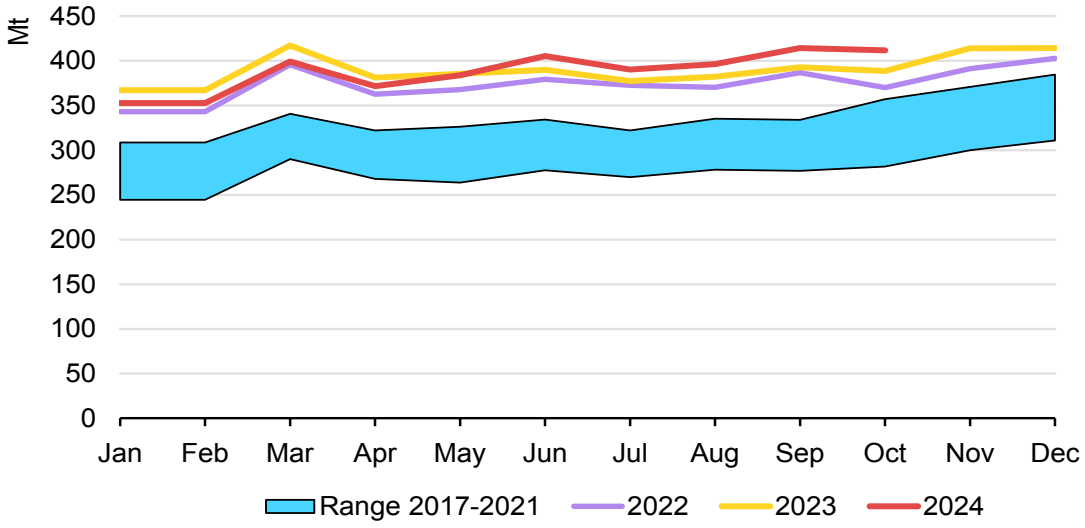
In 2024 we estimate China's coal production to have increased marginally by 1% to 4 653 Mt. The National Bureau of Statistics reported that coal production dipped by 3.0% during the first five months of the year, with March experiencing the period's biggest y-o-y decline of 4.3%. In June coal production experienced a trend

[5] China only reports coking coal and other bituminous coal (thermal coal), although it also produces anthracite and lignite.

reversal with its first significant increase of the year (up 3.9%). During the third quarter China's coal production grew by 4.2% y-o-y, with a production record in September, despite low demand in summer. During the third quarter domestic miners ramped up production ahead of the winter peak, when heating demand edges higher and renewable output edges lower.

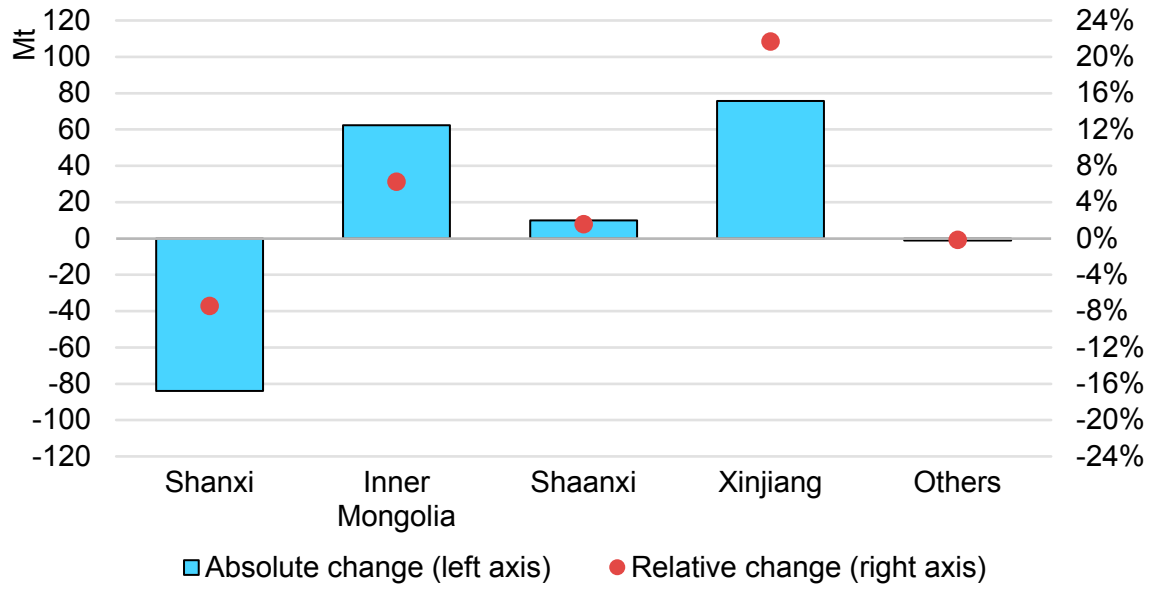
Regionally, three of the four top producing provinces, Inner Mongolia, Shaanxi and Xinjiang, recorded a y-o-y increase in production during the first ten months of 2024, with Xinjiang showing the highest relative increase at 22%. Conversely, Shanxi experienced a significant reduction of almost 10% during this period, as the region adjusted its output after seven years of strong growth, mainly in response to rising safety issues, the region recording an increase of more than 50% in fatal mining accidents in 2023. Moreover, a new safety regulation was implemented as of May 2024, which aims to hold regional governments more accountable for mining accidents, as some have allowed laxer safety measures to ensure higher coal production. In addition, fines for illegal activities and accidents have been raised significantly.

Coal production by month in China, 2017-2024



Note: January and February based on cumulated data from February.
Source: IEA analysis based on National Bureau of Statistics of China (2024), Statistical Database.

Year-on-year change in coal production by region of China, January to October, 2023-2024



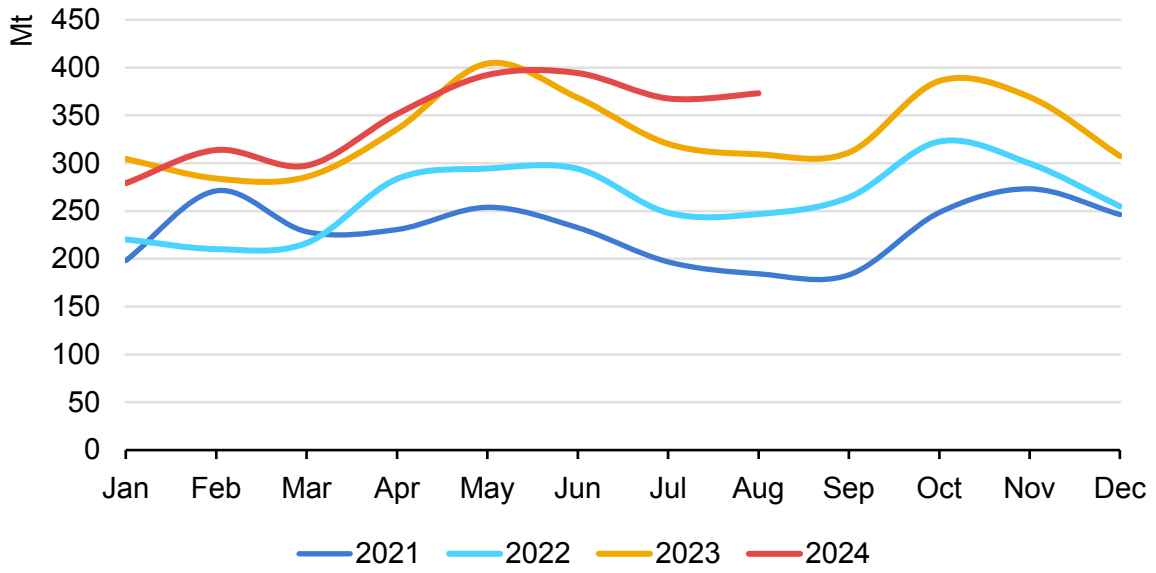
Source: IEA analysis based on National Bureau of Statistics of China (2024), Statistical Database.

Following China's production push in late 2021, a notable imbalance between reported demand and supply emerged, resulting in growing coal inventories. In response to the coal shortages of 2020 and 2021, China has prioritised energy security and robust inventories are a key pillar to buffer short-term fluctuations caused by, for example, market conditions, weather events or geopolitical shocks.

Given China's complex supply chain, inventories can amount to many hundreds of millions of tonnes of coal stored at mines, ports, power plants, industrial facilities and rail transhipment sites. Additionally, the domestic supply chain handles over 4 billion tonnes of coal annually, with more than 2 billion tonnes transported by rail and over 800 Mt by ship, resulting in substantial volumes of coal in transit. As a result, changes in China's supply chain and stockpiles have a direct impact on global coal supply and trade trends.

In the analysis below, we evaluate the stockpiles at representative mines, power plants and ports, and extrapolate data to derive an indicative trend on China's total inventories. Traditionally, China's coal consumption peaks twice a year: once during the heating season and again in the summer, when increased electricity demand for cooling drives coal-fired power generation. Fluctuations in inventories move accordingly, with higher levels prior to periods of peak consumption.

Indicative monthly coal inventories at select sites in China, 2021-2024



Note: Inventories are computed using disaggregated days of use at representative mines, ports and power plants. Analysis does not cover all Chinese inventories such as transhipment sites and final consumers outside the power sector.

Notably, inventory levels have grown significantly since 2021, when shortages weighed on the country. The substantial push in production throughout 2022 and 2023 led to overall supply outpacing demand growth. In our analysis the average inventory at mines, plants and ports amounted to 229 Mt in 2021, while in 2023 this number grew to 332 Mt. In the first eight months of 2024 inventory levels were slightly higher than in 2023, indicating a robust buffer to balance supply or demand vagaries. The analysis comes with an important caveat, as it does not account for stocks at end consumers (other than power plants) or transhipment stations.

China's production is set to plateau through to 2027, as demand slows

During the past three years China has significantly ramped up coal production as well as imports to meet its growing demand and to prepare against shortages such as those experienced prior to 2022. Our analysis indicates that there is a surplus of coal in 2024, as domestic production and imports are expected to amount to more than 5.2 billion tonnes, while demand is expected to turn out slightly over 4.9 billion tonnes in 2024. In our forecast period the lean towards strong or even surplus supply is set to persist, since demand is projected to remain almost flat through to 2027.

China is planning to build a domestic production reserve system by 2027, with the aim of stabilising prices and guaranteeing supplies to power plants. The plan calls for 300 Mt of reserve annual coal production capacity by 2030. Instead of high stockpiles,

which deteriorate[6] over time, a production capacity reserve can also offset long-duration imbalances in supply or demand caused by, for example, trade disruptions. The reserve mechanism would trigger production in the case of such imbalances. This highlights China's intent to prevent coal shortages from occurring again.

More than 1.2 billion tonnes of coal – one-third imported and two-thirds domestically produced – arrive at Chinese coastal ports every year. The arbitrage between domestic production and imports is subject to trade-offs between costs and supply stability. As domestic production shifts westward, rising transport costs are making imports more attractive. At the same time, the government is promoting domestic coal contracts to stabilise prices. In 2024 power generators have been required to procure 80% of their coal via term contracts, slightly reduced from 2023 due to high stock levels. While domestic production is prioritised, the quality of some imported coal can be well suited to blending with domestic, highlighting a role for imports despite abundant stocks.

Against this background, we estimate China's production through to 2027 to remain at levels similar to those observed in 2024.

India

After surpassing the 1 billion tonne mark in 2023, India's coal production growth is set to continue

In 2023 Indian coal production increased by 10%, exceeding 1 billion tonnes (1 020 Mt) for the first time. While most of the output consisted of thermal coal, India does have some lignite and coking coal production.[7] The 10% growth rate aligns with India's long-term strategy of reducing coal imports and enhancing energy security, after shortages and high prices caused difficulties in previous years.

India's coal production can be categorised into three groups: public, captive, and commercial mining.

The public sector is dominated by hard coal producers Coal India Ltd (CIL) and, to a lesser extent, Singareni Collieries Company Ltd (SCCL), together with the state-owned lignite producer NLC India Ltd. Producers in the public sector mostly supply coal to the domestic power sector at notified prices, which are predefined by CIL to guarantee low-cost electricity generation. With a share of almost 80%, CIL accounts for most of the coal production in India. The company's output grew by approximately 7% in 2023, thus contributing less to growth than other companies. In March 2024 CIL's subsidiary company SECL obtained environmental clearance for the 53 Mtpa

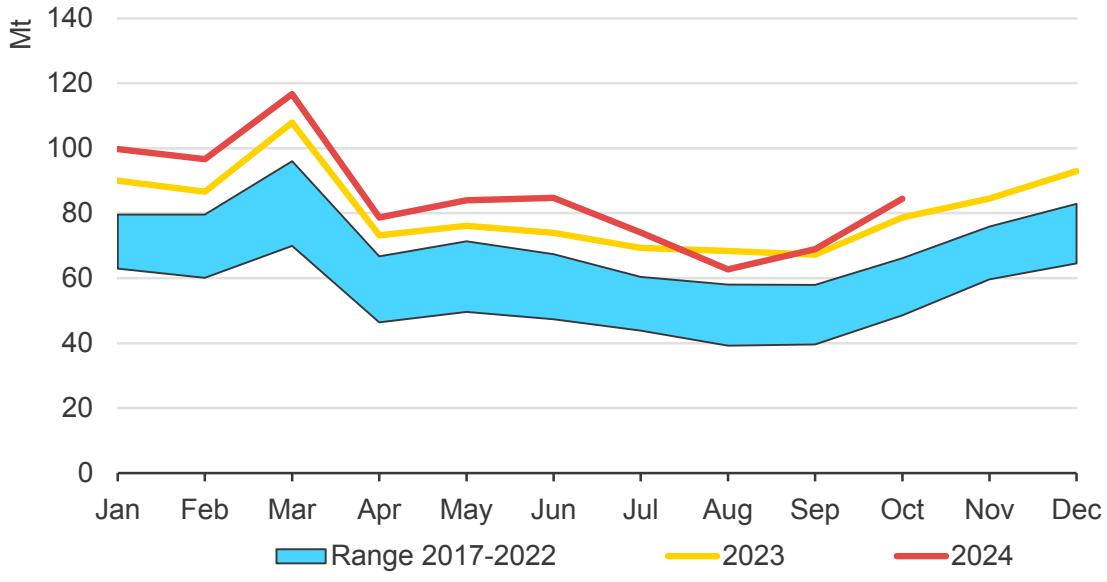
[6] Coal loses energy content through oxidation when stored. In some cases this can lead to self-ignition.
[7] In this report, coking coal used for thermal purposes is classified as thermal coal.

Gevra mine to expand production to 70 Mtpa, which would make it the largest mine in Asia. In November 2024 CIL announced the launch of 36 new mines over the next five years, while Singareni announced seven new mines and NLC two. To further boost coal production, the Ministry of Coal has been focusing on engaging mining developers cum operators (MDOs) to manage operations at CIL-owned mines. These private contractors are responsible for overseeing the entire mining process, from extraction to delivery. In August 2024 the Ministry of Coal expanded its initiative on MDOs from a combined capacity of 168 Mt to 257 Mt across 28 projects, 14 of which have already been awarded to MDOs, including six that have started production.

Coal production in the captive sector is tailored to supplying their own industrial or power facilities, with restricted approval for selling coal on the domestic market. Although the captive sector currently accounts for only approximately 15% of India's coal production, the sector grew by 30% in 2023. The largest producer in the captive mining sector, NTPC, produced 34 Mt in FY24 and has a target to double production within the next three years. We analyse the commercial sector in a separate section below.

In 2024 we expect coal production in India to have grown by 8% to a total of 1 099 Mt. In the first ten months of the year, Indian coal production, excluding lignite, surged by 7%, marking an increase of 59 Mt y-o-y. While August experienced the first y-o-y decline due to heavy rains disrupting open cast mining operations, March 2024 set a new record with monthly output of approximately 116 Mt. Moreover, coal inventories at power plants and pitheads were more than 30 Mt higher in the first three quarters of 2024 than in the same period of 2023.

Monthly coal production in India, 2017-2024



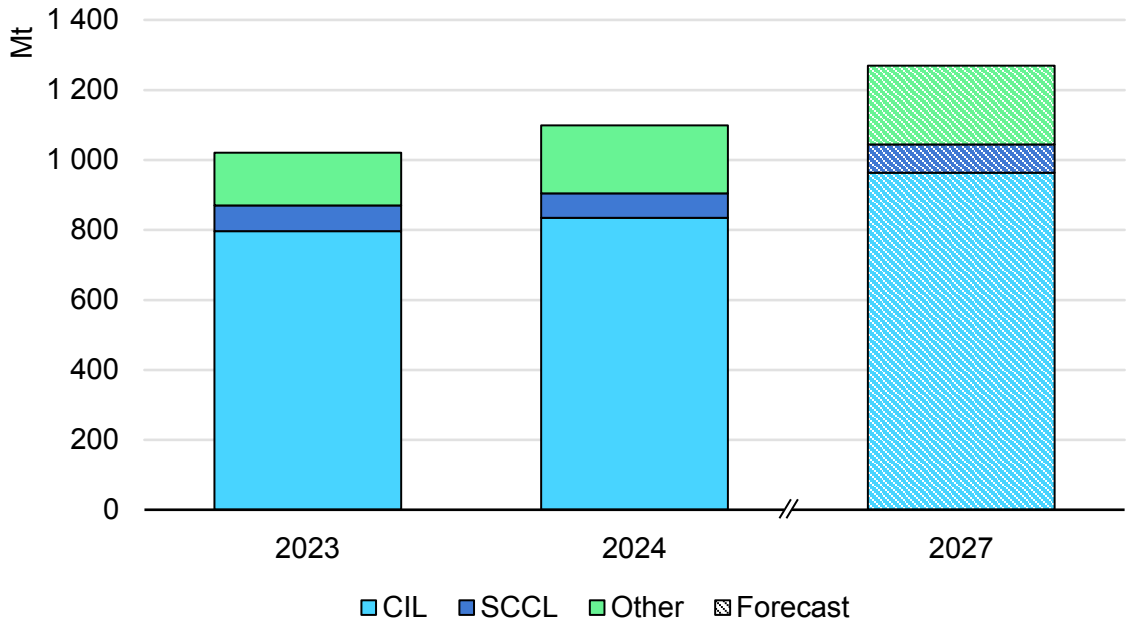
Source: IEA estimates based on McCloskey (2024), McCloskey Coal, Metals and Mining Service.

The significant surge in India's coal production also poses challenges to its infrastructure, particularly transport via rail, which often competes with passenger traffic, as the mines are concentrated in certain regions while consumption is more distributed across the country. In August 2024 the Ministry of Coal announced plans to expand the modal share of rail transport for coal from 64% to 75% by FY2030. To reach this goal, the ministry identified 38 priority rail projects, which are to be developed in close co-operation with the Ministry of Railways, improving connectivity and reducing transport costs.

The Indian government's efforts to improve coal supply and modernise the sector also extends to the approval process. In November 2024 the Ministry of Coal launched the Mine Opening Permission module in the Single Window Clearance System, aimed at accelerating the approval of new coal mines. Additionally, India plans to establish a domestic coal exchange to enhance liquidity and support price transparency.

India's growing demand for coal, together with its endeavours to reduce energy imports and bolster energy security, will push up coal production in the coming years. We estimate coal production increasing by 170 Mt, reaching a total of 1 269 Mt in 2027. However, this forecast remains behind the Ministry of Coal's production target of 1.4 billion tonnes for FY2027.

Annual domestic coal production by company in India, 2023-2027



Sources: IEA analysis based on McCloskey (2024) and IEA estimates.

India’s commercial coal blocks are ramping up

In 1993 India’s government initiated the partial liberalisation of CIL’s monopoly in the coal mining sector by allowing private companies to participate. This enabled the development of captive blocks.[8] In 2015 the government paved the way for commercial coal sales, aimed at enhancing domestic production and reducing the gap between production and demand, which had been driving up imports. In addition, the move aimed to increase the sector’s competitiveness and promote industrial growth. Currently, the allocation of coal mines is managed through a tendering process, with the first round launched in June 2020. Both public and private entities can participate in the auctions.

To date, the government has conducted 10 rounds of auctions for commercial coal mining, underscoring the willingness of the government to allow commercial mining to play a bigger role in coal supply. Unallocated mines are re-auctioned in subsequent rounds.

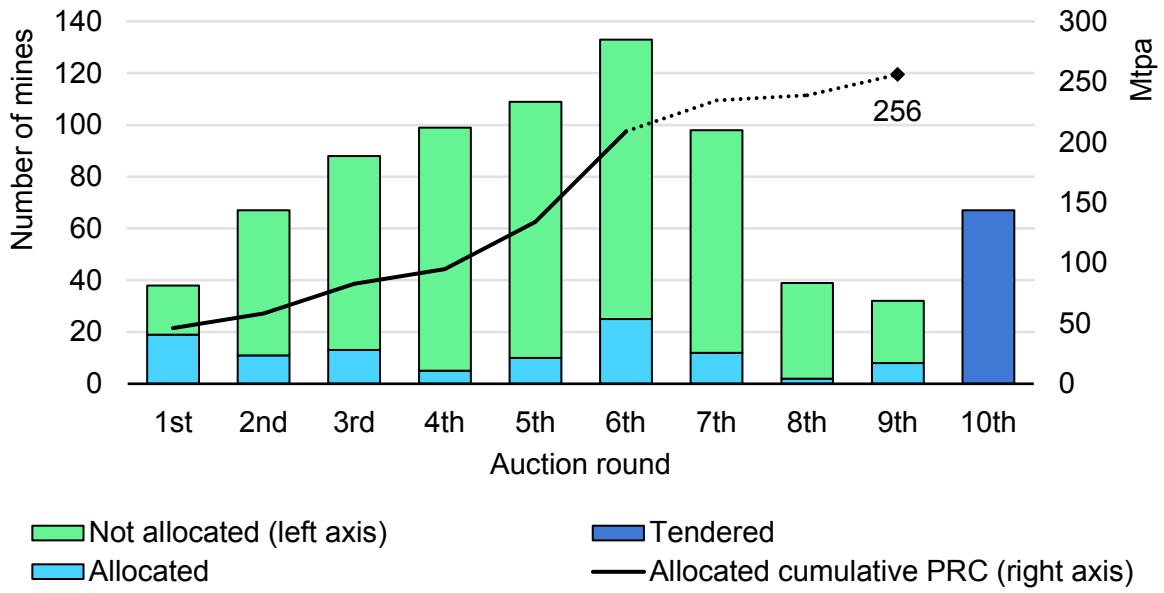
As of November 2024, 113 coal mines have been allocated to bidders in nine completed auctions and the ongoing 10th round. Most of these are thermal coal mines, meeting the demand from captive or on-grid coal-fired power plants. The fully explored allocated mines have a cumulative peak rated capacity (PRC) of around 256 Mtpa, which amounts to over 20% of India’s current annual coal production. This figure is expected to rise as the exploration of the remaining mines is completed. On 5 December 2024 the government launched the 11th round of auctions, in which 27 coal blocks were offered.

Despite the high number of mines offered in each auction round, the allocation rate has been low due to the challenging locations of many sites, which are often in deep forests and difficult terrains. To enhance bidder interest, the Ministry of Coal is now publishing drone videos before auctions, giving potential buyers a clearer view of the mines’ topography.

By January 2024 six commercial mines had commenced operations, increasing to eleven by June 2024. The government aims to produce 380 Mt from captive and commercial blocks by 2030. Given the financial capability of the companies awarded these blocks, primarily large industrial conglomerates, these targets appear achievable.

[8] In India a coal block is a specific geographical area for exploration and/or extraction of coal. Once allocated, it gives the legal right to perform these activities.

Number of mines and expected peak-rated capacity from commercial mines by auction round in India



Note: Values for allocated cumulative PRC between the 6th and 9th rounds are estimated based on the number of allocated mines during these rounds.
Source: IEA analysis based on Ministry of Coal (2024).

Others

After the recent surge, Indonesia's coal production flattens out amid weaker seaborne demand

Indonesia's coal production experienced double-digit growth for the second consecutive year in 2023, rising by 13% to 775 Mt. The destinations of Indonesian coal can be classified into three key markets of similar size – domestic use, export to China, and export to other international markets. In 2023 Chinese demand for seaborne thermal coal grew by more than 150 Mt, and a large proportion of this was met by higher production in Indonesia. Growth in domestic demand of about 23 Mt further contributed to production growth.

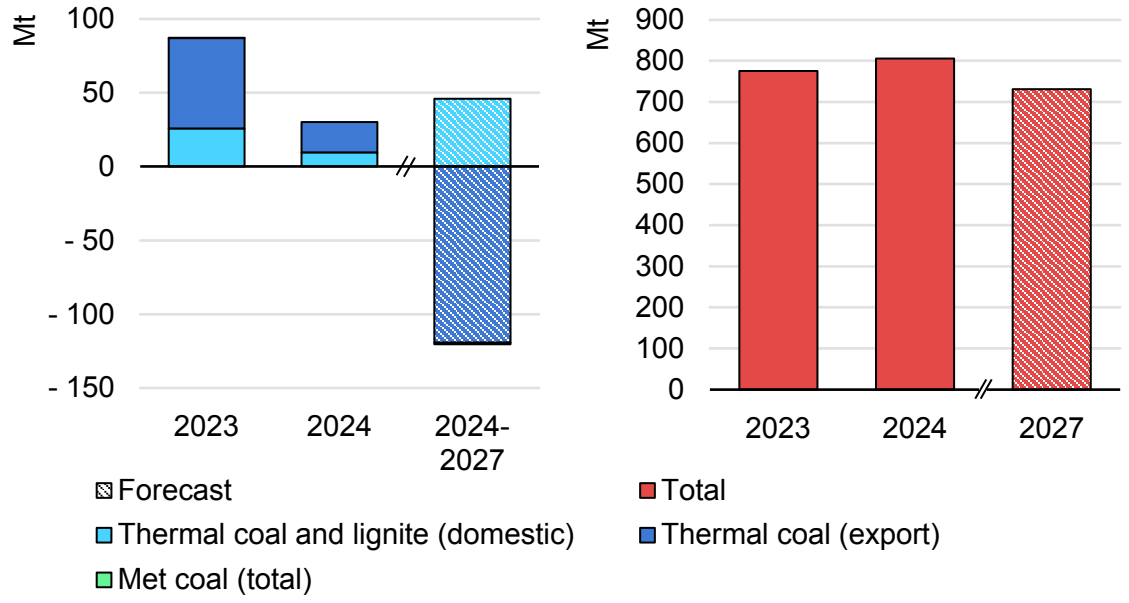
In 2024 we expect growth in Indonesian coal production to have slowed to about 3.9%, which would result in a total of 805 Mt. The Indonesian government raised the production quota for 2024 by almost 30% to 922 Mt, although market participants reported that some producers have struggled with lower prices in 2024 and oversupply in the low- and mid-CV segment.

In the next three years we expect Indonesian coal production to be influenced by exports as well as growing domestic demand. While demand for coal from captive plants and industrial facilities is set to grow, aggregate demand from traditional

importers of Indonesian coal is estimated to decline. Therefore, we estimate Indonesian production decreasing by 75 Mt to a total of 731 Mt by 2027.

Regarding the rest of the ASEAN region, we expect production close to its current levels through to 2027 in Thailand and Viet Nam. In the Philippines the country's only coal producer, Semirara, is expected to increase production by around 9% to 16 Mt in 2024. In October 2024 it announced a USD 5 billion investment in mine expansion, leading to the expected increase in production in the Philippines. In Lao PDR we expect production to increase, mostly driven by supplies to its neighbour Viet Nam.

Change in coal production and total coal production in Indonesia, 2023-2027



Australian production is caught between a declining domestic market and an uncertain export market

Australian coal production is largely export oriented, as only a fifth of its coal output is consumed domestically. Moreover, with the domestic market declining for over a decade, export expectations have driven investment. Therefore, demand and prices on international markets – together with short-term mining conditions such as the weather and long-term circumstances such as political support for coal – significantly affect Australian production.

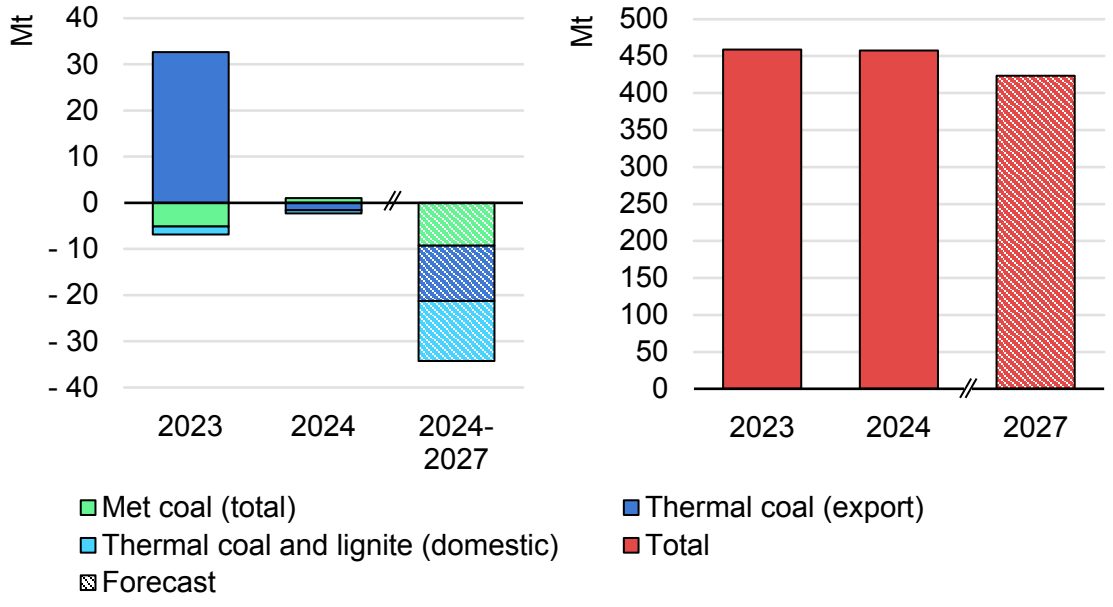
In 2023 Australian coal production increased by 6% to 459 Mt. Most of this growth was recorded in New South Wales, which is one of the two major coal-producing states in Australia, together with Queensland. The increase was favoured by a

change in weather pattern from La Niña to El Niño, which is usually associated with drier weather, and also strong seaborne demand for Australian coal.

In the first three months of 2024 coal production in Australia dipped due to weather disruptions, but rebounded in the second quarter. In June 2024 an underground fire in Anglo American's Grosvenor met coal mine caused a halt to operations; however, Anglo's recent estimate suggests this incident should only slightly affect overall output, although it is uncertain when the mine will be fully operational. Elsewhere, new mines came into operation during 2024, including the Dartbrook mine, the Olive Downs Complex and the open pit Vickery mine. Nonetheless, given the drop in production at the beginning of the year, we expect Australian coal production to remain flat at 458 Mt in 2024.

In the forecast period, met coal imports, of which Australia is the largest exporter by far, are expected to shrink. In addition, Mongolia stepped up to become the second-largest exporter of met coal in 2024, reducing Chinese appetite for Australian exports. Australia's domestic demand for thermal coal and lignite is expected to continue its decline. Against this background, we estimate Australian met coal production decreasing by 9 Mt to a total of 153 Mt by 2027 and its thermal coal and lignite production decreasing by 25 Mt to a total of 270 Mt.

Change in coal production and total coal production in Australia, 2023-2027



Exports offer some relief to US coal producers

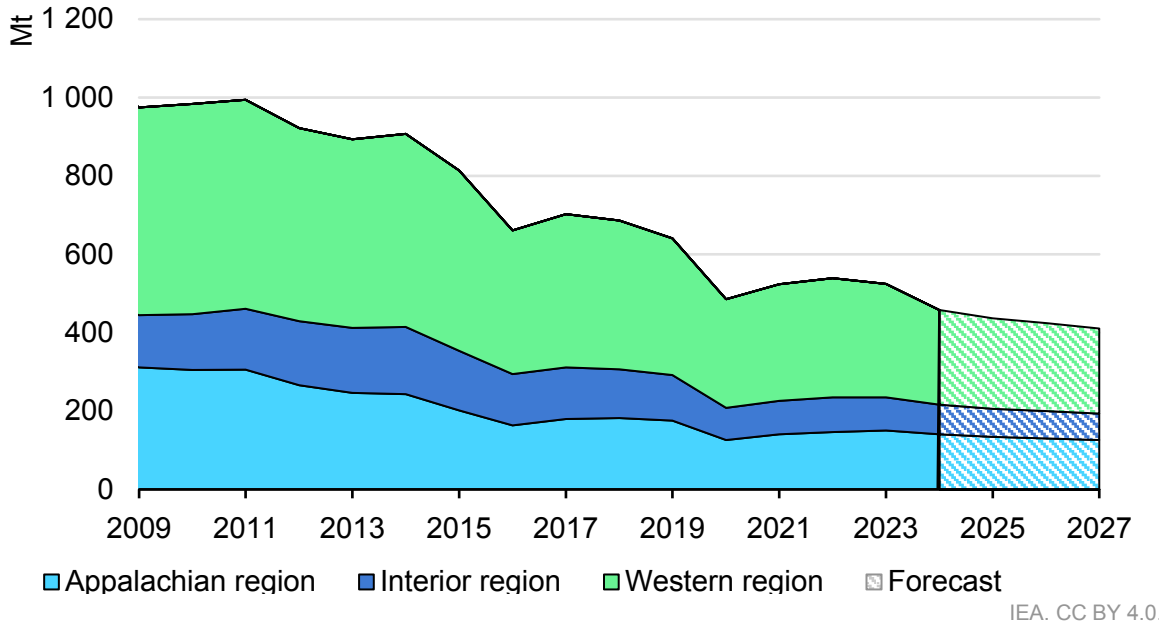
Coal production in the US fell by 2.8% in 2023, although the decline in domestic demand was much stronger. The difference was used to restock inventories and to supply international markets. Aggregate coal production stood at 524 Mt in 2023.

In 2024 we expect coal production to have decreased by 12%, bringing total output down to 463 Mt. This reduction is expected to align production more closely with demand, which is forecast to have declined at a slower pace in 2024 compared to the sharp drop seen in 2023. The US EIA expects coal inventories to remain largely unchanged in 2024, reaching a total of 152 Mt by the end of the year, with most of the coal stored at power plant sites.

In April 2024 US coal production fell below 40 million short tonnes for the first time since the Covid-19 pandemic. Regionally, coal production disproportionately reduced in the Western region, mostly domestic-oriented production, although it is also sensitive to international coal prices after these fell in 2024 compared with 2023. Meanwhile, the Appalachian region saw its lowest output in the second quarter of 2024 since Covid-19 lockdowns in 2020. The collapse of the Francis Scott Key Bridge in Baltimore in March did not help producers seeking to ramp up production for export.

For the forecast period we expect US coal production to decline mostly in line with the decline in domestic and export demand. Over the three-year period we estimate a reduction of 52 Mt to a total of 410 Mt in 2027.

Coal production by region, United States, 2009-2027



Source: Estimates based on US EIA (2024), Coal data.

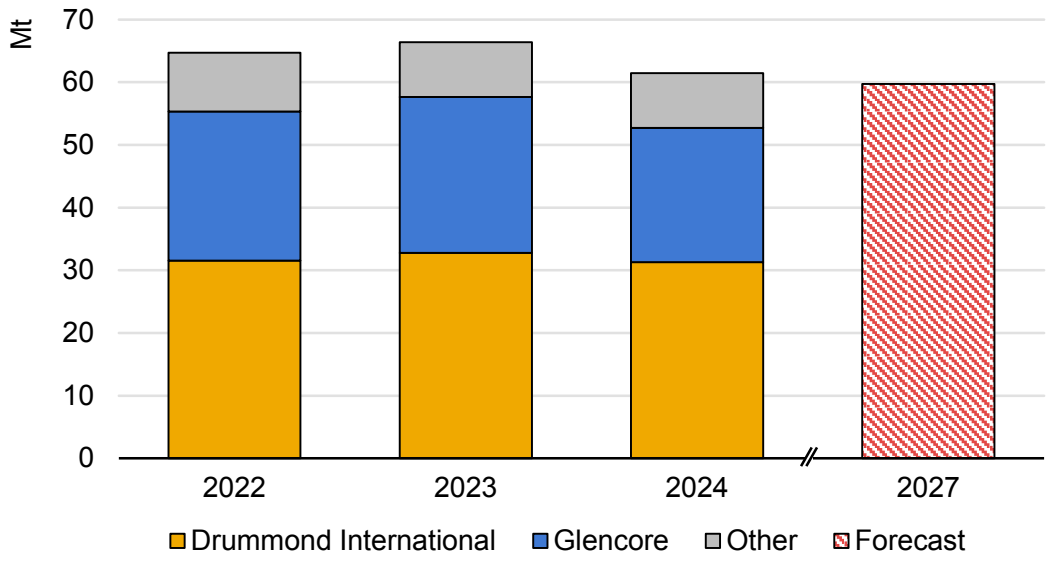
Colombian coal production remains stable, although political headwinds introduce some uncertainty

Coal production in Colombia grew by 1.7% to a total of 66 Mt in 2023, with the majority of output dedicated to international markets. Both major producers, Drummond and Glencore, increased production compared to 2022, when adverse weather conditions and protests weighed on production.

In 2024 Colombian coal production is expected to have declined by 7.4% to a total of 61 Mt. In the first half of 2024 producers were able to take advantage of a dry spell improving mining conditions to increase production. Colombian exports are competitive also in Asian markets, despite the country's export coal terminals being on the Caribbean Sea.

However, a new government proposal in September 2024 could challenge the profitability of future coal trade. The proposed levies would impose a 5% to 15% surcharge on corporate income taxes if coal prices exceed certain benchmarks. This could create additional financial pressures on coal companies. More generally, the government is pushing for a faster energy transition and is targeting coal mining. Several decrees restricting new coal mining activities support this viewpoint. Increasing public opposition is underscored by ongoing blockades of roads and railways preventing coal from reaching ports. One example is Colombian producer Cerrejón, which faced 98 days of disrupted operations in 2024. For the forecast period, we estimate Colombian coal production decreasing by 2.9%, with annual output of 59 Mt by 2027.

Coal production by company in Colombia, 2022-2024, and forecast production, 2027



Source: Adapted from CRU (2024), Coal Cost Model (database).

Canada's coal sector is increasingly dependent on exports

Historically, Canadian coal production has been split between thermal coal and smaller amounts of lignite, primarily for the domestic market, and met coal, mainly for export. In recent years, however, the proportion of met coal has grown due to declining domestic demand for thermal coal. In 2023 met coal production increased by 3.5 Mt, while thermal coal production decreased by 0.6 Mt. As a result, the total output increased by 2.9%, reaching 50 Mt.

In 2024 we expect Canadian production to have decreased by 2.1 Mt or 4.2% amid a reported reduction of 2.2 Mt during the first half of the year. In line with lower demand for coal in the power sector, most of the change is accounted for in thermal coal and lignite production. Given Canada's coal phase-out plans and its decision to end thermal coal exports in 2030, we forecast thermal coal and lignite production decreasing by 62% to 6.5 Mt by 2027. Compared to the larger declines in thermal and lignite coal, we anticipate that met coal production will decrease by just 8% to 28 Mt by 2027 due to recent developments. One example is Conuma Resource's Quintette mine, previously owned by Teck Resources, which was given permission to restart operations in September 2024. The mine has an estimated production capacity of about 3 Mtpa and Conuma is reportedly investing USD 500 million to bring the mine back to life after 24 years.

EU coal production plummeted in 2023 and the decline continues through to 2027

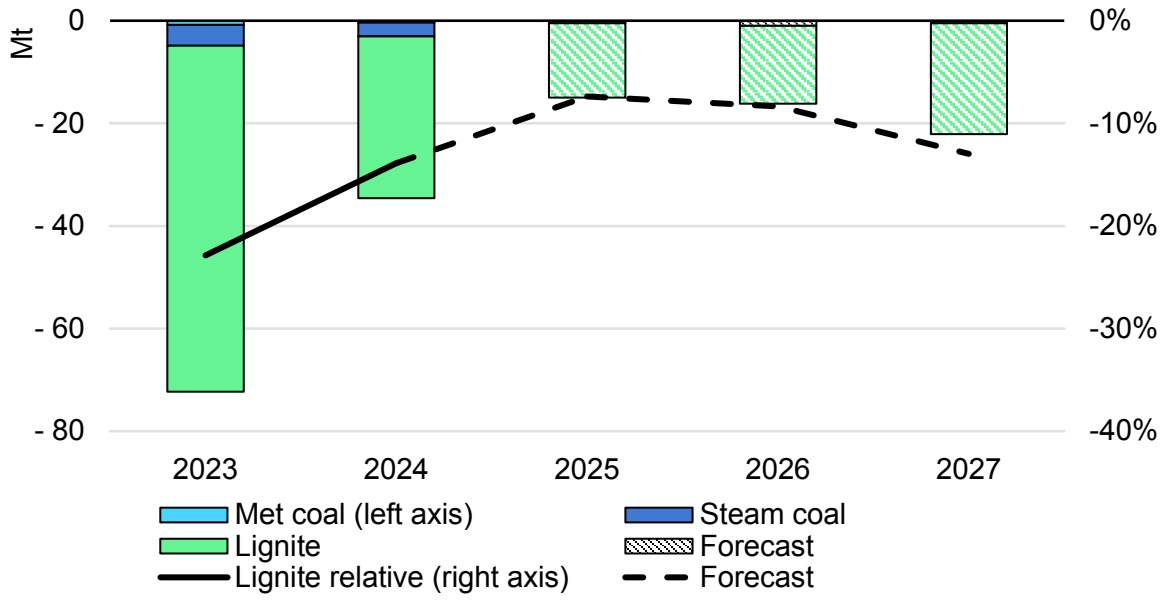
In the European Union more than 80% of overall coal production is lignite dedicated to the power sector. As a result, the power sector is the key driver of coal production in the bloc, with Germany and Poland producing 70% of EU output (278 Mt in 2023). Germany is the largest producer of lignite (102 Mt in 2023), whereas Poland produces virtually all the steam and met coal in the European Union (37 Mt of steam coal, 12 Mt met coal and 43 Mt of lignite).

In the European Union lignite is mostly consumed in power plants close to the mines. Therefore, in 2023 lignite production has declined in line with lignite-fired power generation. Germany, the country with the largest power sector and highest potential for fuel switching, saw the strongest decline across EU countries (down 29 Mt). In relative terms, coal production decreased the most in Bulgaria, by 41% or 15 Mt. In Poland both lignite and steam coal declined (down 16 Mt combined), due to lower demand and the high cost of steam coal compared with the price of imported coal. Czechia was observed to decline as well (down 5 Mt). The result was total coal output of 278 Mt in the European Union in 2023.

In 2024 we expect coal production to have decreased by 35 Mt or 13%, with lignite accounting for most of the decline. Lower gas prices, sluggish electricity demand and growing electricity production from renewables have weighed on lignite demand and production. In addition, met coal production in Poland is expected to have shown a slight decline (down 0.4 Mt) due to fire incidents in two of JSW's mines.

For the forecast period we expect these trends to continue, although not as pronounced as in previous years. In Poland hard coal mines are becoming deeper, increasing costs and putting pressure on producers. Both PGG and JSW, the largest producers, are struggling to manage these rising costs. Consequently, we anticipate a further decline in production through to 2027, also driven by lower demand. The main driver behind the decline in EU lignite production will be Germany given the country's fast-paced coal phase-out, whereas lignite production in Poland, Bulgaria and Czechia are estimated to show low single-digit declines through to 2027. We estimate coal production in the European Union decreasing by 53 Mt to total 190 Mt in 2027.

Year-on-year change in coal production in the European Union, 2023-2027



South Africa's coal production flattens amid infrastructure constraints

Coal production in South Africa grew marginally in 2023 (up 0.7%) to a total of 232 Mt. The main challenges to increasing production in 2023 and 2024 were the unreliable electricity system and continuous disruptions to coal transport, particularly by rail. The state-owned rail operator, Transnet, struggled with

collisions, equipment failures, cable thefts, derailments, power outages and increased costs. The company's growing debt has caused auditors to raise concerns about its operational viability, but Transnet says its recovery plan, which started in October 2023 with new loans, will bear fruit shortly. Thungela, a major coal producer in South Africa accounting for about 12 Mt of the country's output, said it is optimistic that rail performance will improve in 2025.

During the first half of 2024 coal production grew by 2.3%. For the second half we expect this trend to have continued, resulting in a total output of 234 Mt in 2024 (up 0.8%). In the forecast period we expect coal production in South Africa to remain flat.

Coal production in other African countries recorded growth in 2022 due to high prices, reaching a total output of 26 Mt; 2023, however, saw less change. Coal production increased in Zimbabwe (up 0.5 Mt) and Tanzania (up 0.8 Mt), while output in Zambia decreased (down 0.1 Mt). In Mozambique, Africa's second-largest producer, coal production remained flat in 2023.

For 2024 and through to 2027 we estimate that most African countries beyond South Africa will maintain their current output levels, with a slight increase in Ethiopia due to the announcement of a new coal mine in Dawozone. However, growing steel production is set to propel coal production in Mozambique and Zimbabwe. For example, the Benga coking coal mine in Mozambique, owned by the Steel Authority of India, is set to more than triple its current output of 1.3 Mtpa in the next few years. In addition, the Mvuma steel plant in Zimbabwe, built by Chinese utilities, began operation in 2024 with an annual steel output of 0.6 Mt during the first phase and a target of 5 Mtpa in the future, which is assumed to drive up coal production.

Trade

International coal trade is set for another all-time high in 2024

International trade in coal rose by 10% in 2023, reaching a total of 1 510 Mt. Growth was recorded in the trade of both thermal coal (up 100 Mt) and met coal (up 42 Mt). Trade accounted for about 17% of global coal demand and more than three-quarters of traded coal was thermal coal. Seaborne trade accounted for more than 90% of all traded coal in 2023, although land-based trade saw an increase during the year.

The Asia Pacific region once again increased its share of global coal imports, accounting for 84% of the total coal trade during 2023. In contrast, coal trade within the Atlantic Basin experienced a decline. This was propelled by Western bans and sanctions on Russian coal, lower overall demand in Europe, and strong growth in demand for coal imports in Asia, particularly China.

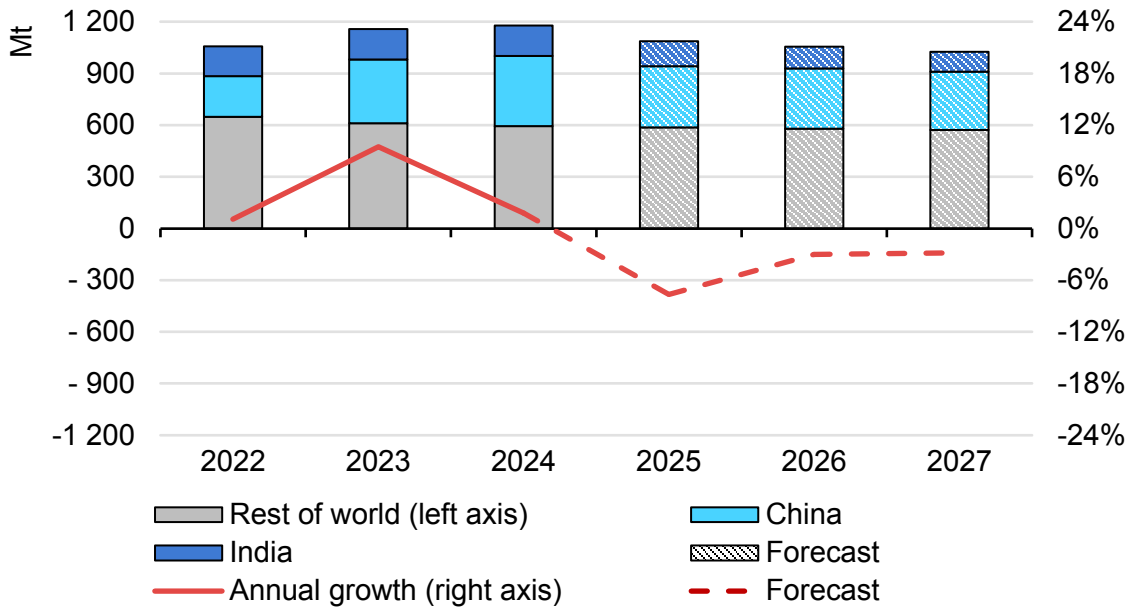
China saw the highest imports of coal in 2023 at around 481 Mt, followed by India (248 Mt) and Japan (167 Mt). Combined, these three countries received almost 60% of global coal imports in 2023. The largest exporters were Indonesia (521 Mt), serving mostly thermal coal, Australia (353 Mt) and Russia (211 Mt), with a combined share of almost three-quarters of global coal exports in 2023. Both Chinese imports and Indonesian exports reached levels never achieved by any country before. Notably, Russian exports saw a significant shift to the east during 2023, following the EU ban on Russian coal imports in 2022. While two-thirds of Russian exports were directed to Asian markets in 2022, this share surged to about 84% during 2023.

In 2024 we expect the global trade in coal to have reached a new all-time high of 1 545 Mt. Thermal coal trade is estimated to have risen by 27 Mt to a total of 1 178 Mt, while met coal trade is projected to have gained 18 Mt, reaching 368 Mt. The growth in imports has once again been led by China, where imports hit record high levels in September, growing 12% during the first three quarters. It is estimated to have surpassed 500 Mt of coal imports for the first time in 2024. This volume is more than twice that of the second-largest importer, India. In addition, it is likely that Viet Nam joined the top five importers during 2024, surpassing Chinese Taipei. Imports into Viet Nam are expected to have gained almost 19% in 2024 amid strong demand and stable domestic production. By contrast, Russian coal trade has faced increasing difficulties in 2024 amid Western sanctions, infrastructure disruptions and profitability issues, with total exports expected to have decreased by 6%.

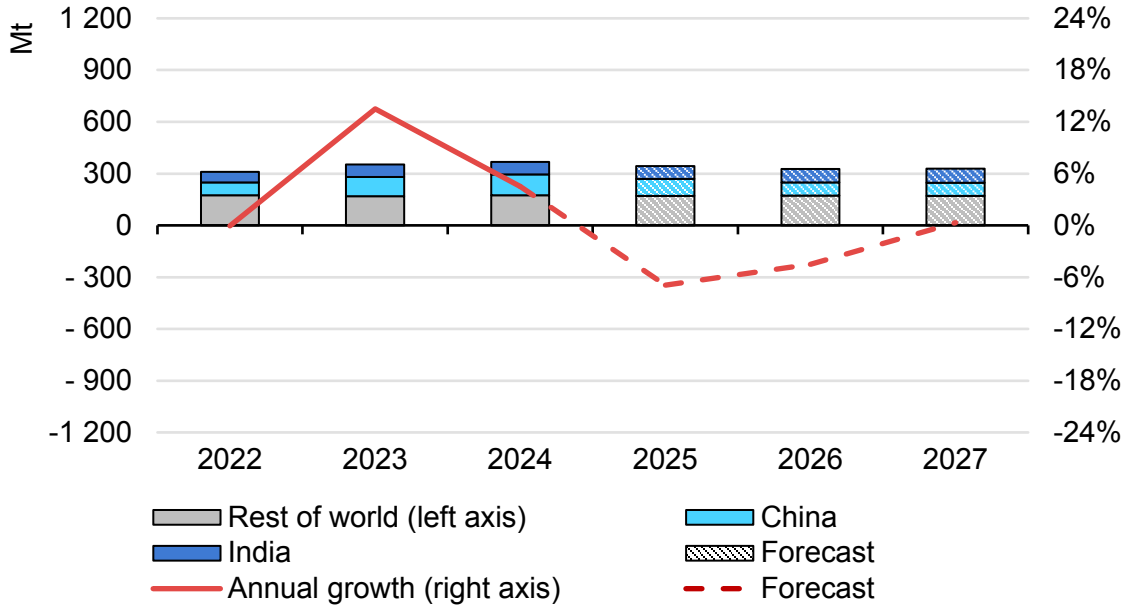
Through to 2027 we anticipate the global coal trade to experience a reversal of trend, initiated by China and India. In the case of China, flat coal demand with healthy domestic production is set to lower the demand for imports. In India the ongoing push for domestic thermal coal production is expected to outpace the growth in demand. While other countries in Southeast Asia are estimated to see growing demand for thermal coal imports, this should be balanced by plans to phase out coal-fired power generation in many Western countries causing their imports to decrease.

Global coal trade is expected to cool down, subject to Chinese evolution

Thermal coal trade growth and exports by destination, 2022-2027



Met coal trade growth and exports by destination, 2022-2027



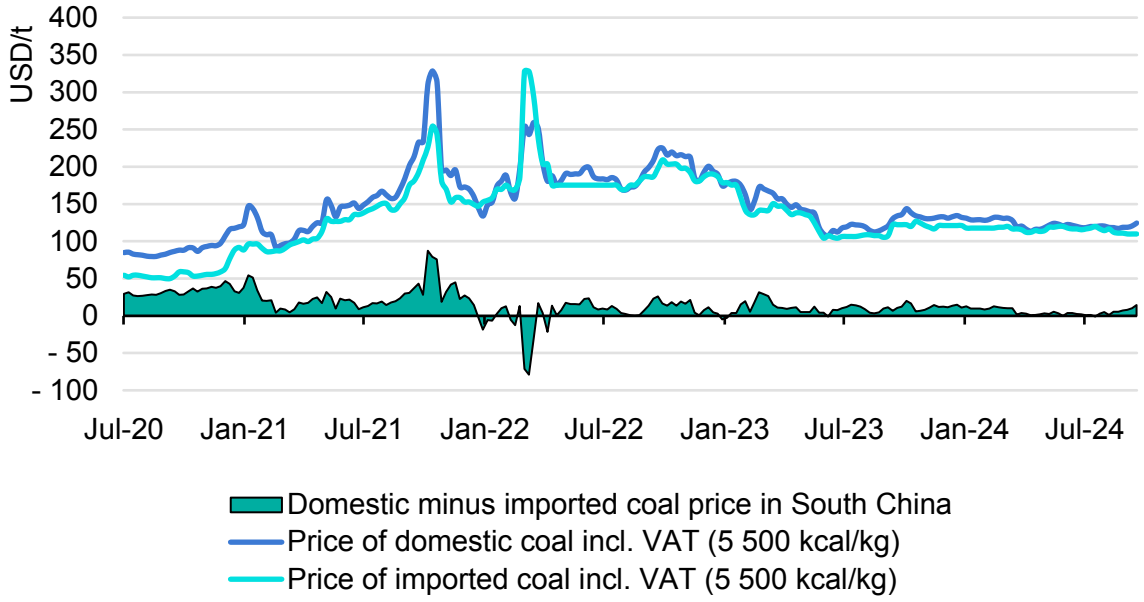
Thermal coal

Thermal coal trade rose to a new record in 2023

Global trade in thermal coal rose by almost 10% to a total of 1 157 Mt in 2023. This comes despite growing domestic production in key importing countries such as China and India. These two countries alone accounted for about half of global thermal coal imports in 2023, up from around 40% a year earlier. Conversely, the European Union and Japan saw significant drops in coal imports as a result of lower coal-fired power generation. Globally, the share of thermal coal demand met by international thermal coal trade stood at 15%.

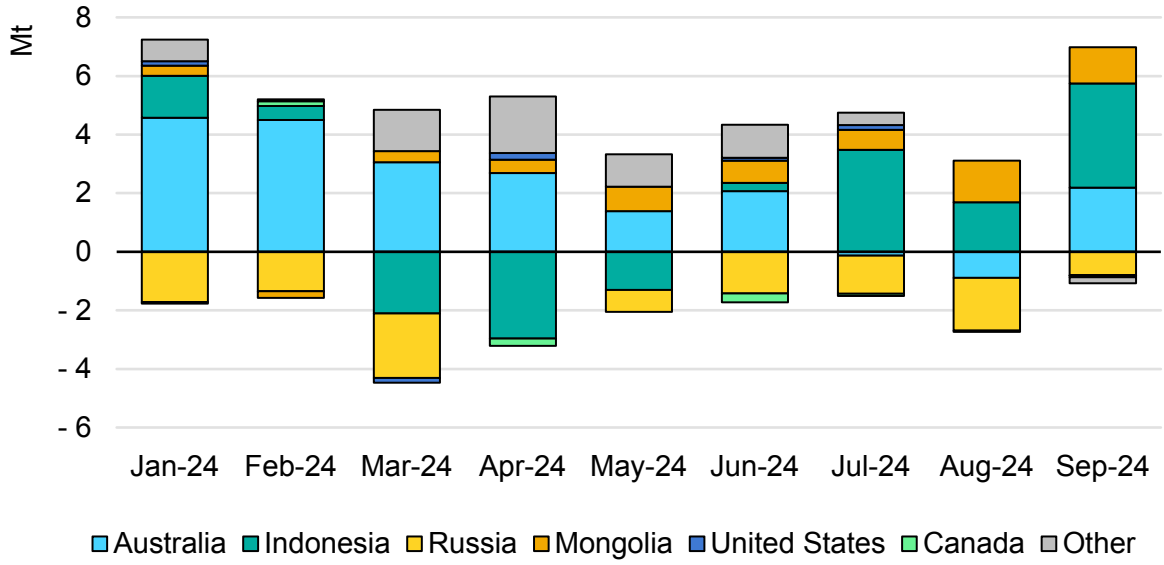
With a total of 369 Mt, China was by far the largest importer of thermal coal in 2023. As domestic production growth slowed in 2023, a large part of the growth in demand was met by increased imports of thermal coal to fuel the power sector. This was supported by a return to imports from Australia, which had been restricted between 2020 and January 2023. Another indicator of the robustness of Chinese imports is their growth in 2024, even though price arbitrage against domestically sourced thermal coal is no longer possible. In total, Chinese thermal coal imports grew by 133 Mt (or 56%) in 2023, contributing the most to growth in global thermal coal imports.

Price arbitrage on domestic versus imported coal in China, 2020-2024



Notes: Imported coal is South China CFR; CFR = cost and freight; VAT = value added tax.
Source: IEA analysis based on CRU (2023).

Change in monthly y-o-y thermal coal imports by source in China, 2024



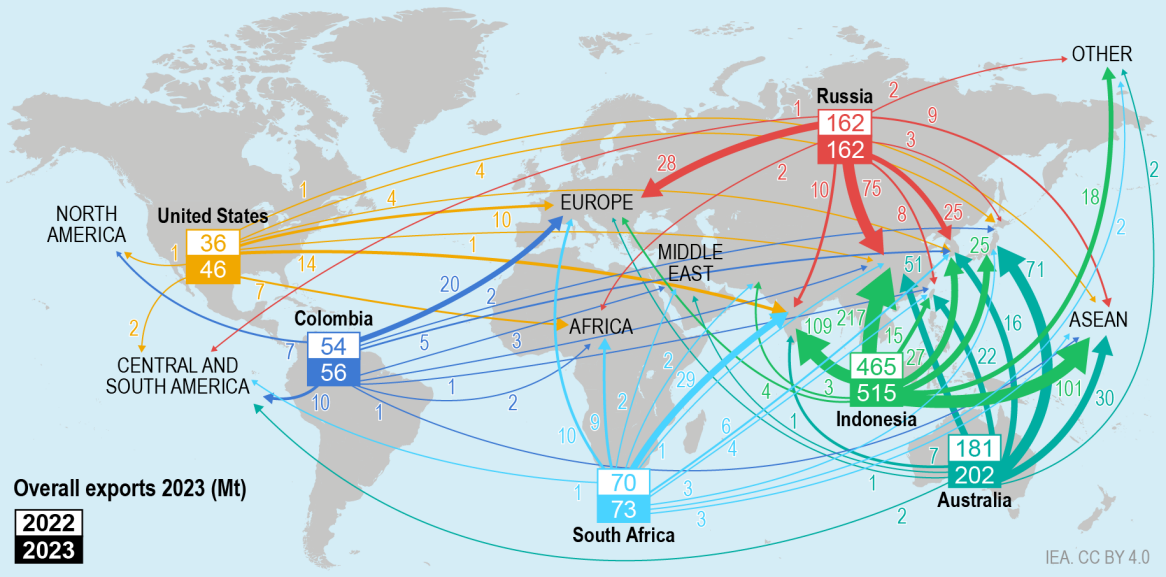
Source: IEA analysis based on McCloskey (2024). McCloskey Coal, Metals and Mining Service.

India, the other country with notable growth in thermal coal imports, recorded 176 Mt of imports in 2023, up 4 Mt. Once again, the growth in domestic supply was unable to keep pace with the surging coal demand driven by power generation.

Conversely, the European Union's thermal coal imports declined again, after 2022's short-lived uptick, which was driven by high gas prices. The ban on Russian coal imports from August 2022 prevented Russian coal being exported to the European Union. The drop in Russian supplies was offset by additional supplies from other exporters, albeit European thermal coal imports declined from 82 Mt down to 51 Mt. Other large importers saw moderate declines in 2023, in part driven by gas becoming relatively more competitive than coal, with Japan decreasing by 9%, Korea lowering imports by 6%, and Chinese Taipei recording a fall of 9%. The decline in coal demand across various regions was primarily driven by a reduction in coal-fired power generation. In the European Union the lower cost of domestically produced lignite led to a more significant reduction in thermal coal imports than the overall decline in coal-fired power generation.

The growth in imports into China and India was largely met by higher exports from Indonesia (up 50 Mt) and Australia (up 22 Mt), supported by the end of the unofficial ban on Australian coal in China. In 2023 US coal exports increased by 9 Mt, reaching a total of 45 Mt. This growth in exports helped offset the slowing demand in the domestic market. Russian trade was severely affected by Western sanctions, but the uptick in exports to China was able to alleviate the diminished exports to the European Union. In total, Russian thermal coal exports remained flat in 2023, at 162 Mt. Despite lower prices, South Africa managed to keep exports steady, growing slightly by 3 Mt in 2023 to a total of 73 Mt. Lower demand for imports in the European Union was outweighed by higher imports into Northeast Asia.

Main trade flows in the thermal coal market, 2023 (Mt)



Note: Map values are based on available export data and do not necessarily match import numbers due to reporting times.

Thermal coal trade rises to new highs in 2024, but is expected to decline through to 2027

Global thermal coal trade is expected to have increased by 1.8% in 2024. Mature economies such as Japan, Korea and the European Union are expected to have seen moderate declines in imports amid lower coal-fired power generation, while the opposite is true for China, India and other Asian countries such as Viet Nam. In total, thermal coal imports are expected to have totalled 1 178 Mt, with trade concentrated in Asia.

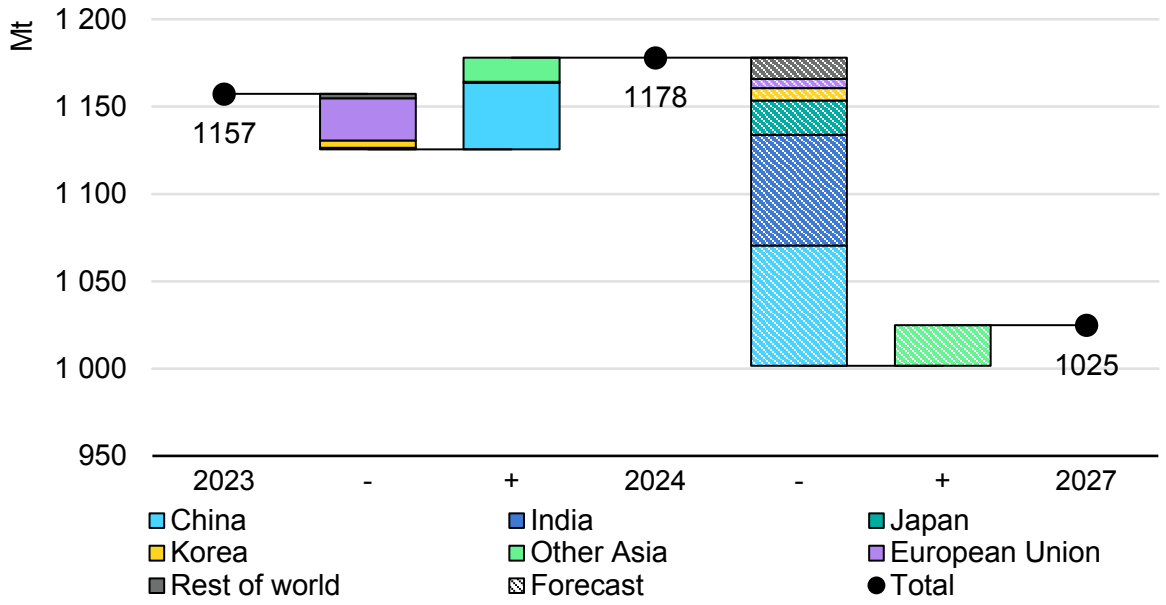
After significant growth in thermal coal imports in 2023, Chinese imports are estimated to have grown again in 2024, by 10% to 408 Mt. China's growing coal demand for power generation, together with a smaller increase in domestic supply and continued efforts to guarantee energy security, favour the rise of imports in 2024. In India the strong growth in imports slowed in 2024 amid strong performance from domestic production. To ensure a secure supply, India's government has extended the obligation for power plants to blend at least 4% imported coal with domestic coal until the end of 2024. Additionally, the government has proactively requested imported coal-fired power plants to boost electricity generation throughout the year.

Notably, Viet Nam's imports are expected to have surged by about 18% to balance the low performance of hydropower plants and to cater for rising demand from the power sector, thus, surpassing Chinese Taipei to become the fifth-largest importer of thermal coal. Looking ahead, the country is seeking to boost coal imports from Lao PDR with a reported target of 20 Mt, which would imply trade between the two

increasing tenfold. This endeavour is underscored by a planned 6 km conveyor belt connecting Lao PDR and Viet Nam with a capacity of about 30 Mtpa, which would replace less efficient road transport. Other Asian countries, including the Philippines and Chinese Taipei, are estimated to have increased thermal coal imports by 4 Mt in 2024.

Through to 2027 we estimate global thermal coal imports shrinking by 153 Mt to a total of 1 025 Mt. The decline in coal imports is primarily driven by China, where flat demand, increased domestic production and an end to the strong stock building that took place between 2021 and 2024 contribute to the reduction. A similar trend in imports is estimated for India, albeit mainly initiated by its growing domestic production and ambition to reduce imports. However, quality preferences and domestic arbitrage pose upside risk to the import projections for the two largest importers of thermal coal. The decline in Western countries seems certain given their efforts to phase out coal. The only countries with notable growth in thermal coal imports over the next three years are estimated to be the Philippines, Viet Nam and Bangladesh, with imports collectively set to grow by between 5 Mt and 16 Mt. Part of the growth in Bangladesh could be met by exports from India, according to a logistics plan recently issued by the Coal Ministry of India.

Forecast global thermal coal import changes, 2023-2027



Russian thermal coal exports drop in 2024

We expect Russian thermal coal exports to have seen a significant decrease of 8% in 2024, down to 149 Mt. The reduction is attributed to various difficulties, including tighter profit margins, infrastructure bottlenecks and the impact of further international sanctions.

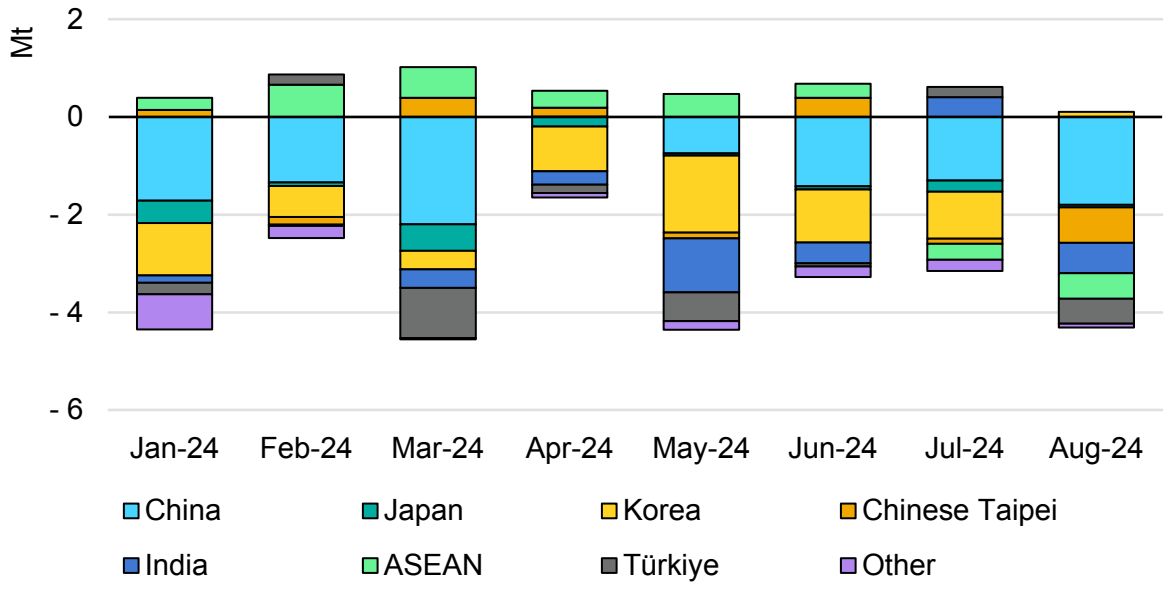
In February 2024 the United States placed Russia's largest thermal coal producer, Suek, along with Mechel, on its Specially Designated Nationals and Blocked Persons (SDN) list. Throughout the year the SDN list was continuously expanded, including producers of all coal grades, like Sibanthracite in May, Elga and Coalstar in June, and SDS-Ugol and Stroyeservis in August. By August 2024 about half of Russian coal exports were under US sanctions. Most sanction-compliant markets have already reduced imports from Russia. The fear of secondary sanctions and indirect effects, such as payment disruptions, have further diminished the attractiveness of Russian coal. Following numerous international bans, international markets are increasingly reluctant to accept Russian coal.

In the first three quarters of 2024 Russian thermal coal exports directed to Korea decreased by about 7 Mt, to 12 Mt, compared to the same period in 2023. Korea has not officially banned Russian coal but complies with US sanctions. However, in the third quarter of 2024 some Korean tenders were reported to prohibit all coal of Russian origin. Another traditional buyer with a significant reduction in Russian thermal coal imports is China, with imports decreasing by 11 Mt (or 18%) in the first nine months. This decrease comes despite China recording strong coal imports overall in that period. In fear of secondary sanctions, some Chinese banks stopped processing transactions with Russia. Moreover, China reimposed import tariffs at the beginning of 2024, with a 6% levy on thermal coal and 3% on met coal. As the policy excludes Australia and Indonesia due to free trade agreements, the levy mainly weighed on the attractiveness of Russian coal imports. Russian thermal coal exports to other key markets saw moderate declines, with Türkiye and India lowering imports by 2.2 Mt and 2.6 Mt respectively in the first nine months of 2024.

Russian thermal coal trade in 2024 also suffered from increasing railway bottlenecks in eastbound directions. Existing transport capacity was preferably used for the more profitable met coal trade over thermal coal. In response to transport capacity shortages in the centrally located Kuzbass region, the regional government requested an increase in eastbound rail freight capacity reserve from 54 Mt to 68 Mt. In addition to logistical hurdles, railway tariffs and transhipment rates at ports have increased during 2024. An extreme example is the Black Sea port of Taman, where coal exports plunged by 80% to 1.4 Mt in the first quarter of 2024 due to higher transhipment rates.

In light of the lower profitability of Russian exports, the government suspended the duty on coal exports in May 2024 for three months and extended the suspension in August for another three months. The duty, introduced in October 2023, imposed a 4-7% surcharge on coal exports depending on the rouble's exchange rate against the US dollar.

Monthly y-o-y change in thermal coal exports from Russia by destination, 2024

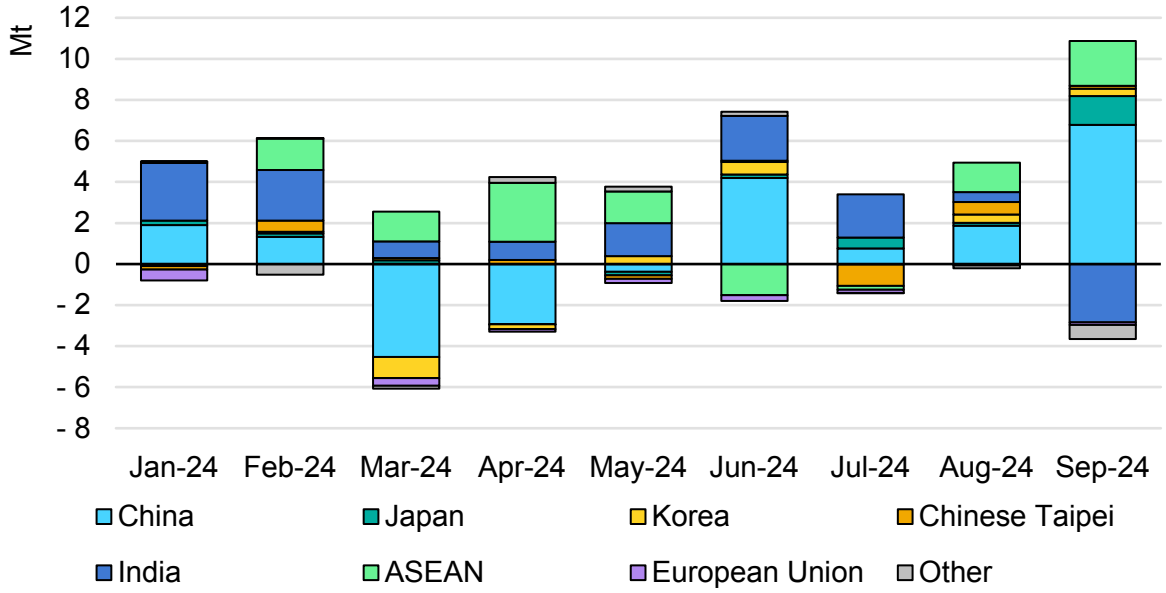


Source: IEA analysis based on McCloskey (2024), McCloskey Coal, Metals and Mining Service.

Indonesian exports have been increasing in 2024

We expect Indonesian thermal coal exports to have increased by 7% in 2024, to a total of 551 Mt. In the first three quarters of the year exports gained an estimated 30 Mt y-o-y, driven by higher production. The markets behind this growth were China, India and ASEAN countries, whose imports from Indonesia grew by 9 Mt, 11 Mt and 9 Mt respectively compared to the same period last year. The largest destination for Indonesian coal remains China, receiving about 42% of Indonesian exports in 2023. This share is expected to remain constant in 2024.

Monthly y-o-y change in thermal coal exports from Indonesia by destination, 2024



Source: IEA analysis based on IHS Markit (2024), Coal Price Data and Indexes.

Australian thermal coal exports are estimated to have gained 2.7% to a total of 208 Mt in 2024. During the first nine months of the year, Chinese monthly imports from Australia increased by 20 Mt, in part replacing lower imports from Russia. As a result, the share of Australian thermal coal in Chinese imports grew from almost 25% in 2023 to more than 33% in 2024. Conversely, Australian exports to ASEAN countries were about 7 Mt lower during the first three quarters of 2024, while exports to other key destinations remained about the same level as in 2023.

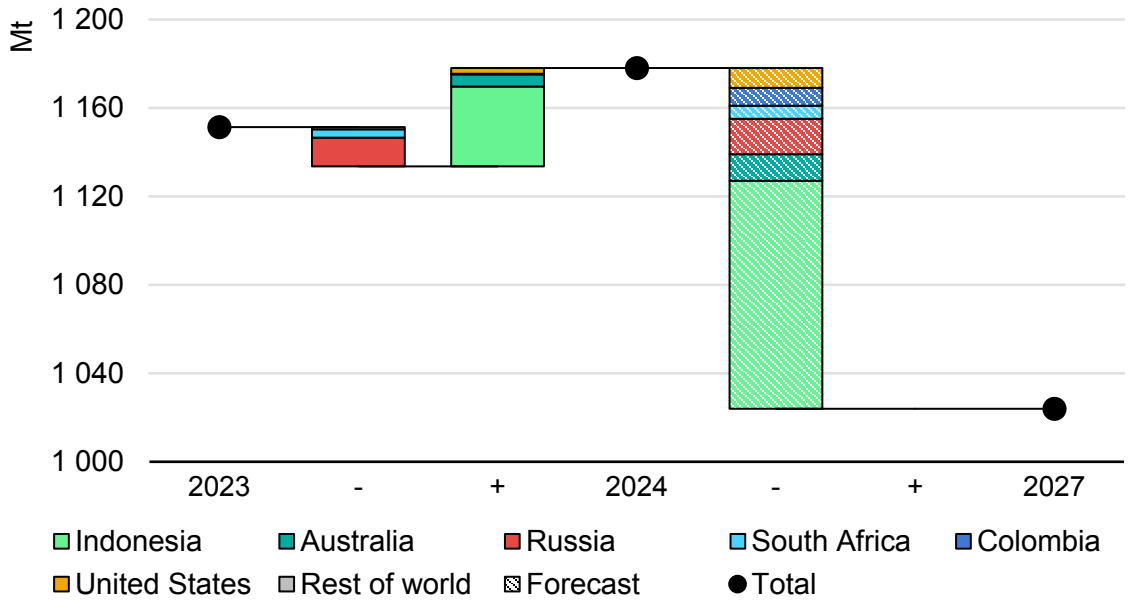
Thermal coal exports from South Africa are expected to have decreased by about 4 Mt in 2024, as lower demand from Europe and a lack of competitiveness weigh on exports. In July the country saw an immense reduction in exports of 36% y-o-y, due to lower demand from Korea among others.

Kazakhstan increased exports to Europe in 2023 following the ban on Russian coal. However, during the first half of 2024 Kazakh deliveries via Russian and Latvian ports dropped by 24% owing to weak European demand. Kazakhstan is looking for potential new markets. Malaysia began a trial testing thermal coal imports from Kazakhstan in November 2024, supplying the power plants of Malaysia's Kapa Energy Ventures, Jimah Energy Ventures and Tanjung Bin.

Lower demand for thermal coal imports is set to weigh on all major exporters through to 2027

In our forecast period we estimate global thermal coal exports decreasing by 154 Mt, down to 1 024 Mt by 2027. While all major exporters are expected to see lower exports in absolute terms, we forecast a more pronounced decline for Russia and especially for Indonesia. In respect of Russia, Western sanctions and the implications of infrastructure bottlenecks as well as profitability are not likely to change soon. Indonesia is the primary supplier to China, which is about to see a significant reduction in imports. Conversely, Australia is estimated to experience a lower relative decline in coal exports, due to a smaller drop in demand from its main customers, such as Japan. The forecast on trade relations is subject to several uncertainties, including the increasing importance of geopolitical considerations.

Change in global thermal coal exports, 2023-2027



Metallurgical coal

Met coal trade surged in 2023, and Mongolia steps up as a key supplier

Global met coal trade rose by 13% in 2023, reaching a total of 352 Mt. The increase was largely driven by higher demand from China, while imports into the European Union and Japan saw slight declines. While met coal trade accounts for

approximately a quarter of total coal trade, the importance of trade to the met coal segment stands out, as it covers about one-third of total met coal demand.

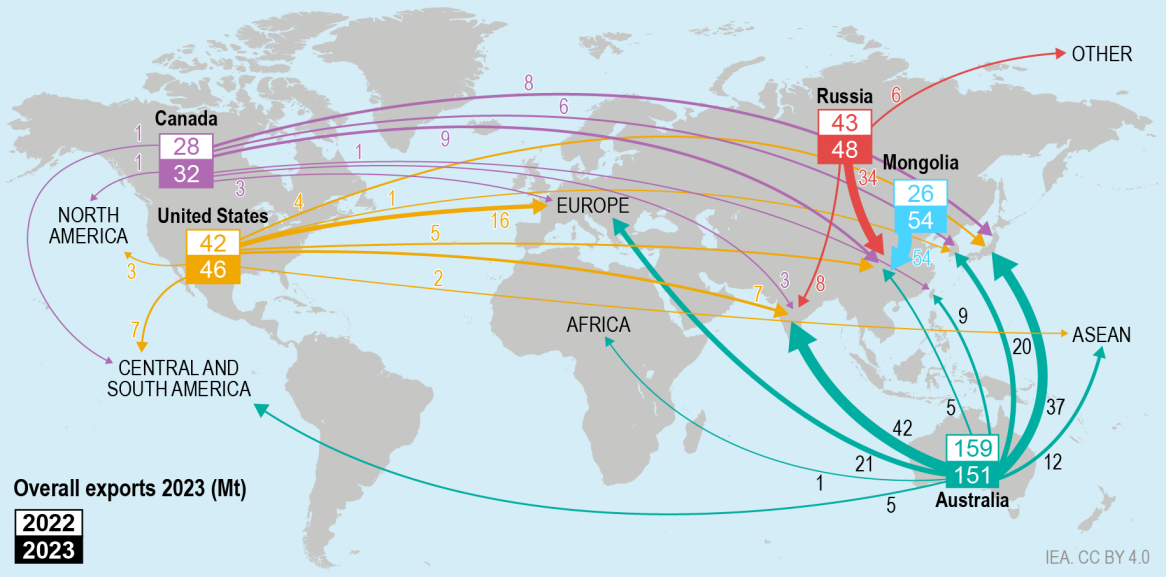
The largest importers of met coal are China and India, together accounting for half of global met coal imports. While in China coal imports complement domestic supply, India is more dependent on imports to meet its met coal demand. In 2023 China was the largest importer of met coal, with import volumes surging by 49% to reach 112 Mt. Growth in demand paired with lower domestic production of met coal resulted in a surge in Chinese imports. Imports to India grew by 16% amid its growing demand and low volumes of domestic met coal production. In light of lukewarm economic growth, imports to the European Union decreased by 1.5% to a total of 44 Mt, and Japanese imports lost 3 Mt, down to 38 Mt.

Traditionally, the supply of international met coal markets is dominated by a handful of countries. In 2023 Australia accounted for 43% of global exports, followed by Mongolia with a share of 15%. Notably, Mongolia significantly ramped up met coal exports during 2023, more than doubling them to 54 Mt. Thus, the country overtook Russia as second largest met coal exporter. Russia had a share of 14% of global met coal exports. The United States and Canada supplied 13% and 9% respectively.

Australian met coal exports decreased by about 5% in 2023, down to a total of 151 Mt. The decline, despite the lifting of China's import ban, was prompted by weather challenges and a few mine suspensions, as well as stronger exports from Russia, which was offering coal at a discount. Instead, China recorded higher imports from Russia and Mongolia.

Russian met coal exports rose by approximately 13% in 2023 to 49 Mt, despite import bans in the European Union and Japan. The decline in imports in these regions was more than offset by strong imports into China, accounting for almost three-quarters of Russian met coal exports in 2023, and India.

Main trade flows in the met coal market, 2023 (Mt)



Note: Map values are based on available export data and do not necessarily match import numbers due to reporting times.

China is the key driver of growth in met coal imports in 2024

In 2024 we expect global met coal trade to have grown by 5% to a total of 368 Mt. Once again, China is expected to record the strongest absolute growth in met coal imports, from 112 Mt in 2023 to 119 Mt in 2024. India, traditionally a growth engine for met coal imports, is expected to have gained 2 Mt during 2024. The sluggish economic performance in Europe and Japan has been weighing on their demand levels, resulting in estimated met coal imports of 43 Mt and 36 Mt compared with 44 Mt and 38 Mt in 2023 respectively.

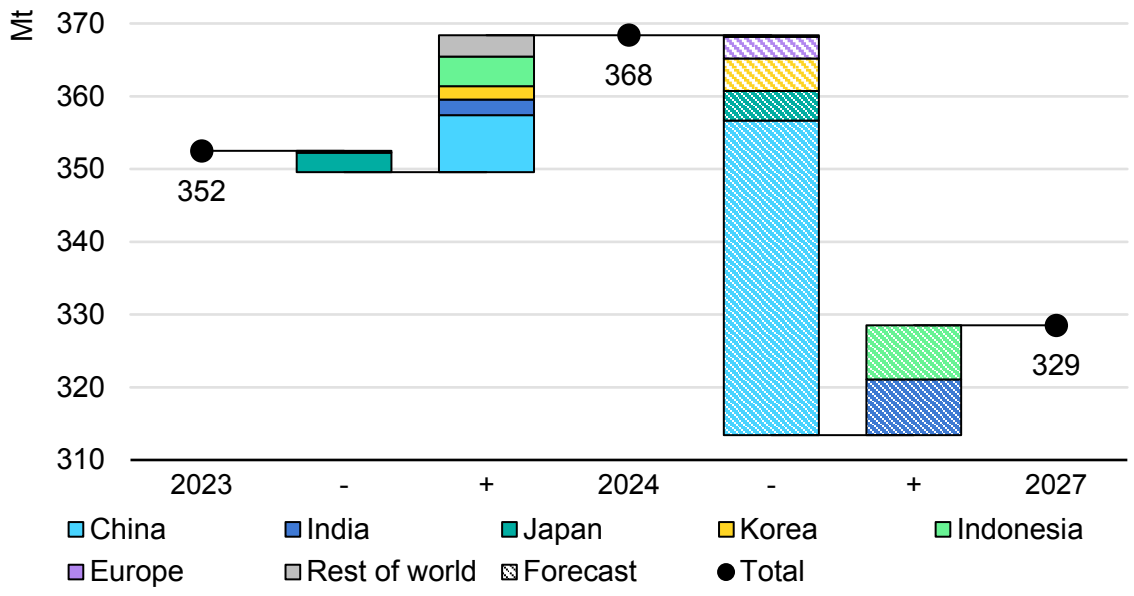
Despite China's lower demand for met coal, imports in the first three quarters of 2024 increased by more than 23%. Higher imports have been underpinned by lower output from its primary coking coal production sites in Shanxi, the largest coking coal producing province by far, amid safety inspections. Nonetheless, Russian met coal exports to China rose too, particularly after the United States started to sanction Russian producers in February 2024.

India's shift to Russian met coal imports in 2023 has moderated during 2024. The share of Russian met coal in total Indian imports levelled off at around 11% during the first three quarters, similar to the same period in 2023. Met coal imports into the European Union stood about 3 Mt lower during the first three quarters of 2024, and most of the reduction was accounted for by lower imports from Australia.

Higher imports into India and Indonesia are to be more than offset by lower imports into China through to 2027

We forecast global met coal imports decreasing by 40 Mt to 329 Mt by 2027. The decline is largely driven by China, whose met coal demand is projected to decline during the forecast period. Nonetheless, the government issued economic stimulus packages in the second half of 2024, and their effects on steel demand, and hence, on met coal demand remain to be seen. Met coal imports into Japan and Korea are both expected to decline by 4 Mt, while imports into Europe are set to fall by 3 Mt. Conversely, Indian met coal imports are expected to grow amid the limited availability of domestic coking coal and increasing demand. India is currently investigating ways to import Mongolian coking coal in a move to diversify import sources, following its high reliance on Australian supplies. We also note that Indonesia, traditionally an importer of coke, is expanding its coke production capacity, and therefore set to import larger quantities of coking coal in the future. Market participants estimate Indonesian coke exports reaching 10 Mtpa within this decade, but the precise amount is to be monitored. Indonesian met coal imports are forecast to grow by 12% annually through to 2027.

Change in met coal imports, 2023-2027

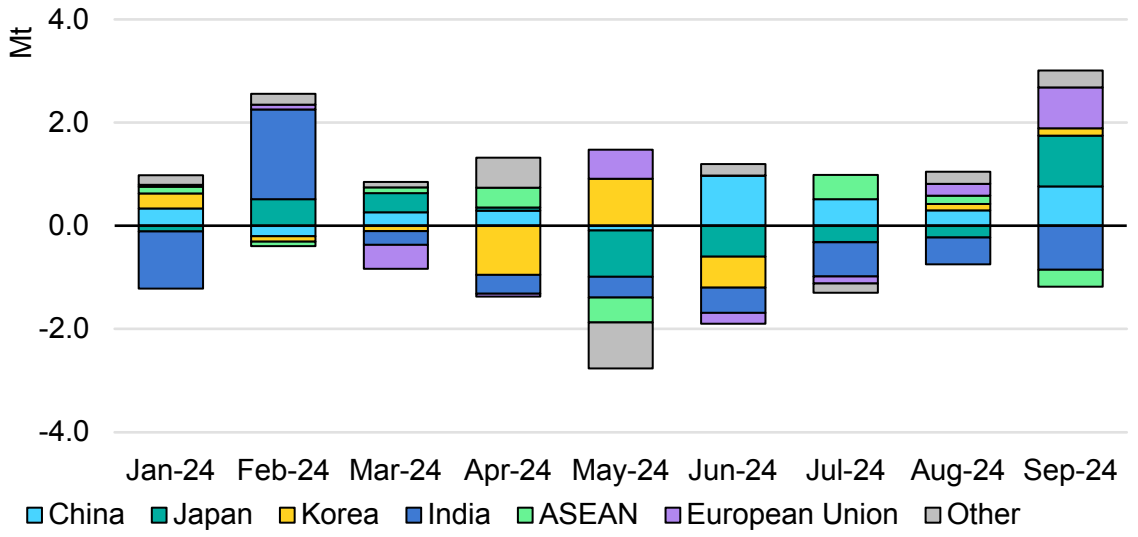


Australia remains the undisputed leader of seaborne met coal exports

Although global met coal exports are expected to have grown by 5% in 2024, volumes from the world's largest exporter, Australia, are estimated to increase by

just 1.3%, reaching 153 Mt by the end of 2024. Notably, Australian met coal prices declined significantly from more than USD 300/t in January to less than USD 200/t in September and market participants reported some Australian traders were reluctant to sell at the new price level, weighing on exports. India, after Japan the primary destination of Australian met coal, accounted for about a quarter of Australian exports. During the first three quarters of 2024, exports to the country decreased by 2.9 Mt. The decline was mitigated by an increase in exports to China, which grew by 3.1 Mt during the same period, and to the European Union and Japan. In our forecast through to 2027, Australian exports decline 5% down to 145Mt, remaining the largest met coal exporter by far.

Monthly y-o-y change in met coal exports from Australia by destination, 2024



Source: IEA analysis based on IHS Markit (2024), Coal Price Data and Indexes.

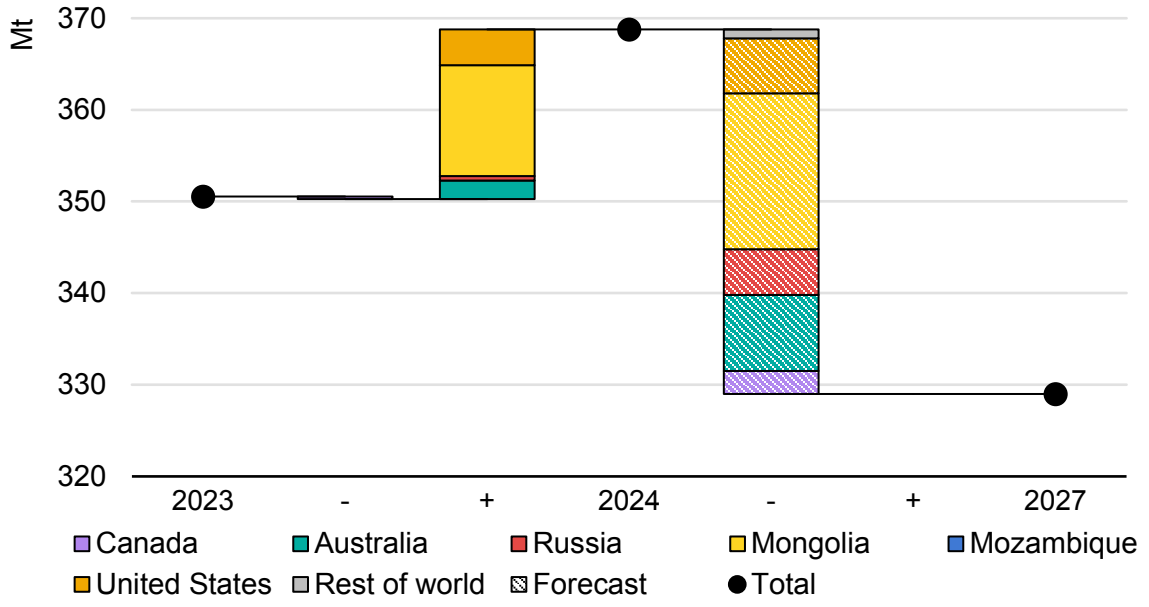
Russian met coal exports are expected to decrease by 10% over the next three years, reaching a total of 44 Mt in 2027. As described above, Russian coal trade faces significant hurdles amid Western sanctions and payment difficulties, even with buyers in Asia. Moreover, it faces disruptions in logistics, although met coal transport is reported to be generally favoured over thermal coal transport within Russia. To facilitate trade, Russian exports still require discounts, and the lower price level in 2024 has been weighing on the profitability of exports. In the first three quarters of 2024 almost two-thirds of Russian met coal exports were directed to China, but the increased demand from China has not been met by higher exports from Russia.

Instead, Mongolia is associated with the largest share of growth in met coal exports in 2024. After more than doubling exports in 2023, exports rose by more than 25% in the first eight months of 2024. For the full year, we expect Mongolian

met coal exports to total 66 Mt, up by 12 Mt. The United States is estimated to have increased met coal exports by about 4 Mt during 2024, serving higher demand from India.

In our forecast through to 2027, Mongolian exports see the steepest decline across major exporters. The overall decline in imports is expected to be driven by China, the sole destination of Mongolian met coal. For Russia, a gloomy outlook is driven by the sanctions imposed on the country.

Change in met coal exports, 2023-2027



Prices and costs

Prices

Coal prices remain higher than the 2017-2019 average

Amid the energy crisis of 2022, thermal coal prices surged to unprecedented levels, driven by tight supply-demand fundamentals, soaring natural gas prices and geopolitical risks. High-CV thermal coal benchmarks exceeded the USD 400/t mark multiple times, far surpassing previous records. Notably, for over six months thermal coal prices outstripped those of coking coal, an unusual development. However, as coal markets began to stabilise in 2023, following trends in other energy commodities, coking coal prices once again surpassed thermal coal, with the average annual premium returning to historical norms. This shift signals a normalisation of the coal price relationship, more in line with market fundamentals.

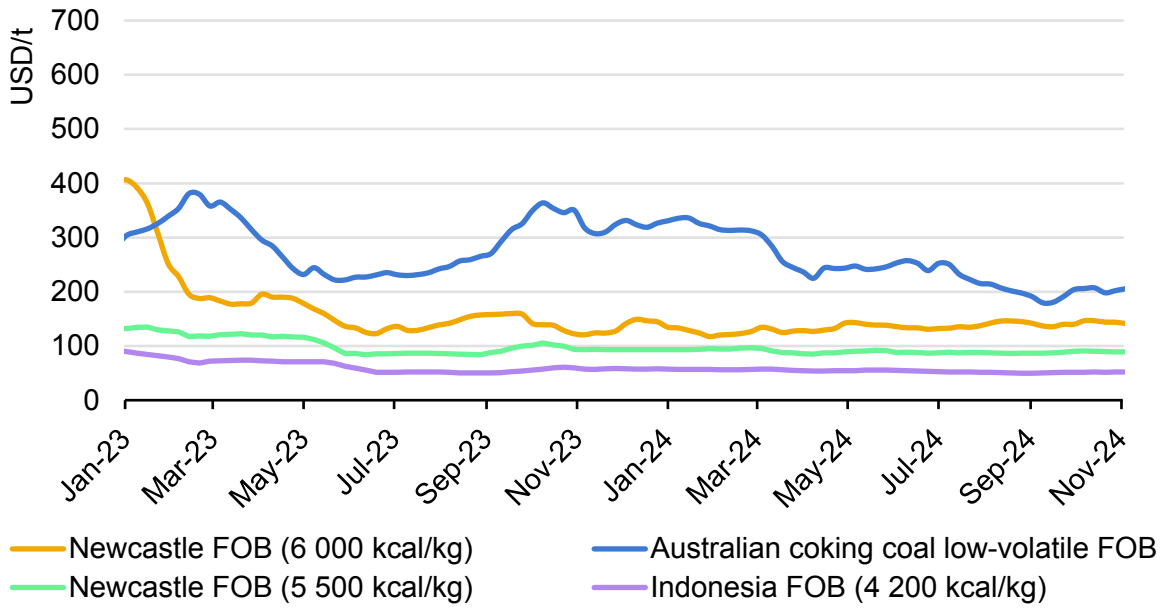
More generally, prices for different qualities of coal are typically correlated since they can partially substitute for each other. Coking coal is mainly utilised to produce coke, which is used in processes like steel production. Thermal coal is predominantly used in power generation and can be categorised into low-, mid- and high-CV coal. In some cases, direct substitution is possible, as is blending higher-grade coal with lower-grade coal to achieve a desired quality.

In the Pacific Basin, thermal coal price markers were well correlated before the energy crisis until the high-CV segment experienced extreme scarcity, with prices entering a level far exceeding other thermal price markers. Despite a cooling in coal markets during the first half of 2023, the Australian high-CV price marker showed notably higher volatility than lower-grade price markers between mid-2023 and mid-2024. The price difference between the minimum and maximum for high-CV coal during this period was USD 43/t, while mid-CV and low-CV coal saw deltas of USD 22/t and USD 11/t, respectively.

Price fluctuations in the coking coal market segment since mid-2023 have been significantly higher than in the high-CV market segment and have followed a different trajectory. After the price decrease in early 2023 due to improvements in mining conditions in Australia, coking coal prices surged again in the third quarter of 2023 to more than USD 350/t amid an uptick in demand from China and India. The tight market conditions loosened in the second quarter of 2024, also supported by stronger exports from Mongolia to China. The average spread between Australian coking coal and high-CV thermal coal in the second and third quarters of 2024 decreased to USD 97/t compared to USD 190/t in the previous two quarters.

The dynamics in recent years indicate that coal price movements can be generalised only to a limited extent, as they are shaped by specific drivers within each market segment, varying by region and coal quality. However, thermal price indicators point to greater stability in 2024 compared with previous years, while coking coal prices still exhibit substantial fluctuations.

Price markers for different qualities of coal, 2023-2024



Note: FOB = free on board.
Source: IEA analysis based on data from Argus Media group (all rights reserved).

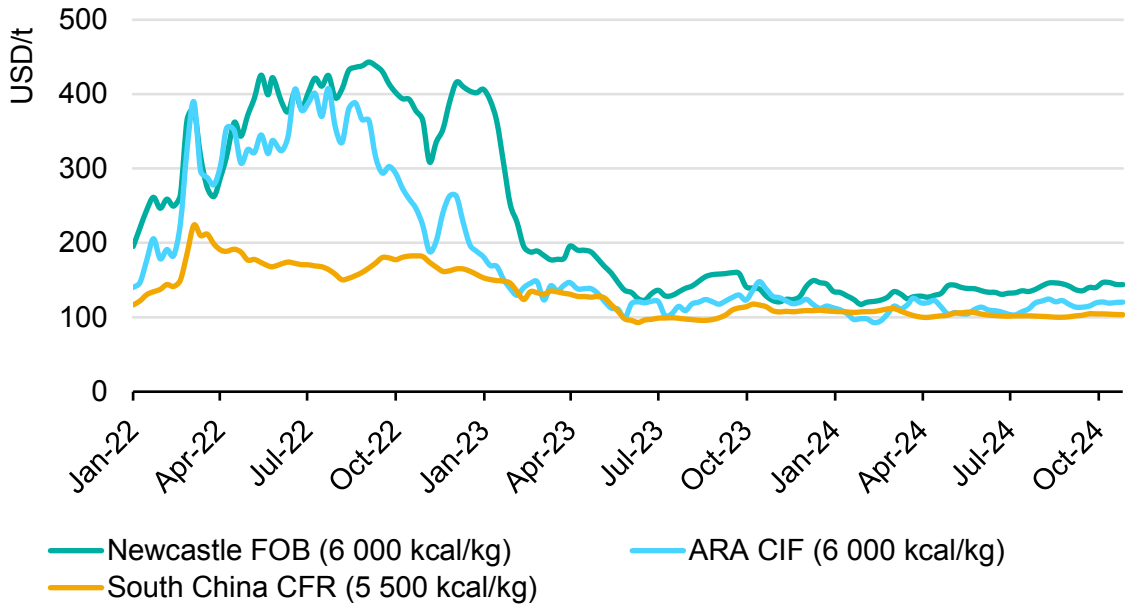
Spreads between different thermal coal price markers have returned to historical levels

During the energy crisis, thermal coal price markers experienced vastly different trajectories across quality segments and regions. In March 2022 Australian and European price benchmarks for high-CV coal soared to record levels, exceeding USD 400/t, driven by tightening markets and the destabilising effect of Russia's invasion of Ukraine. The Chinese mid-CV price marker experienced a significant increase during March 2022 as well, but followed a more stable path throughout the remainder of 2022, underscoring the market segmentation between the grades of coal.

Thermal coal prices at European ports saw a substantial decline in the second half of 2022, settling at more moderate levels of around USD 150/t by early 2023, having seen a brief uptick in November 2022 due to a cold snap in the region. In contrast, the Australian price marker remained elevated for longer as robust demand from East Asian countries, coupled with supply disruptions in Australia,

sustained higher prices throughout the second half of 2022. By the second quarter of 2023 European high-CV price markers had stabilised within a range of USD 99/t to USD 147/t, setting the stage for pricing trends to the third quarter of 2024. The upper end of this range was reached in late 2023, ahead of the heating season, when European coal prices typically increase. Between mid-2023 and mid-2024 the Australian equivalent averaged USD 21/t higher, including an uptick in May 2024 when heatwaves in Southeast Asia boosted demand. In August 2024 Australian high-CV prices hit their 11-month high, supported by strong exports into Northeast and South Asian countries, favouring high-quality coal from Australia. In contrast, the South Chinese mid-CV price marker has remained more stable at around USD 100/t since mid-2023, showing limited sensitivity to the temporary fluctuations in the high-CV segment.

Thermal coal price markers, 2022-2024



Note: FOB = free on board; ARA = Amsterdam Rotterdam Antwerp; CIF = cost, insurance and freight; CFR = cost and freight.
Source: IEA analysis based on data from Argus Media group (all rights reserved).

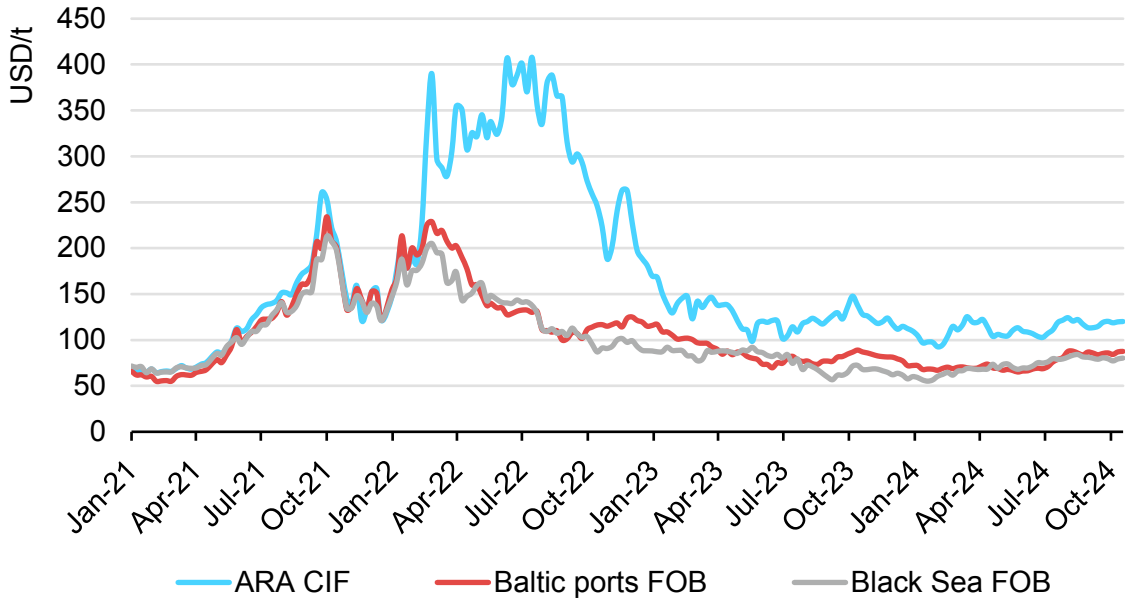
Russian discounts vary by region and quality

Prior to Russia's full-scale invasion of Ukraine in early 2022, Russian coal prices from its Baltic and Black Sea ports displayed a strong correlation with European import prices (ARA), since Russia was a key supplier to European markets at that time. However, the onset of the war and the subsequent imposition of sanctions, including an EU ban on Russian coal imports, led to significant disruptions. As a result, price markers for Russian coal began to decouple from European benchmarks. This divergence was further exacerbated by an increase in demand

in EU countries, coupled with a war premium amid geopolitical uncertainties, while Russian coal had to be offered at discounts due to the sanctions. During the energy crisis of 2022, Russian coal prices at its southern and northwestern ports followed a downward trend, even as global coal prices surged.

By early 2023, as Europe managed to mitigate the worst impacts of the energy crisis, ARA prices stabilised, returning to more moderate levels. By mid-2023 the gap between European import prices and Russian FOB prices from the Baltic and Black Sea ports had narrowed. Despite this relative stabilisation, a persistent discount on Russian coal has remained evident since mid-2023. Russian coal exports from its Baltic ports traded at an average discount to ARA of USD 38/t between October 2023 and October 2024, disregarding the cost attributed to insurance and freight. This reflects the ongoing challenges faced by Russian coal exporters in finding alternative markets.

European and Russian high-CV (6 000 kcal/kg) price markers, 2021-2024



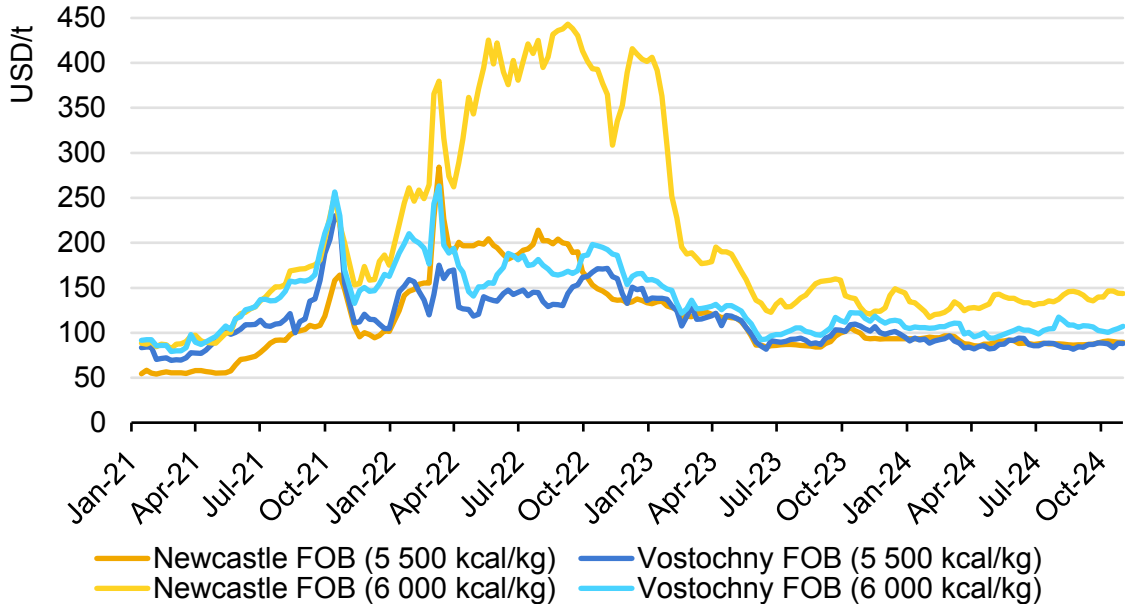
Notes: ARA = Amsterdam Rotterdam Antwerp. FOB = free on board. CIF = cost, insurance and freight.
Source: IEA analysis based on Argus Media Group (all rights reserved).

A similar trend is evident in the evolution of Russian discounts at the country's Far Eastern ports for the export of high-CV coal. Historically, prices for Russian coal from these ports closely tracked Australian high-CV coal, given their shared buyer base in the Asia Pacific region. However, following Russia's invasion of Ukraine, some traditional buyers in the region reduced their imports of Russian coal, leading to remarkable discounts for Russian coal, mirroring the situation in Europe. During the same period supply disruptions in Australia contributed to a widening price gap, with Newcastle high-CV prices averaging USD 191/t higher than their

Russian counterparts at Far Eastern ports between April 2022 and April 2023. Although energy markets were easing in 2023, the discount on high-CV Russian coal at the port of Vostochny has persisted, albeit at a significantly lower level than in 2022. The average discount between mid-2023 and mid-2024 was recorded at USD 30/t.

The high-CV market is very much influenced by the preference of Japanese customers for Australian coal due to its higher and consistent quality, and the limited supply. The mid-CV market segment followed a different pattern. Prior to Russia's invasion of Ukraine, the Australian price marker traded at a discount to the Russian, mainly due to China's import ban on Australian coal at that time. With the beginning of the energy crisis, the price relationship changed and the discount flipped. Nonetheless, price spreads between Newcastle and Vostochny during the energy crisis were lower than in the high-CV segment and had already begun to narrow in early 2023. By mid-2023 the discount on mid-CV Russian coal had largely disappeared.

Australian and Russian thermal coal price markers, 2021-2024



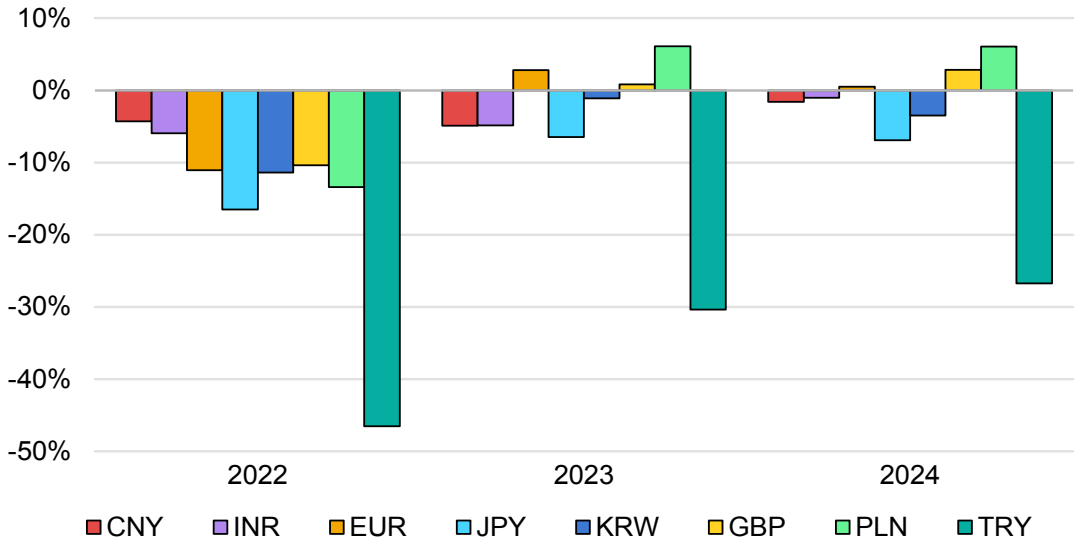
Notes: FOB = free on board. Vostochny = port in the Russian Far East.
Source: IEA analysis based on Argus Media Group (all rights reserved).

The appreciation of the US dollar has had an impact on coal trade

International coal trade is mainly priced in US dollars, making exchange rates a crucial factor in the competitiveness of coal traded. When a currency depreciates against the US dollar, it generally increases the cost of coal for buyers, making purchases more expensive.

During 2022 the US dollar strengthened significantly against other currencies as the US Federal Reserve raised interest rates multiple times. This contributed to an additional increase in already elevated coal prices, particularly in 2022. Major importing countries and regions experienced notable currency declines, with the Turkish lira showing the most significant drop, while the Chinese yuan and Indian rupee saw smaller declines. Despite being less affected by depreciation, importers in China and India shifted towards lower-grade coal, benefiting the Indonesian low-CV coal market. In 2023 the pace of currency depreciation against the US dollar slowed, with the Polish zloty (6%), the euro (2.8%) and the British pound (0.8%) even appreciating. These trends have largely persisted throughout 2024, with the Chinese yuan, Indian rupee and euro experiencing minimal depreciation. However, the significant currency depreciation against the US dollar seen in 2022 has not been fully offset by subsequent appreciations, keeping coal imports relatively more expensive than pre-crisis levels. A notable exception is Poland, where the zloty appreciated by more than 5% in both 2023 and 2024.

Year-on-year development of select importing countries' currencies against the US dollar, 2022-2024



Notes: CNY = Chinese yuan renminbi. INR = Indian rupee. EUR = euro. JPY = Japanese yen. KRW = Korean Republic won. GBP = British pound sterling. PLN = Polish zloty. TRY = Turkish lira. 2024 values represent average exchange rates to October 2024.

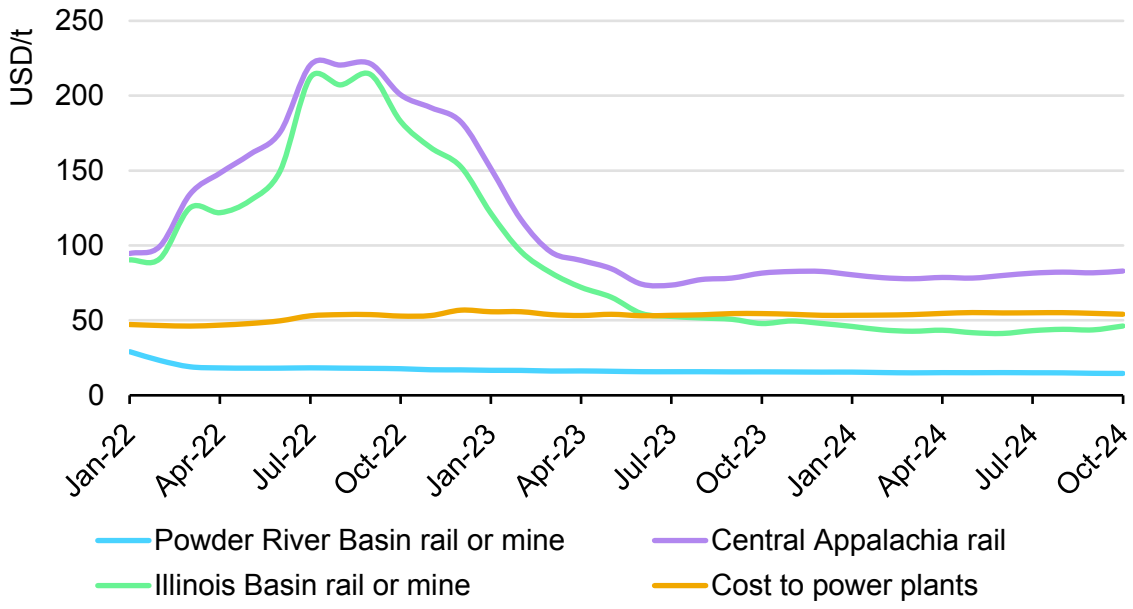
Source: OECD (2024), Monthly Monetary and Financial Statistics (MEI) exchange rates (USD monthly averages).

US coal consumers with contracts benefited from more stable prices than on the spot market

Most of the coal produced in the United States is consumed domestically and sold through long-term contracts, typically indexed to cost inflation metrics. As a result, average coal delivery costs to US power plants were less affected by the sharp rise in global spot prices for thermal coal during the energy crisis in 2022 than in other regions. The average cost of coal delivered to US coal-fired power plants during 2022 increased by 20% to USD 57/t. In contrast, spot prices in the Central Appalachian region and the Illinois Basin more than doubled in the first half of 2022, given their exposure to international trade. Simultaneously, spot prices in the Powder River Basin remained relatively unaffected, as only a small portion of its coal is exported. Given the high share of long-term contracts for domestic coal, producers did not fully capitalise on rising prices during 2022. However, growing production costs prompted miners to establish new measures to mitigate price risk, such as a link to diesel prices or the inclusion of reopener clauses.

During the first half of 2023 spot prices in the Central Appalachian region and the Illinois Basin returned to levels comparable to those seen before the energy crisis. Moreover, the price spread between the two regions reestablished itself, with Appalachian prices averaging USD 33/t higher than Illinois Basin prices from mid-2023 to mid-2024. This spread, also present before the crisis, largely reflects differences in coal quality. During the crisis, however, the spread narrowed as coal became scarce. A brief divergence in prices occurred from April 2022, following Russia's invasion of Ukraine. Importers had previously blended the high-sulphur coal from the Illinois Basin with low-sulphur Russian coal. When Russian imports ceased, Illinois Basin coal prices temporarily stopped surging while prices for Appalachian coal were on the rise.

Spot coal prices in different regions and cost of coal supplied to power plants in the United States, 2022-2024



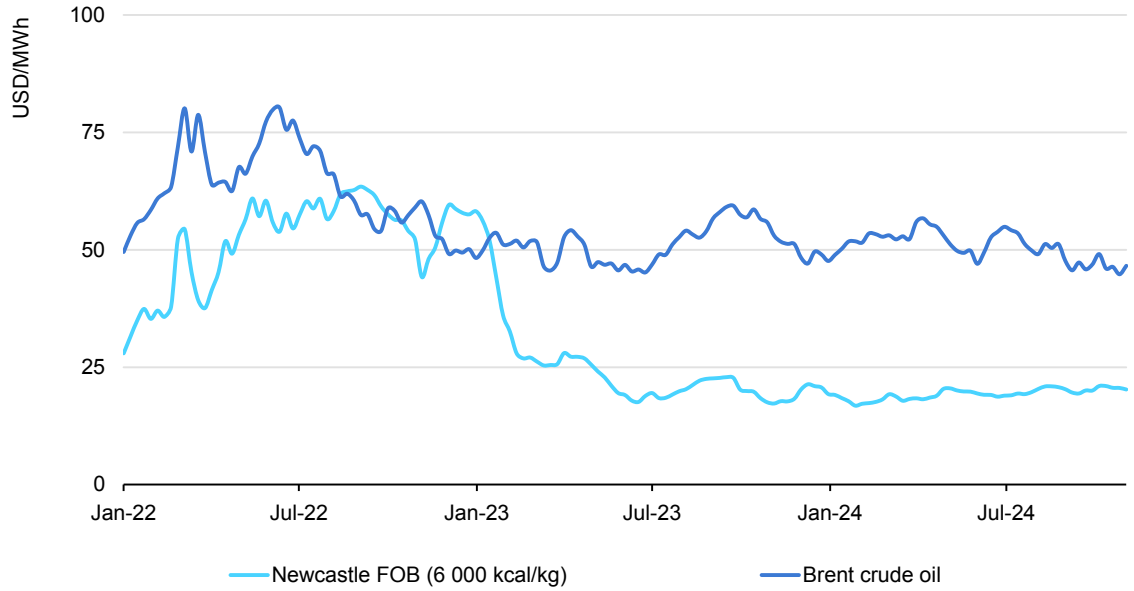
Sources: IEA analysis based on Argus Media Group (all rights reserved) and EIA (2024), STEO.

Gas and coal prices show a strong correlation

Energy commodity prices are typically correlated, as they can serve as substitutes (e.g. coal and gas in electricity generation) or are linked through supply chains (e.g. oil used in coal mining and transport). However, market disruptions in 2022 led to a temporary weakening of the usual correlation between coal, gas and oil prices.

During 2021 Brent crude oil traded at a premium of about USD 20/MWh to high-CV coal from Australia. In 2022 this price spread narrowed given the scarcity in Australian coal supply and tight coal markets overall. In the second half of 2022 an unusual market development occurred: while oil prices declined coal prices continued to rise. This highlights the limited substitutability between coal and oil, with coal prices being more driven by demand dynamics than by supply costs. By January 2023, as Australia's coal production recovered and global markets stabilised, coal prices sharply dropped to more moderate levels. Since July 2023 the premium of oil over coal has ranged between USD 26/MWh and USD 39/MWh, slightly higher than pre-2022 levels.

Price markers for Australian high-CV coal and Brent crude oil, 2022-2024

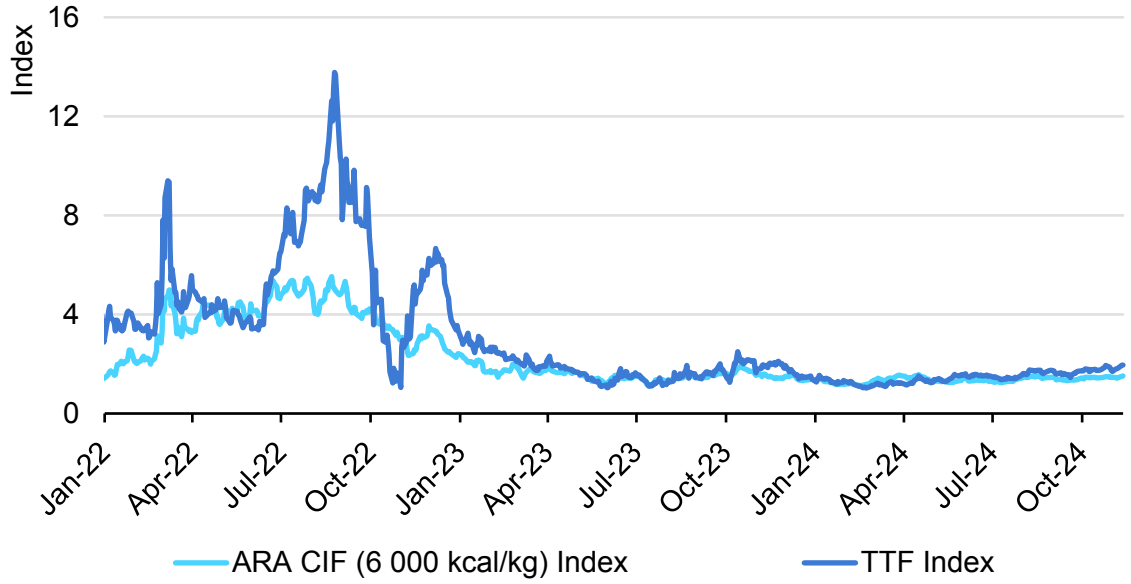


Note: FOB = free on board.
Source: IEA analysis based on Argus Media Group (all rights reserved).

The 2022 gas price spike, exemplified by the European benchmark TTF, was more pronounced than for coal. This stemmed primarily from the halting of many Russian piped deliveries to Europe. To accommodate this supply shock, Europe had to shift its gas imports to more LNG, for which the required infrastructure (pipelines and LNG terminals) was not always available. The higher dependence among European countries on the global LNG market caused gas prices to increase globally. In the second half of 2022 and over the course of 2023 more infrastructure such as LNG terminals and interconnectors was built, releasing tension in the market.

The price level of gas further decreased moderately in 2024, reaching its lowest point in March, but a tightening supply side and concerns such as the war in Ukraine and the crisis in the Middle East, which threatened production or distribution, stopped further price decreases. In Europe weak demand and high storage levels countered these concerns, resulting in prices for TTF that were still lower overall than in 2023. Moreover, gas prices saw less volatility compared to the previous year, although still above coal prices.

Trajectories of ARA CIF coal and TTF gas prices, 2022-2024



Notes: ARA = Amsterdam Rotterdam Antwerp; CIF = cost, insurance and freight; TTF = Title Transfer Facility.
Source: IEA analysis based on Argus Media Group (all rights reserved).

Coal markets no longer in strong backwardation

Prior to the 2022 energy crisis, coal and gas futures in Europe generally moved in close association with spot prices, indicating stable market conditions. However, from mid-2021 both markets experienced pronounced backwardation, with the forward curves reflecting falling prices over time. This trend was the result of a supply shortage, with higher prices in the short term due to supply difficulties. Following Russia's invasion of Ukraine, market disruption led to a significant upward movement in both spot and futures for both coal and gas. At the beginning of November 2022 forward prices for deliveries in 2024 were around USD 29/MBtu for TTF, the European gas benchmark, while ARA, the European coal benchmark, was over USD 200/t.

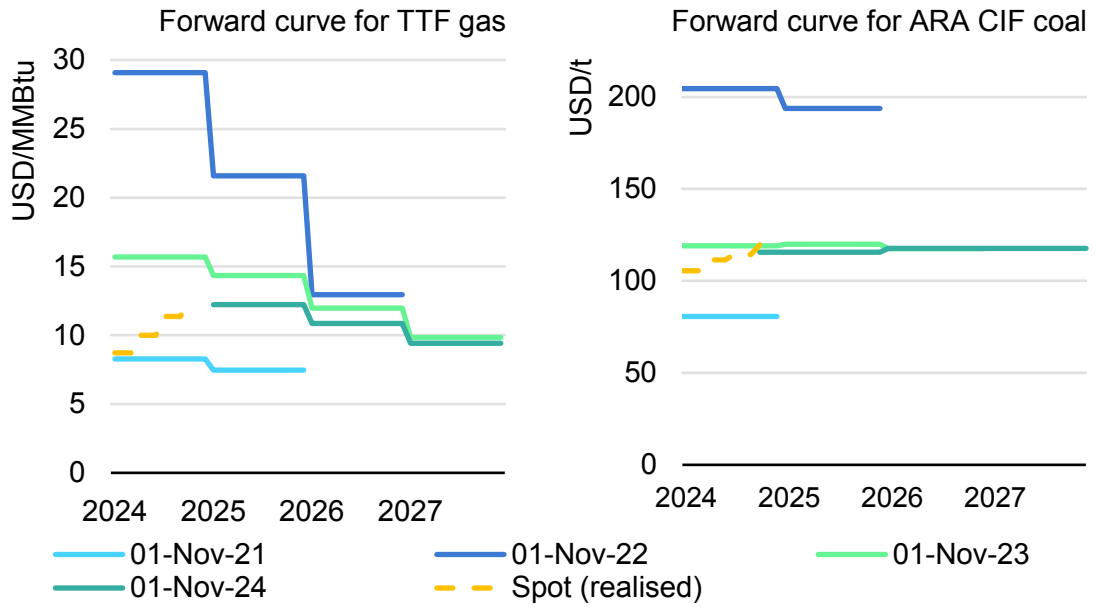
Throughout 2023, and to a lesser extent 2024, the forward curves for both commodities were revised downwards, reflecting market players expectations of a better balance between supply and demand in upcoming years. Furthermore, the gas curves flattened in 2024, meaning the difference between the delivery years became less pronounced. Despite this general downward trend, volatility within 2024 was notable, with the price curve bottoming out in March before recovering and approaching 2023 levels.

Normally, movements in the gas market influence coal prices, as gas is an important substitute for power generation. However, in November 2024 the forward curve for

coal remained at the same level as that seen in 2023. Moreover, coal curves have been generally flat across the coming years, diverging from the curves of gas.

In summary, stabilising market conditions relative to the crisis period are reflected in market expectations as given by the current forward curves. Coal and gas price correlation has weakened and whereas the gas market remains in backwardation, the coal market does not.

Forward curve development for ARA CIF coal and TTF gas prices, 2021-2024



Notes: ARA = Amsterdam Rotterdam Antwerp; CIF = cost, insurance and freight; TTF = Title Transfer Facility.
Source: IEA analysis based on Argus Media Group (all rights reserved).

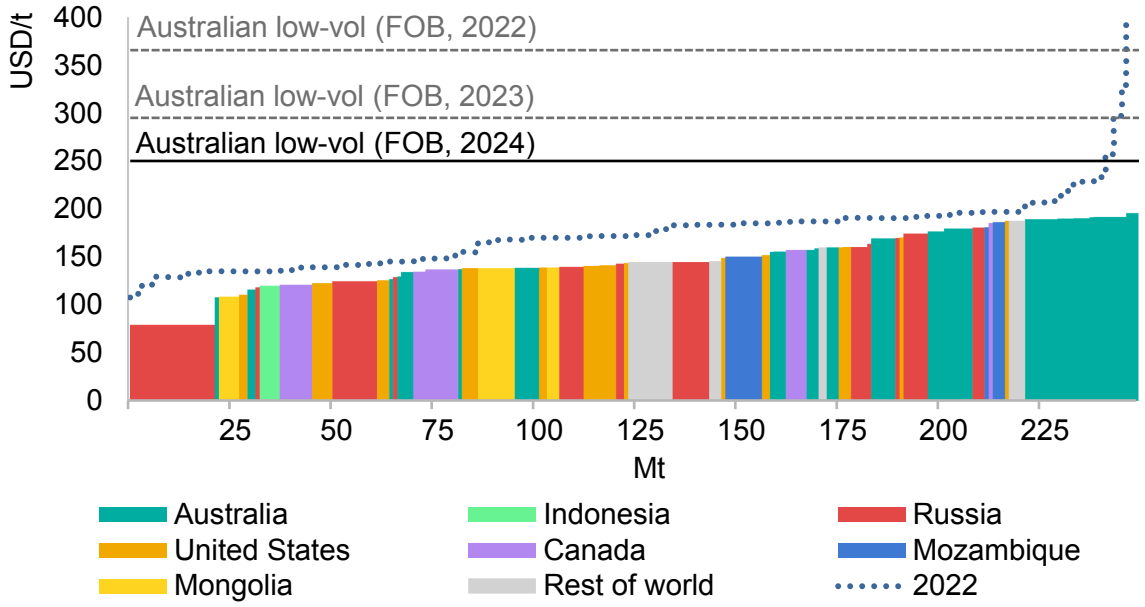
Costs

Coking coal supply curve continues to be lower than in 2022

In 2023 the supply cost curve for hard coking coal fell slightly compared to the previous year. 2022 was characterised by sharply increasing costs for input factors, inflating supply costs. However, as global energy markets eased in 2023, certain input costs such as the cost of diesel declined, reducing the overall supply costs for coking coal producers. Despite the decrease in costs, the indicative profitability of coking coal mining decreased notably from its high in 2022, since weighted supply costs have decreased by about 10%, while average prices for Australian hard coking coal plummeted by 19% between 2022 and 2023. Nevertheless, weighted average costs still accounted for only 53% of the average Australian hard coking coal price, indicating the persistent profitability of hard coking coal mining.

Overall production declined slightly by 5 Mt in 2023 compared to 2022, with the largest reductions seen in the United States (down 7 Mt) and Australia (down 7 Mt). Conversely, Mongolia recorded the most significant production increase, driven by demand from China. Both the Talvan Tolgoi and the Ukhaa Khudag mines more than doubled their output to a combined production of 15 Mt in 2023. In contrast, Russian production reduced by 3 Mt.

Indicative hard coking coal FOB supply curve, 2023, and average FOB price markers, 2022-2024



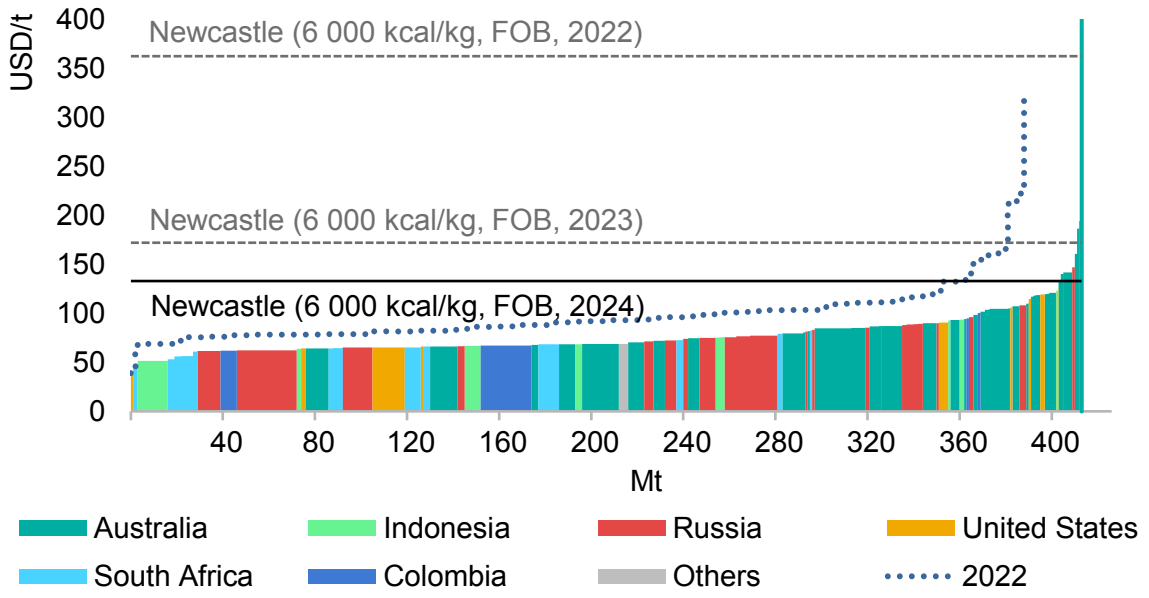
Notes: low-vol = low-volatile. FOB = free on board. Cost curves account for variable production costs, overburden removal, royalties, inland transport, and port usage fees. The annual average FOB price marker is based on the monthly average index for Australian prime hard coking coal. The 2024 price is based on the average from January to September.

Sources: IEA analysis based on Argus Media Group (all rights reserved) and adapted from CRU (2024), Metallurgical Cost Model (database).

Thermal coal mining typically incurs lower costs compared to met coal mining. This is largely because met coal is mostly mined underground, usually in smaller mining sites, and tends to show higher preparation costs. Despite these added expenses, met coal's superior quality and higher price justify its higher production costs.

In the high-CV market segment the supply cost curve fell in 2023, with average supply costs dropping by about 9% year-on-year. However, prices as indicated by the Newcastle high-CV price marker dropped more sharply – by over 50% – from the crisis-driven highs in 2022 to an average of USD 172/t in 2023. This price decline coincided with an expansion in the supply curve of approximately 25 Mt. Most of the additional capacity was recorded in Australia, where prior supply disruptions had weighed on production in 2022. As a result, profitability moderated from the extreme uptick of 2022.

Indicative high-CV (> 5 700 kcal/kg) thermal coal FOB supply curve, 2023, and average FOB price markers, 2022-2024

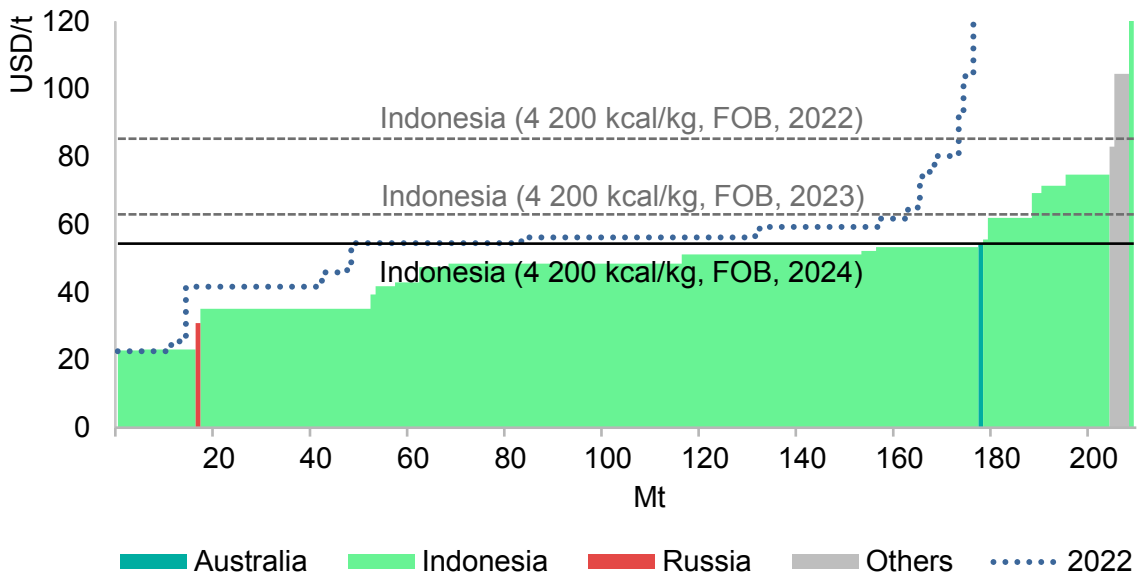


Notes: The cost curves account for variable production costs, overburden removal, royalties, inland transport, and port usage fees. The cost curve is not adjusted for different qualities of coal. The transport costs given are to the closest port, so the FOB costs of Russian producers in Asia can be somewhat higher than shown in the figure. The 2024 prices are based on the monthly average from January to September.

Sources: IEA analysis based on Argus Media Group (all rights reserved) and adapted from CRU (2024), Thermal Cost Model (database).

The low-CV market segment is dominated by Indonesia, whose deposits are rich in that type of coal. In 2023 production costs in this segment declined, with average costs decreasing by about USD 5/t. This was accompanied by a significant expansion in the supply cost curve of 31 Mt, after 2022 already showed an expansion of 9 Mt. The reduction in prices outpaced the reduction in costs, decreasing on average by USD 22/t (or 26%) from 2022 to 2023.

Indicative low-CV (< 4 500 kcal/kg) thermal coal FOB supply curve, 2023, and average FOB price markers, 2022-2024



Notes: The cost curves account for variable production costs, overburden removal, royalties, inland transport, and port usage fees. The cost curve is not adjusted for different qualities of coal. The transport costs given are to the closest port, so the FOB costs of Russian producers in Asia are somewhat higher than shown in the figure. The 2024 prices are based on the monthly average from January to September.

Sources: IEA analysis based on Argus Media Group (all rights reserved) and adapted from CRU (2024), Thermal Cost Model (database).

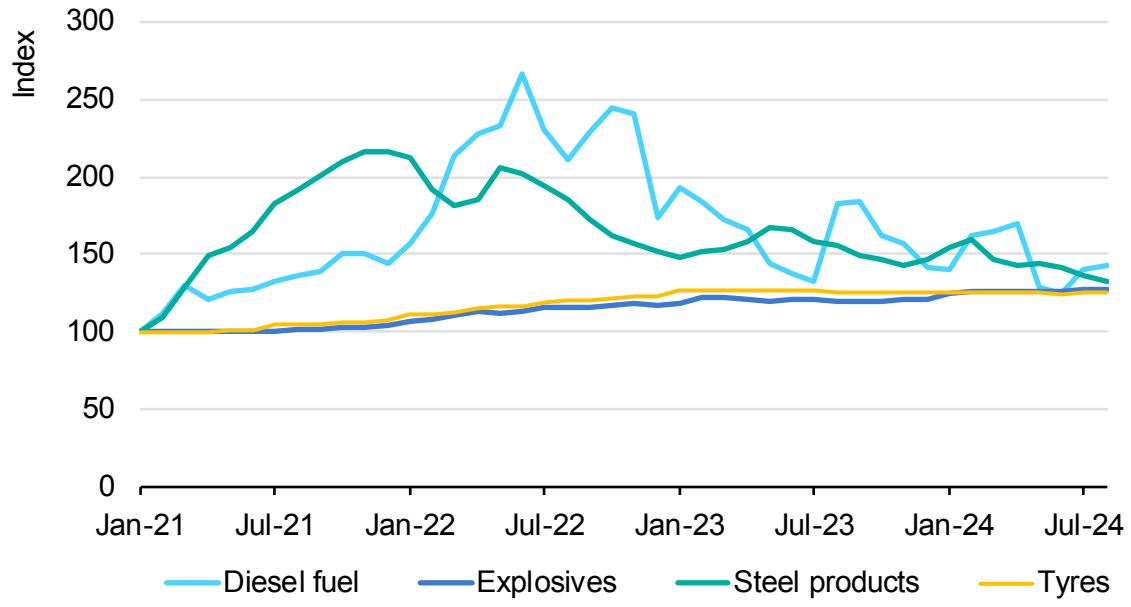
Input costs drive the coal supply cost curve, displaying varying volatility

The cost structure of coal mines is primarily shaped by operating expenses, comprising mainly of labour, fuel costs, taxes and royalties, alongside transport costs such as inland transport, port charges and seaborne freight. The proportions of these costs can vary significantly depending on the mining method used, whether surface or underground, and can differ widely based on the producer, country and the characteristics of each mine site.

Input factors such as fuel, explosives, tyres and steel products are globally traded commodities, and their prices are influenced by international market trends. Notably, price movements in explosives and tyres saw significantly less volatility than those of diesel and steel products between mid-2021 and 2023. Nonetheless, the cost to mining operators of explosives and tyres steadily increased during that period. By the beginning of 2024 their price had surged by about 25% compared to the first half of 2021. A similar increase was recorded in the case of steel products and diesel; however, they experienced very different trajectories over the same period. While the price of steel products reached its peak in late 2021 at more than double the price of January 2021, the price of diesel saw its peak in mid-2022

during the energy crisis. Both price markers subsequently displayed a downward trend, albeit characterised by strong volatility, especially in the case of diesel.

Nominal prices of select commodities and input factors used in coal mining, 2021-2024



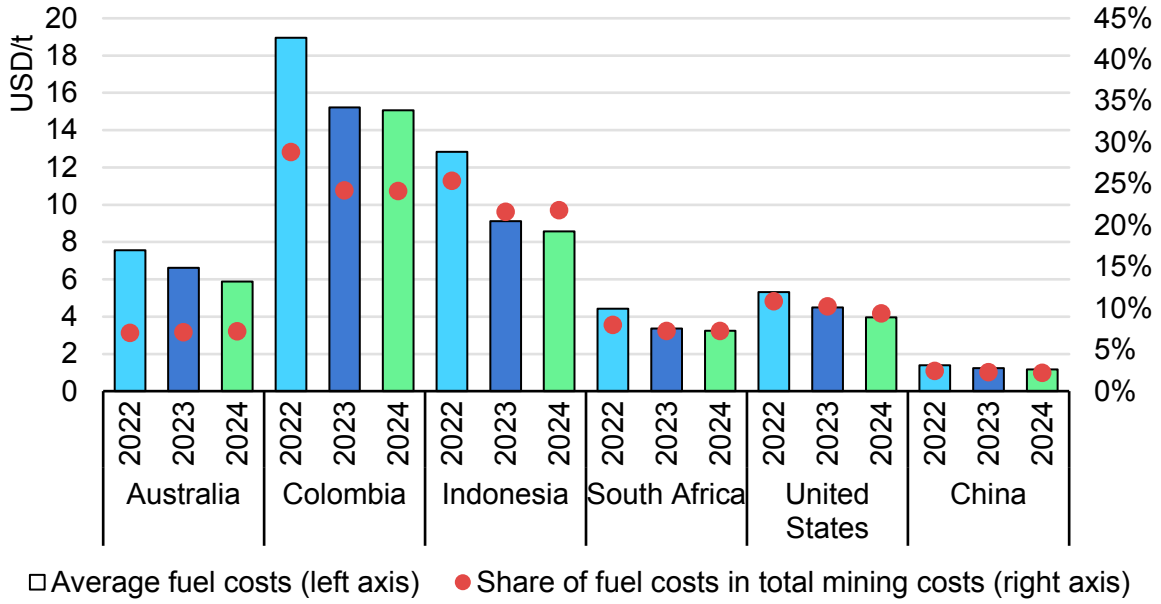
Source: IEA analysis based on US Bureau of Labour Statistics (2024), Producer Price Indexes.

Fuel costs are highest in Colombia and Indonesia

Diesel fuel costs play a significant role in the overall cost structure of coal mining, especially in countries that rely heavily on opencast mining, such as Colombia and Indonesia. These mines depend on diesel-powered machinery and vehicles, making fuel expenses a larger portion of their total costs. In contrast, in countries like China, where underground mining is more prevalent, fuel costs have a lower impact on a mine's cost structure.

Given their high share of opencast mining, Colombia and Indonesia consistently exhibit the highest absolute and relative fuel costs in coal mining. In 2023 most coal producers across the globe experienced a decline in fuel costs as energy markets softened following the peaks of the 2022 crisis. This decline in fuel prices also led to fuel costs accounting for a reduced share of total mining expenses since other cost factors such as labour did not change as much. In 2024 this share remained largely stable in each country, steadying between the extremes of 2% in China and 24% in Colombia, similar to the previous year.

Average fuel costs and share of total coal mining costs, select countries, 2022-2024



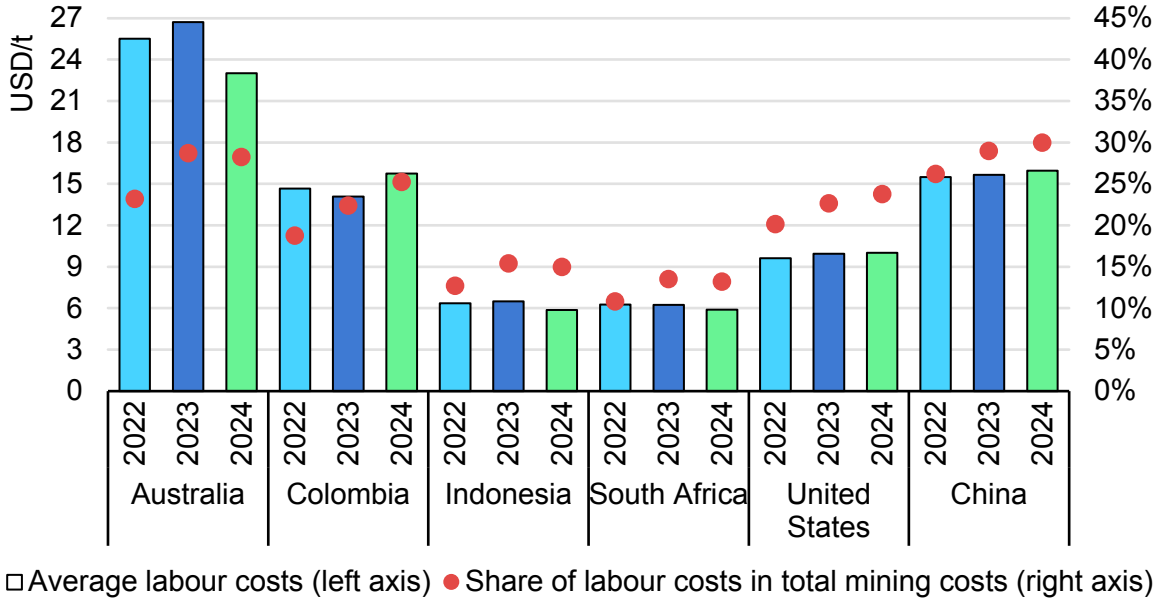
Source: IEA analysis based on CRU (2024), Thermal Cost Model (database).

Labour costs account for up to a third of total mining costs

Labour costs (expressed in USD/tonne) represent a substantial portion of overall mining expenses and can vary significantly across coal-exporting countries, depending on factors like mining methodology, productivity or salary levels. In this analysis,[9] labour costs range from about USD 6/t in Indonesia to almost USD 27/t in Australia, while the share of labour costs in total mining costs varies between low double-digit numbers in South Africa to almost a third in the case of China. While absolute labour costs saw modest volatility between 2022 and 2024, labour costs as a share of total mining costs have been rising slightly in most countries. A key reason for this is the decrease in the cost of other input factors during this period.

[9] This analysis includes China since its domestic coastal coal trade, at more than 800 Mt, is comparable with global trade.

Average labour costs and share of total coal mining costs, select countries, 2022-2024



Source: IEA analysis based on CRU (2024), Thermal Cost Model (database).

Royalties have been declining with coal prices…

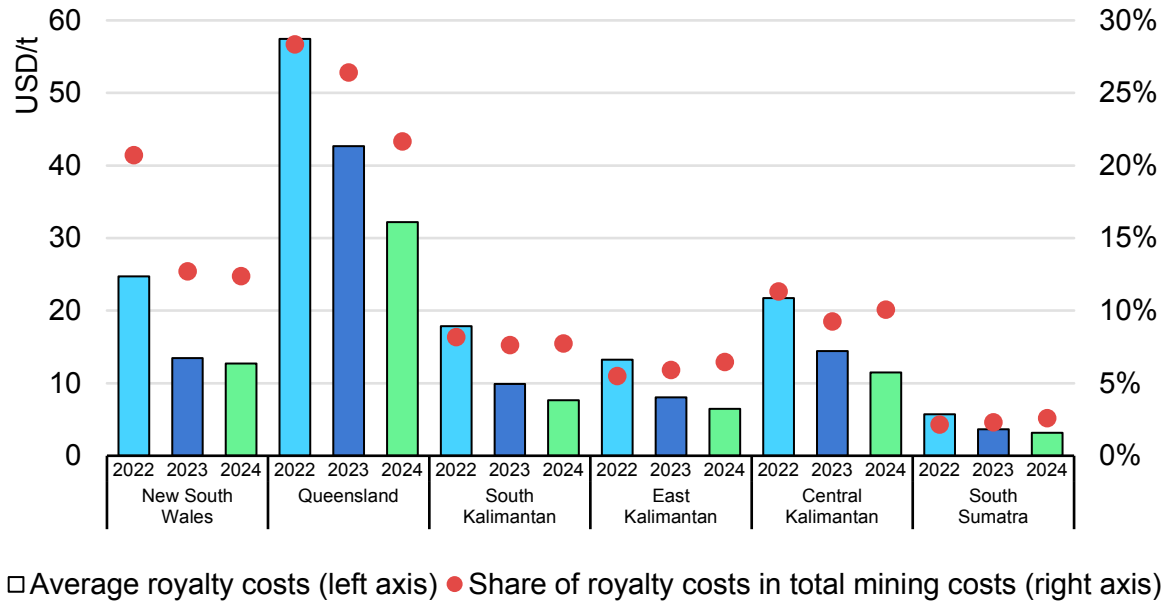
In return for granting mining licences, most national or regional governments levy royalties on each tonne of coal produced or sold. In response to high prices, specifically in 2022, coal mining royalties have been subject to adjustments, albeit varying strongly according to the country or region of origin.

The highest royalties in the last three years were recorded in Queensland, where royalties accounted for 22% to 28% of total mining costs. In 2023 alone these royalties earned the state over USD 9.1 billion. The Queensland royalty scheme is characterised by a progressive system, as royalty rates increase with the price per tonne sold. In 2022 the royalty scheme was adjusted upwards, resulting in costs close to USD 60/t, given the high prices for coal during that period. This represents by far the highest royalties payable compared to any other region. With prices moderating in subsequent years, royalty rates also reduced to about USD 32/t. In May 2024 the Queensland government released the Progressive Coal Royalties Protection Bill 2024, aimed at preventing future governments from lowering royalty rates. Other states in Australia have different schemes in place, such as a royalty rate depending on the method used for coal extraction in New South Wales. In addition, the share of royalties as a proportion of mining costs is significantly lower, especially in Western Australia.

In Indonesian regions the rate of royalties levied on total mining costs mostly increased between 2022 and 2024, although absolute royalties notably

decreased. The Indonesian government raised royalty rates[10] in 2022 from 13.5% to a range between 14% and 28%, with the upper range applying when prices exceed USD 100/t. In September 2024 Indonesian mining associations submitted a proposal to adjust royalty rates, as they consider royalties to be too high given the tightening margins being experienced by producers.

Average royalties and royalties as a share of total coal mining costs, select areas, 2022-2024



Source: IEA analysis based on CRU (2024), Thermal Cost Model (database).

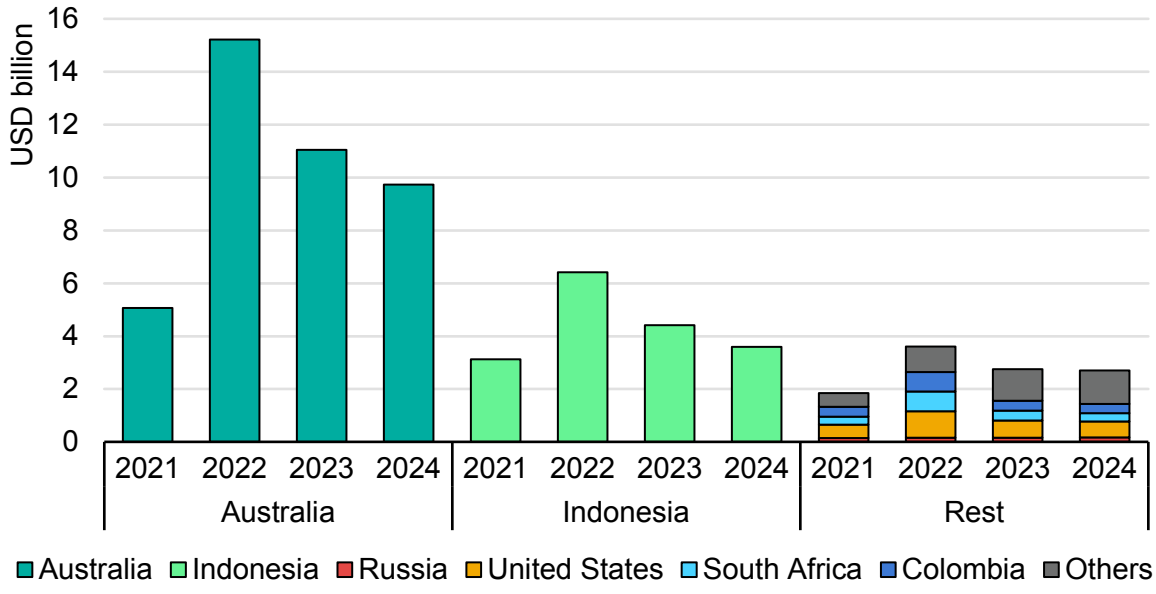
… and so too have state revenues from royalties

The development of global coal prices in 2022, together with adjustments in royalty schemes, significantly increased state incomes from coal exports for some major exporters. Based on our assessment of trade and prices, our analysis shows a tripling of total royalties from coal exports in Australia in 2022 to more than USD 15 billion and a doubling in the case of Indonesia to USD 6.4 billion. Despite global trade volumes rising during 2023 and their likelihood to have done so in 2024, total royalties have significantly fallen since 2022 as prices came down from the crisis-driven highs. However, Australian royalties are estimated to remain about twice as high in 2024 compared to 2021, supported by adjustments in state royalty schemes in 2022, while Indonesian royalties are estimated to be at a level 15% higher than 2021.

[10] Royalty rates for coal sold under the domestic market obligation are capped at 14%.

Export-related royalties in other exporting countries are significantly lower than in Australia and Indonesia. However, some governments have taken steps to capitalise on coal trade by adjusting tax rates or royalty schemes. For instance, Russia implemented a duty on coal exports in September 2023, with the duty rate tied to currency exchange rates. In a move to support its struggling coal sector, Russia temporarily removed export duties on thermal coal and anthracite between May and August 2024.

Total royalties on exported coal, select countries, 2021-2024

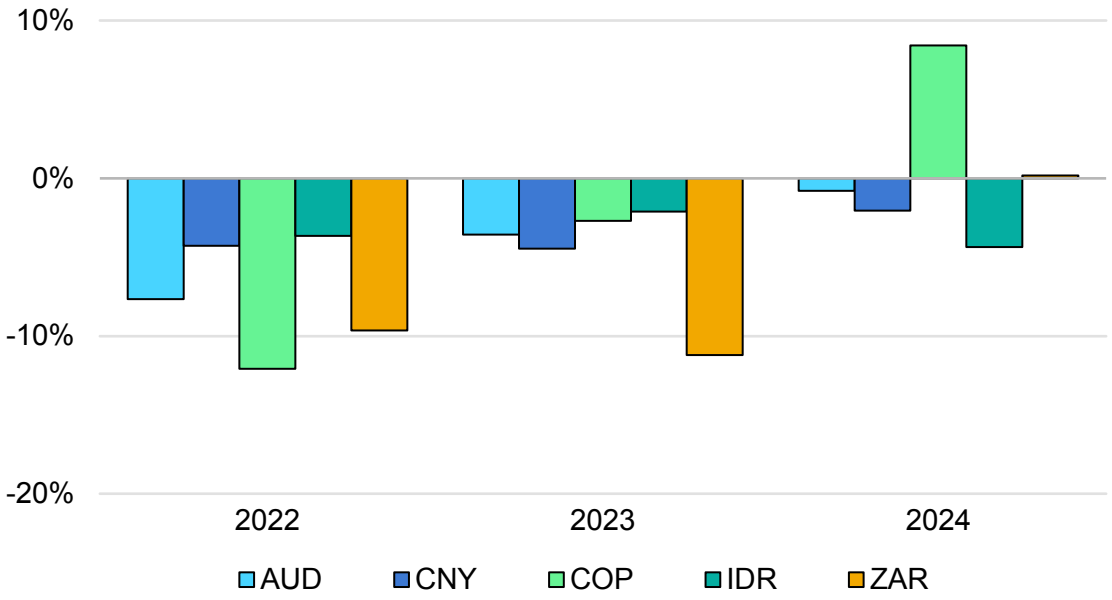


Sources: IEA estimates based on CRU (2024), Thermal Cost Model (database) and Metallurgical Cost Model (database).

Exporters currencies continue their devaluation

Currency exchange rates affect the global competitiveness of coal exporters. While international coal trade is primarily conducted in US dollars, a significant proportion of mining operating costs are paid in local currencies. As a result, given a local currency depreciation against the US dollar, operational costs in dollar terms decrease, thereby enhancing the cost-efficiency and competitiveness of the producers in the global market. As the result of rising interest rates in the United States, most currencies devalued against the US dollar over the period 2022-2024. An exception is the Colombian peso, which has appreciated in recent years due to the country's strong economic performance.

Year-on-year development of China's and exporting countries' currencies against the US dollar, 2022-2024



Notes: AUD = Australian dollar. CNY = Chinese yuan renminbi. COP = Colombian peso. IDR = Indonesian rupiah. ZAR = South African rand. The chart displays the y-o-y average exchange rate development of the select currencies expressed as the change from the previous year. 2024 represents average exchange rates to October 2024.

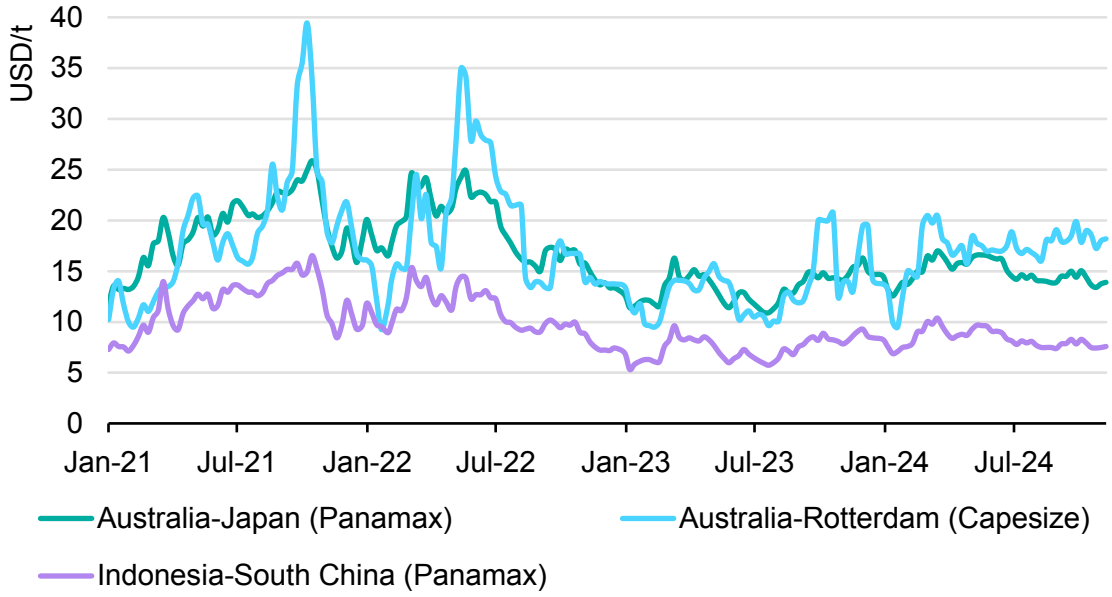
Source: OECD (2024), Monthly Monetary and Financial Statistics (MEI): Exchange rates (USD monthly averages).

Freight rates remain volatile

Global coal trade is predominantly seaborne, accounting for over 90% of total trade. In seaborne trade, coal is transported by dry bulk vessels that can be classified by their deadweight tonnage (dwt). The primary vessel types include Capesize (over 80 000 dwt) and Panamax (60 000-80 000 dwt), which are the most used. Freight rates depend on factors such as vessel type, route, and the balance between supply and demand. Moreover, fuel costs significantly affect freight rates. Coal accounts for about a quarter of total dry bulk trade, second only to iron ore, which represents almost a third of the total.

In the aftermath of the Covid-19 pandemic and due to the implications of Russia's invasion of Ukraine, freight rates saw high volatility at the beginning of this decade, peaking in October 2021 and June 2022. As economic outlooks dimmed and demand for dry bulk carriers softened in the latter half of 2022, alongside lower port congestion, freight rates moderated significantly. By January 2023 freight rates had approached their lowest levels in over two years. However, during 2023 freight rates began to rise again, supported by iron ore trade, which expanded by 5% y-o-y in 2023. Projections suggest further growth in this trade in 2024. In the first three quarters of 2024 freight rates for the Australia-Japan route (Panamax) increased by 16%, while the Australia-Rotterdam route (Capesize) saw a 37% rise compared to the same period in 2023.

Freight rates on select routes, 2021-2024

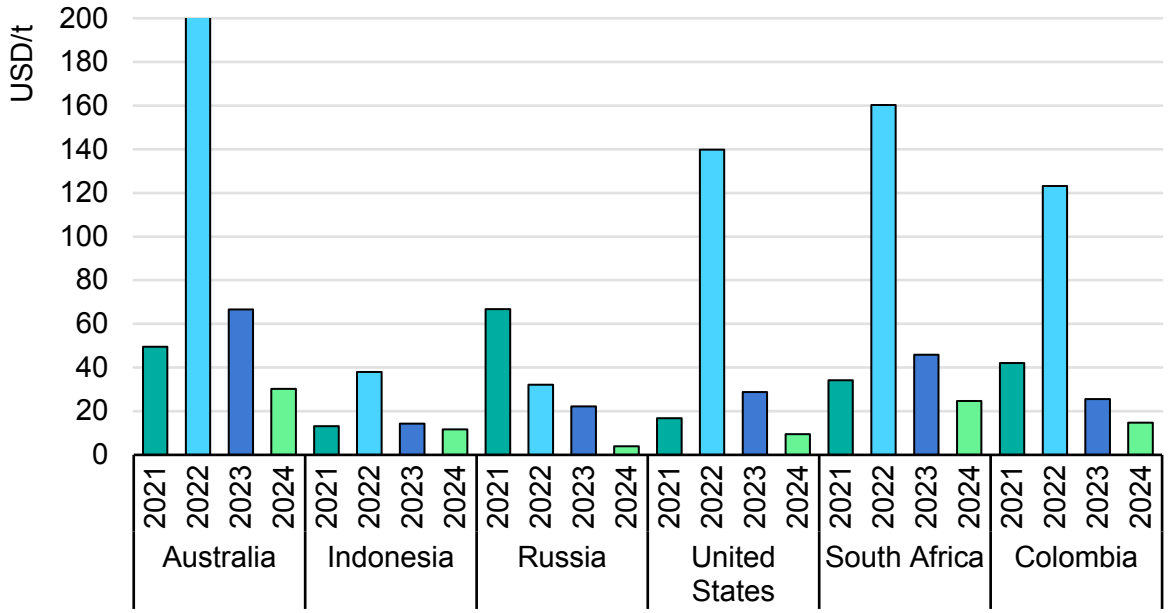


Source: IEA analysis based on Argus Media Group (all rights reserved).

Coal mining continues to be profitable in 2024

The early years of this decade saw significant variance in the profitability of coal trade worldwide. As demand collapsed during the Covid-19 pandemic, coal prices plummeted, leading to widespread losses for coal producers. From the latter half of 2021 and throughout the 2022 energy crisis, coal prices reached unprecedented levels and profitability surged. Profit margins in the Australian high-CV segment approached USD 200/t, with other countries seeing triple-digit profits per tonne traded. However, in 2023, as prices fell sharply, global profitability for high-CV thermal coal trades declined, albeit remaining above 2021 levels. During 2024 mining costs remained elevated while prices saw a modest decline, further reducing profitability. Thus, our indicative analysis shows profits averaging slightly below 2021 levels. In the case of Russia, rising costs, railway congestion and higher rail tariffs, international sanctions and export duties have all weighed on the profitability of Russian thermal coal trade in 2024. Market participants report many miners finding themselves on the verge to unprofitability, underscored by our analysis. In order to improve the economics of coal producers, the Russian government announced the removal of export duty from 1 December 2024.

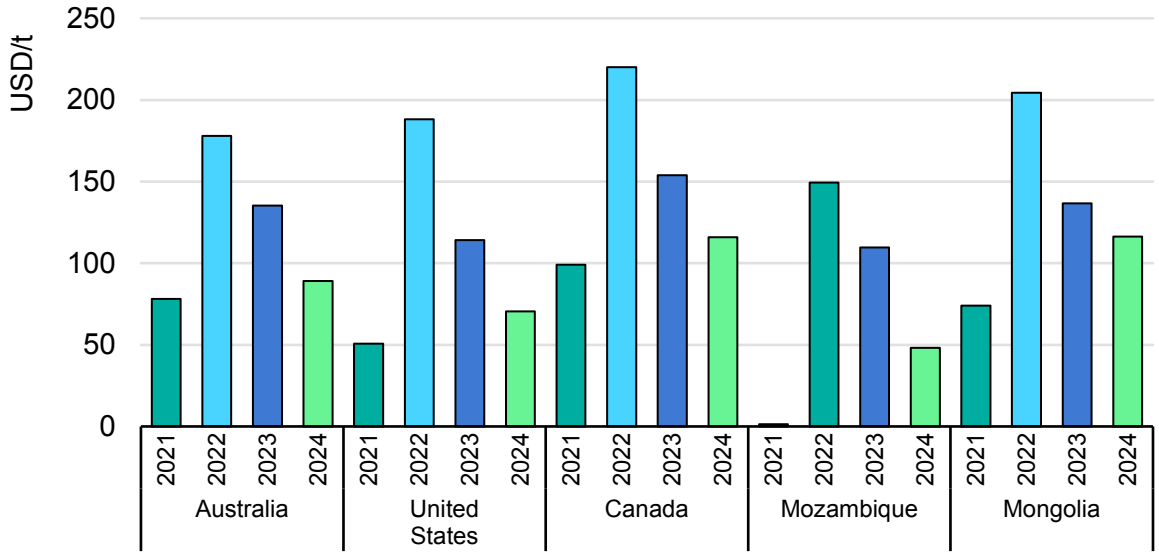
Indicative profitability of high-CV thermal coal trade, select countries, 2021-2024



Note: The profit margin is defined as the difference between weighted average prices and weighted average costs.
Source: IEA analysis based on CRU (2024).

In the hard coking coal market segment, the price rally during 2022 was less extreme than in the high-CV market segment, causing profit margins in relative terms to stay mostly below those of high-CV coal trade. However, the subsequent price decline was also more moderate, keeping profitability steadier. In 2024 average profits have mostly ranged between USD 48/t and USD 151/t, depending on the quality and exporting country. Moreover, profit margins stayed generally above 2021 levels, underscoring the nuances in coal market segments.

Indicative profitability of hard coking coal trade in select countries, 2021-2024



Notes: The profit margin is defined as the difference between weighted average prices and weighted average costs.
Source: IEA analysis based on CRU (2024).

While lower than in 2022, revenues remain strong for coal-exporting countries

Global coal exports generate substantial revenues[11] for major exporting nations. Our analysis shows that in 2021 combined coal export revenue reached approximately USD 158 billion. This figure nearly doubled in 2022, soaring to close to USD 300 billion, before stabilising at around USD 200 billion in 2023. Thus, the global coal trade market is estimated to have a value comparable to that of the global LNG market, although the latter tends to experience greater fluctuations.

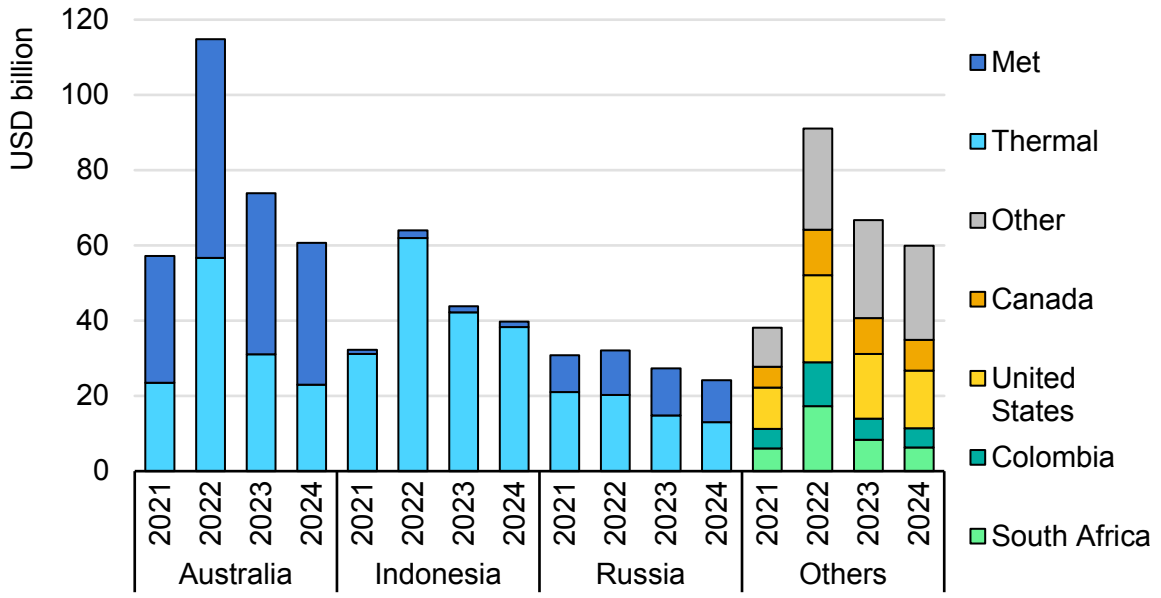
Over 70% of global coal export revenues are concentrated in just three countries, which dominate the market in both volume and value. Australia leads the trio, accounting for about 37% of total export revenue in 2023, or USD 74 billion. Although Indonesia surpasses Australia in terms of export volume, Australia maintains its lead in revenue thanks to its significant share of high-value met coal exports. Prior to Russia's invasion of Ukraine, Russia's coal export revenues were comparable to Indonesia's, hovering around 20%. However, due to a shift in the buyer base and subsequent supply chain disruptions, ongoing sanctions and payment challenges, Russian exporters struggled to capitalise on high coal prices in 2022, with revenues estimated close to 2021 levels.

[11] In this section, revenues mean coal sales to other countries assessed on a FOB basis.

Despite global coal trade being expected to grow in 2024, total revenues are projected to have decreased due to the lower prices across most market segments, particularly met coal. Nonetheless, most exporting countries are expected to show higher revenues than in 2021, with the notable exception of Russia. Russian exports continue to require discounts to attract buyers, primarily due to war-induced risks, the country's exclusion from the SWIFT payment system and concerns over secondary sanctions on buyers. These ongoing challenges, together with slightly lower prices in 2024, result in an estimated revenue of USD 25 billion for Russia in 2024, about 20% lower than in 2021.

Coal exports also play a vital role in the economies of some countries. While Australia's coal exports represent a small, single-digit percentage of its GDP, Mongolian coal exports accounted for more than 20% of its GDP in 2021 and more than 35% in 2022, underscoring the importance of coal exports for certain nations.

Coal export revenue, select countries, 2021-2024



Notes: Revenue for Australia, Indonesia and Russia calculated using weighted average realised prices (FOB). Realised prices for 2024 are based on data to June 2024. Canadian realised prices based on US realised prices. Revenues include land-based trade assuming the same realised prices as FOB.

Source: IEA analysis based on CRU (2024).

Update on investment and coal abatement

The project pipeline for new export-oriented mines shrinks further

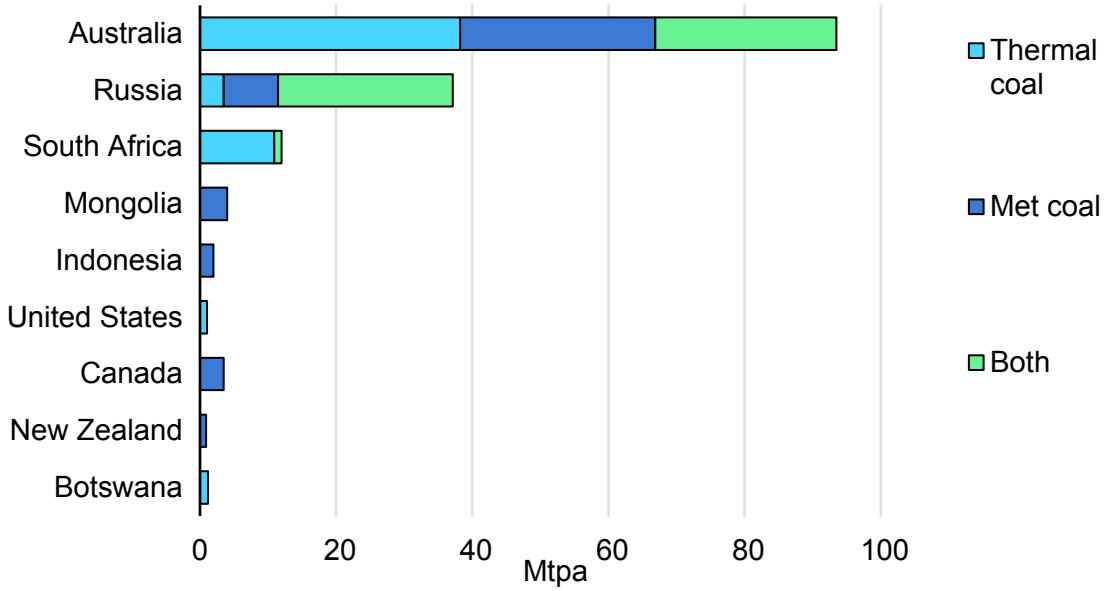
Projects for new, expanded and extended coal mines aimed at the export market have a total capacity of 430 Mtpa at the time of writing, marking a decrease of 31 Mtpa compared to our previous report. We classify these projects as either more-advanced or less-advanced projects.[12] This reduction in the project pipeline is largely attributed to the decline in less-advanced projects, whose capacity has fallen from 314 Mtpa to 275 Mtpa. Many of these projects have faced prolonged inactivity and are effectively considered shelved. In addition to the weakening economic outlook, the development of coal mining projects continues to be hindered by the progression of more stringent climate policies. Nevertheless, a few projects have successfully made the transition from less-advanced to more-advanced. This transition, combined with the addition of new projects, has resulted in the more-advanced project pipeline growing by an additional 62 Mtpa of combined capacity. As more-advanced projects with a total capacity of 49 Mtpa started operation, the net growth of the more-advanced pipeline amounts to 13 Mtpa.

Overall, most projects under consideration are concentrated in Australia (62%), with Russia (11%) and South Africa (10%) following. However, due to limited transparency in some countries, such as export-focused Indonesia, these figures should be interpreted with caution.

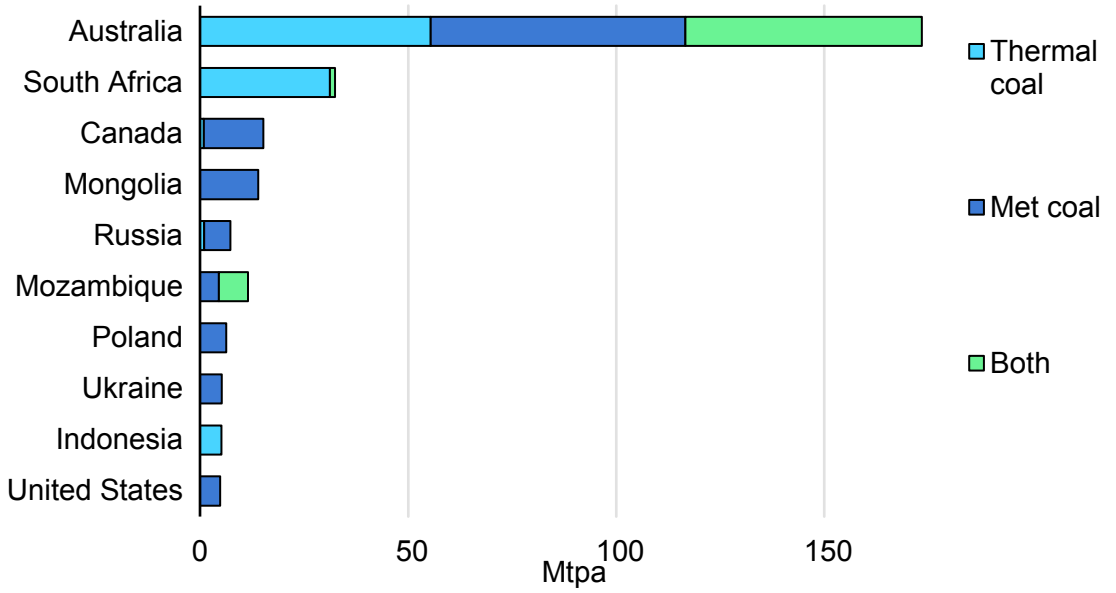
Rather than focusing on expanding coal mining capacity, some countries are channelling investment into infrastructure development. In Africa and Indonesia new railways and ports are being constructed to increase export capabilities. Meanwhile, Russia is enhancing its terminal infrastructure in the eastern region, a strategic move to strengthen ties with the Asian market. This shift is a response to a broader trend of coal markets pivoting towards Asia, accelerated by the EU ban on Russian exports after its invasion of Ukraine.

[12] More-advanced projects have secured approval and reached a final investment decision or are currently under construction, while less-advanced projects remain at the feasibility or environmental assessment stage, or are pending approval.

Capacity of more-advanced export coal mining projects, 2024



Capacity of less-advanced export coal mining projects, 2024



Met coal projects look more attractive to investors than thermal coal projects

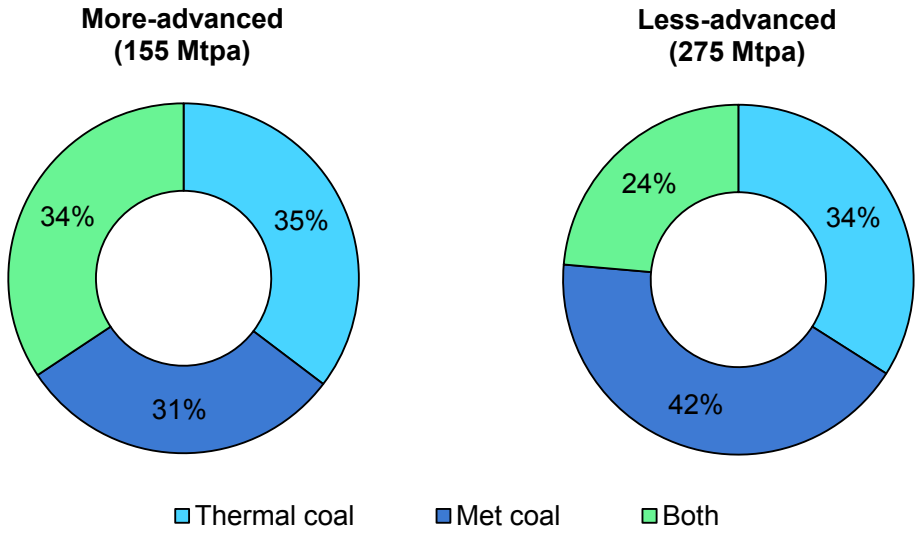
Although thermal coal's share of total coal market exports is approximately three times that of met coal, over the past three years the thermal coal proportion of less-advanced coal projects has significantly decreased, from half of the projects

under consideration to roughly one-third. Meanwhile, the met coal share of projects has gradually increased across both less-advanced and more-advanced stages. In the short to medium term, steel production from iron ore is likely to continue to be highly dependent on met coal, as alternative inputs, such as hydrogen, are not expected to reach commercial viability soon. Conversely, coal substitution is already occurring in the thermal coal segment, with a range of different low-carbon options for electricity generation. This shift is reflected in the decreasing share of thermal coal in new mining projects.

Climate objectives and environmental pressures are exerting significant constraints on the development of new coal projects. Early-stage projects are particularly vulnerable to government restrictions, and with numerous viable alternatives to thermal coal already available, the outlook for thermal coal mining projects remains highly uncertain.

At present, the more-advanced project pipeline is almost evenly distributed among thermal coal, met coal and combined coal projects. This trend highlights investors' increasing preference for met coal or combined coal over projects centred exclusively on thermal coal.

Coal grades in hard coal export mining projects, 2024



Australia approves new mines, but the overall project pipeline shrinks

Australia continues to dominate the project list for new or expanding coal mining projects aimed at exports. Australia has a total of 47 projects at both the less-advanced and more-advanced stages, with most targeting the production of met

coal or a mix of met and thermal coal. Australia's share of new or expanding projects in the global pipeline stands at 62%, although this figure should be interpreted with caution due to the high transparency of project listings in Australia compared to other regions. Given that mining project development typically spans several years, there were few transitions from the less-advanced to more-advanced stages between 2023 and 2024. However, the government of New South Wales approved the Narrabri Underground Mine Stage 3 Extension Project, the Ravensworth Underground Mine and the Mount Pleasant Optimisation project. The first two keep their extraction licences of up to 11 Mtpa and 3 Mtpa, which are extended to 2044 and 2032, respectively. The Mount Pleasant Optimisation Project, which is operated by MACH Energy, can double its coal extraction to up to 21 Mtpa of run-of-mine (ROM) coal until 2048.

Besides the approval of mining projects, Australia has seen other projects coming into operation. Australian Pacific Coal (AQC) has resumed operations at the Dartbrook mine, located in the Hunter Valley of New South Wales. It aims to increase production to 5 Mtpa of high-CV thermal coal and PCI coal. In late 2023 New Wilkie Energy started shipping coal from its reopened Wilkie Creek mine near Dalby, aiming to produce 2.4 Mtpa of high-CV thermal coal. However, the company soon after faced insolvency, on 27 December 2023, due to its debt burden, leading to layoffs for its miners. Also in late 2023 Fitzroy Australia Resources commenced longwall mining at Ironbark No. 1, which was formerly known as the Ellensfield Project. The mine is proposed to produce up to 2.7 Mtpa of both met and thermal coal. In April 2024 Pembroke inaugurated the Olive Downs Complex, targeting initial production of 6 Mtpa of ROM met coal. Within its approvals, the facility has the potential to expand its capacity to up to 20 Mtpa. The extension of the Vickery coal deposit by Whitehaven saw its first coal production in the second quarter of 2024. The project aims to reach a capacity of 1.2 Mtpa of ROM coal, primarily consisting of met coal, with some high-CV thermal coal as well. In June 2024 Peabody commenced operations at its Centurion asset, a met coal mine located in the Bowen Basin. The mine is projected to ramp up production throughout 2025, with a target of reaching 4.8 Mtpa by 2026.

Sanctions have accelerated infrastructure projects in Russia

Western sanctions have forced Russian coal producers to seek alternative markets, primarily in Asia. They have responded by aiming to develop domestic infrastructure to support additional flows. In general, investment in the Russian coal mining sector was heterogeneous in 2024. Thermal coal projects stalled amid falling coal prices and high costs, even occasionally resulting in loss-making operations. Furthermore, Western sanctions caused further trade barriers, diminishing the market outlook for Russian producers.

Conversely, investment in met coal mines has persisted due to a more favourable market outlook compared to thermal coal, particularly for exports to Asia. Therefore, investment has taken place, particularly in the eastern regions of Russia. Most notably, A-Property increased the capacity of its Elga mine in Yakutia, located in the Russian Far East, to 38 Mtpa. The medium-term capacity goal, stated for 2027, is 52 Mtpa. Similarly, Kolmar, another Yakutia-based firm, is advancing the second phase of its Inaglinskaya-2 washing facility. The company aimed to increase coal output by 2 Mt to 13.5 Mt in 2024 and is targeting future production capacity of 20 Mtpa. In Kuzbass, also in close proximity to China, Raspadskaya is constructing the Raspadsky-4 block, which has over 60 Mt of reserves and is intended to launch production by 2027. Suek is focusing on the Urgalugol asset in the Khabarovsk region bordering China, aiming to double its current output of 11 Mt of bituminous high-volatile G-grade coal, which can be used as thermal or met coal. Coalstar started anthracite production at the Bogatyr opencast in the Novosibirsk region in 2024, aiming for output of 3.7 Mt in 2025.

Besides mining activities, notable investment was channelled into infrastructure, such as railway and ports, facilitating the export of coal to international markets. Four different Far Eastern coal ports have seen development during 2024. A-Property's Elga mine is constructing a seaport with an initial capacity of 30 Mtpa, which could expand to 50 Mtpa. The port and an additional railway connection are expected to be operational by the beginning of 2025. The capacity of the Daltransugol sea terminal in the pacific port of Vanino has been increased to 33 Mtpa from 24 Mtpa. The sea port of Sukhodol reached its initial handling capacity of 12 Mtpa in September 2024. Lastly, the smaller Coalstar sea terminal in the port of Vostochny started operation in May with an initial capacity of 1.5 Mtpa.

Despite the eastern focus, western terminals have also seen developments. The 18 Mtpa Barents Sea terminal port of Lavna, near Murmansk, is nearing completion and is expected to start operations by the end of 2024. Additionally, Lugaport in northwest Russia has recently completed dredging works to accommodate larger vessels.

According to Russia's Ministry of Energy, the overall capacity of Russian coal ports increased by around 47 Mt to 391 Mt last year. However, the lack of adequate railway capacity emerged as a critical bottleneck, significantly preventing the full utilisation of newly developed ports and limiting the potential growth of coal exports in the short to medium term.

African countries want to develop new infrastructure projects jointly

South Africa remains the African country with the longest project pipeline. Mostly focusing on thermal coal, 16 projects with an aggregate capacity of 44 Mtpa are proposed. At the beginning of 2024 Canyon Coal started shipments from its new Gugulethu coal mine. The mine is set to produce 2.4 Mt of coal annually, with half of this output being mid-CV thermal coal at 5 500 kcal/kg NAR (net as received). Another project, albeit a smaller one, is the Mngeni underground section of the Zululand Anthracite Colliery, which started operations in 2024. This project has a capacity of 0.15 Mtpa of met coal. The Optimum Coal mine was added to the project pipeline. After years in administration, the new owner Liberty Coal settled outstanding legal issues regarding the mine. It is intended to reach a capacity of 11 Mtpa of mid-CV thermal coal. However, the mine needs significant reconstruction, hence it is classified as a less-advanced project.

In Mozambique the Indian-based SAIL announced plans to more than double the capacity of its Benga coking coal mines to 4.5 Mtpa, investing up to USD 200 million over the next four years. This expansion aims to secure met coal resources and reduce reliance on other imports, with most of the output intended for SAIL's internal use in India.

In July 2024 Mozambique, Zimbabwe and Botswana announced a significant infrastructure project. They signed an agreement to develop the new Techobanine deep-water port in the Mozambique capital Maputo and the Limpopo railway line. The project is estimated to cost between USD 0.8 billion and USD 1.5 billion. Botswana aims to revive a long-standing rail project to the port, creating a 1 700 km rail link that also crosses Zimbabwe. This would enable landlocked Botswana to export its substantial coal reserves, estimated at around 200 billion tonnes, via Mozambique. Additionally, South African infrastructure operator Grindrod has announced its full consolidation of ownership of the existing Matola Coal Terminal (TCM). The company plans to spend USD 77 million to acquire the remaining 35% of shares from Vitol. Grindrod intends to expand the terminal's capacity beyond its current 7 Mtpa. The third announced port project is by Thai Moçambique Logistica (TML), which has proposed constructing a new coal port at Macuse, centrally located in the country. This project includes building a new railway to connect the port with coal mines in Tete Province.

Additionally, neighbouring Malawi aims to import coal from the same province. To facilitate this, the Balaka-Lilongwe railway in Malawi has been rehabilitated, enabling coal exports from Tete Province to Malawi's capital, Lilongwe. The country is seen as a favourable option for coal exports compared to South Africa, whose ports are expected to reach capacity limits.

Indonesia expands its infrastructure, aiming for higher exports

In recent years the Indonesian coal market has demonstrated significant adaptability in response to volatile market conditions. However, less transparency than in other countries complicates the assessment of new mining projects. Estimating the total capacity of projects in the pipeline remains challenging, as many projects do not provide clear indications.

The Indonesian energy ministry has recently revised the approval process for coal miners, resulting in delays in approvals this year. Despite these challenges, Adaro Energy's thermal coal subsidiary AAI is progressing with the development of the Pari and Ratah Coal projects.

Infrastructure development has seen notable progress. Geo Energy has partnered with two Chinese enterprises to develop an infrastructure project that includes a road and a port terminal. This project aims to enable the TRA mine in South Sumatra, acquired by Geo Energy last year, to increase production from 8 Mtpa to 25 Mtpa. Similarly, Bayan Resources has invested in a new haul road to boost its capacity to 60 Mtpa. Bukit Asam, a state-owned coal producer, has partnered with KAI Logistics to develop a coal loading and unloading system at the Kramasan Coal Unloading Terminal in South Sumatra. This facility should handle 3 000 t per hour per train unloading station and have a stockpile capacity of around 0.5 Mt. This terminal is part of the new Tanjung Enim–Kramasan railway line, which is expected to be operational by mid-2025.

Few projects in other countries, mostly coking coal

In the United States and Canada most proposed projects aim to mine met coal. In total 13 mines with an aggregate capacity of 24.6 Mtpa are in the project pipeline.

The Longview complex based in West Virginia, in which USD 600 million was invested, was put into operation at the end of 2023. It has a planned annual output of 3.3 Mt of met coal for both domestic and export markets. The mine is operated by the newcomer Allegheny Metallurgical, which was founded in 2021.

In September 2024 Conuma Resources obtained permission to restart the Quintette Mine in Tumbler Ridge, Canada, which it bought for USD 120 million in early 2023 from Teck Resources. The met coal mine has a capacity of 3 Mtpa. Grassy Mountain in Canada won community support in a non-binding plebiscite among residents in November 2024. Despite this, there is major uncertainty about the project's progress.

In Europe no projects are under consideration. Whitehaven's met coal project in Cumbria in the United Kingdom was subject to environmental concerns and lost a

subsequential legal battle in September 2024, hence we removed the project from the pipeline. In Poland the government blocked the Jan Karski and Dębieńsko met coal mines in 2020, leading to a legal dispute with the developer, Australia-based GreenX Metals. In October 2024 an international tribunal awarded the company USD 325 million in compensation. Meanwhile, in Ukraine coal projects are stalled due to the ongoing war, although any new production would offset production lost in the Donbas region.

Australian-listed Aspire Mining has received final approval for the Ovoot Project in northwestern Mongolia, allowing for the production of up to 2.5 Mtpa. The company is now focusing on securing project financing.

Cash availability is pushing mergers and acquisitions in the sector

Mining companies have been able to accelerate M&A activities by the high cash flows enjoyed by some coal producers following the energy crisis, combined with the desire of other companies to reduce their coal exposure. Despite recent high revenues, the profitability of export-oriented coal mines is volatile as it mainly depends on prices in international markets. Investment in coal is increasingly hindered by widespread opposition from shareholders, financial institutions, insurers and the general public. This opposition is particularly strong against thermal coal projects and companies with significant coal exposure. In contrast, the resistance to met coal investment is somewhat less pronounced.

The high emissions intensity of coal has led to a reluctance among investors to commit to continuous investment, especially in thermal coal, as the decarbonisation of electricity is progressing more rapidly than that of steel production. But even in the met coal sector, the brief periods of high margins have not been sufficient to stimulate significant new investment in mining operations, and hence progress in announced new projects has been very slow. Additionally, the investment climate is further complicated by inflation rates that remain above pre-crisis levels and ongoing uncertainties regarding the broader economic outlook.

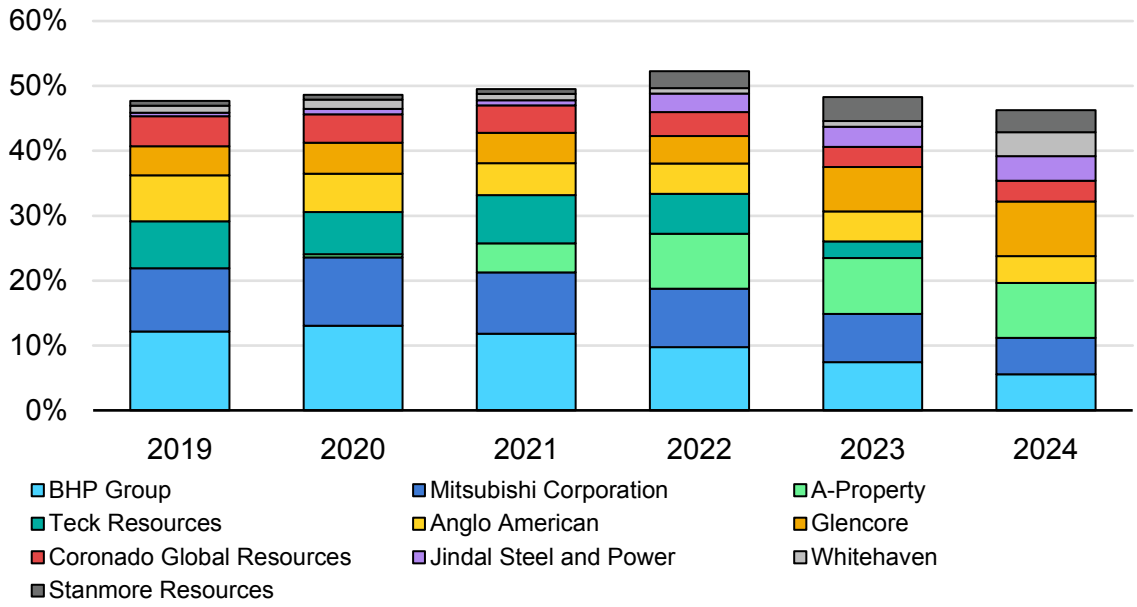
New projects face the issue that countries in the western hemisphere are committed to ambitious climate targets, which could induce lower demand for coal. Of more direct impact, financial institutions want to reduce their exposure to carbon-intensive projects due to environmental, social and governance (ESG) concerns, making financing more difficult. For the same reasons, insurers show little interest in selling polices to coal projects, especially to newly developed ones. Consequently, premiums are severe, or coverage is not available at all.

In light of these increasing political, regulatory and financial obstacles, investing in already developed assets is less risky for producers, which want to maintain marketed volumes. In addition, steel producers want to hedge their procurement by investing directly in met coal projects. Sellers, encouraged by shareholders or the financial sector, are divesting themselves of coal assets in light of ESG concerns, as well as more bearish market expectations, leaving more assets available for acquisition.

Transactions are focused more on assets producing met coal. From a producer's perspective, the met coal market outlook for volumes and margins is more beneficial than for thermal coal, since alternatives, such as hydrogen, are not ready for the market yet while thermal coal already has suitable substitutes.

In recent years large, diversified mining companies such as BHP and Anglo American have been divesting from coal to focus on other commodities; therefore, smaller and coal-focused miners have been able to acquire these assets. This shift has resulted in a slight decrease in market concentration, with specialised coal firms gaining a more prominent role. The market share of the four largest coal-mining companies declined from 37% in 2019 to an expected 29% in 2024. One notable exception is Glencore, a diversified miner that has increased its exposure to coal by acquiring 77% of Teck Resources' coal operations.

Global met coal export shares of select companies, 2019-2024



The following list is intended to cover the most important transactions, but due to the lack of transparency in many parts of the world, it does not claim to be complete.

In the United States, Arch Resources and Consol Energy Inc. merged into Core Natural Resources in August 2024, which is estimated to have a market capitalisation of around USD 5 billion. Consol shareholders own 55% of the new company. The merger consolidates coal sales of 101 Mtpa in 2023 and brings together 11 mines, with a strategic focus on met coal and high-CV thermal coal.

In Australia, South32 has sold its Illawarra met coal mines in New South Wales, with annual production of 5 Mt, for USD 1.65 billion, allowing the company to exit the coal business and focus on copper and zinc. Singapore-based Golden Energy and Resources has secured USD 1.1 billion to acquire a 70% stake, while M Resources, owned by the Indonesian Widjaja family, will hold the remaining 30%. The Widjaja family also controls 59% of Stanmore Resources, a listed met coal mining company.

Stanmore Resources in turn sold the southern part of the Australian Wards Well met coal project to Peabody for USD 136 million. Peabody plans to integrate the project into its nearby Centurion mine complex.

Anglo American is continuing its transition away from coal towards other commodities, a shift that began some years ago. The company has auctioned five met coal mines in Queensland. Peabody Energy and Anglo American have agreed to the transaction, valued at USD 3.78 billion, of which USD 450 million is linked to the reopening of the Grosvenor mine, which is facing significant rehabilitation costs of USD 1 billion following a fire, with production and export losses expected for at least two years. Once the sale is completed, Anglo American will join Rio Tinto and South32 as major diversified miners without coal assets. Further advanced is the sale of the Canadian met coal Peace River mine to Conuma Resources for USD 166 million. Anglo American ceased production at the mine with a capacity of 1.5 Mtpa in 2014 and has since maintained it under care and maintenance.

Similarly, the mining major BMA sold the Daunia and Blackwater mines in Queensland to Whitehaven. The deal has a total value of up to USD 4.1 billion and includes an asset with a ROM production capacity of around 40 Mtpa. It is estimated that 70% of the production will be met coal and 30% thermal coal. Whitehaven subsequently sold 30% of the Blackwater mine shares to Nippon Steel and JFE Steel for USD 1.08 billion. The two Japanese steelmakers want to ensure stable raw material procurement.

For the same reason, Nippon Steel took a minority stake in the purchase of Elk Valley Resources, the former coal division of Teck Resources, last year. Glencore became the majority owner of Elk Valley Resources, Canada's largest met coal producer, paying USD 6.9 billion for 77% of the shares. In addition, JSW Steel intends to acquire up to 66.7% of the Australia-based M Res.

Meanwhile, the Indonesian Delta Dunia Group has acquired the Atlantic Carbon Group, which operates four hard coal mines in Pennsylvania, for USD 122 million. Together, these mines have around 20 Mt of reserves in opencast mining. At the same time, Adaro Energy, one of the largest Indonesian producers, is restructuring its business. The company has spun off its thermal coal unit into an independent subsidiary valued at approximately USD 2.45 billion. Additionally, it has increased its stake in Adaro Minerals Indonesia (ADMR) from 68.6% to 83.8% for USD 504 million. ADMR will now focus on other minerals, including met coal.

In 2021, A-Property acquired the Sibanthracite Group, Russia's largest met coal producer at the time. The previous year, A-Property had purchased Elgaugol from Mechel and Gazprombank, the primary asset being the Elga mine. Following these acquisitions, A-Property significantly expanded operations at the Elga mine. By 2024 this expansion had positioned A-Property as the world's leading exporter of met coal, with exports totalling 33 Mt.

Unabated coal is still the current standard practice

The IEA has received inquiries about the relationship between coal demand forecasts and CO_2 emissions, considering the advancements in CO_2 capture, utilisation and storage (CCUS) technologies. To address these valid inquiries, *Coal 2024* highlights the progress of abated coal globally.

Coal, the most carbon-intensive fossil fuel, is the largest source of anthropogenic CO_2 emissions, contributing approximately 15.5 Gt in 2023, which is over 40% of energy-related emissions, including those from industrial processes. Coal-fired power plants, which consume two-thirds of the coal produced, are responsible for around 11 Gt.

In addition to CO_2, coal combustion produces emissions such as particulates, sulphur, nitrogen oxides and other local air pollutants. Most emissions are associated with coal use, although small amounts are released during coal mining, which comprise some CO_2 and methane, a potent greenhouse gas with a much higher warming potential than CO_2, originating from the decomposition of organic material and trapped in coal seams. This methane is released into the environment unless captured (or flared, in which case it contributes to CO_2 emissions, although CO_2-eq emissions are reduced by one order of magnitude).

Globally, around two-thirds of coal is burned to produce heat, which is used to turn water into steam and generate electricity via a steam turbine-generator set. Nearly 20% of coal is used directly by end consumers to produce heat, steam and/or as a reductant agent. Approximately 15% of coal undergoes pyrolysis to produce coke, a high-carbon solid primarily used in iron production. Additionally, a small share of coal is gasified for various purposes.

In all cases, except for the carbon that remains in products when coal is used as a feedstock (e.g. in coal-based plastics) or the very small fraction of unburned carbon due to imperfect combustion, the rest of the carbon in coal is eventually released as CO_2.

To relate coal volumes (i.e. tonnes of coal) to CO_2 emissions, carbon content is the key parameter. Excluding its use as feedstock and assuming, as an acceptable simplification, that there is no unburned carbon, multiplying the carbon content by 3.7 gives the tonnes of CO_2 released per tonne of coal.

Relating energy from coal to CO_2 emissions is complex. Coal is not a uniform substance, but a diverse set of solid, sedimentary fossil rocks formed from the transformation of organic material under pressure and temperature over time, in the absence of oxygen. Coal is classified by rank, which indicates the degree of coalification or transformation of the original components. The main ranks, from highest to lowest, are anthracite, bituminous coal, subbituminous coal, and lignite.

To relate energy and CO_2 emissions, key parameters include carbon content, the carbon-to-hydrogen ratio, and moisture content. The IPCC has proposed default values for emissions from coal combustion: 95 kg CO_2/GJ for bituminous coal and 101 kg CO_2/GJ for lignite. These values are widely used despite variations in content and properties within the same rank. Considering a wider scope, other life cycle emissions should also be accounted for, such as methane.

A more practical parameter is the relationship between electricity generated by coal plants and CO_2 emissions. This requires considering both the specific emissions of coal and the efficiency of the plants. Efficiency depends on factors such as plant design, fuel used and operating conditions. Indeed, if the coal is co-fired with low-carbon fuel (e.g. biomass, ammonia), CO_2 emissions per unit of generated electricity will be lower, although in our account, biomass and ammonia produce no CO_2 emissions and the remaining emissions are allocated to coal.

As benchmarks, a plant with 43% efficiency using bituminous coal would release 795 kg CO_2/MWh, while a plant with 35% efficiency using lignite would release 1 039 kg CO_2/MWh. For CHP plants, CO_2 emissions must be allocated to both the electricity and the heat supplied.

The use of CCUS is a potential way to reduce CO_2 emissions from the use of coal. However, the current global capture capacity of coal plants is 7.75 Mtpa, which is approximately 0.05% of global emissions from coal. In other words, virtually all coal consumed today in the world is unabated. Nevertheless, CCUS technologies are poised to play an important role in the energy transition. Without these technologies, the transition will be more challenging and costly, in particular, in sectors like cement. Additionally, without significant deployment of CCUS, coal's role in the energy transition will be very limited. However, as of today, CCUS has

not progressed as much as required. The operational projects at commercial scale (> 100 000 tpa) capturing CO_2 from coal are listed in the table below. Most known projects are located in China, with a combined targeted capacity of 2.35 Mtpa. However, the Great Plains Synfuel Plant and Boundary Dam operations in North America, with a combined capacity of 4 Mtpa, overshadow them.

Coal-based CCUS projects in operation

Project	Location	Start year	Annual capacity (Mt)	Sector
Great Plains Synfuel Plant	United States	2000	3	Other transformation
Boundary Dam	Canada	2014	1	Power and heat
Petra Nova Carbon Capture (TX)	United States	2016	1.4	Power and heat
China Energy Guohua Jinjie Power	China	2021	0.15	Power and heat
Sinopec Nanjing Chemical Industries CCUS Project	China	2021	0.2	Chemicals
Yanchang integrated CCUS Yulin Coal Chemical	China	2022	0.3	Other transformation
Sinopec Qilu Petrochemical Shengli	China	2022	1	Fertilisers
China Energy Taizhou power	China	2023	0.5	Power and heat
Guanghui Energy CCUS integration project	China	2023	0.1	Chemical
Jinling Petrochemical CCUS (Nanjing refinery)	China	2023	0.1	Other fuel transformation

Other projects are at various stages of development. Notably, the Huaneng Longdong Energy Base project, set to become operational in 2025, will be the largest post-combustion CO_2 capture plant, with a capacity of 1.5 Mtpa. Globally, capture capacity is around 50 Mtpa of CO_2, with two-thirds of this capacity at natural gas processing plants.

Coal-based CCUS projects under construction

Project	Location	Start year	Annual capacity (Mt)	Sector
China National Energy Ningxia	China	2025	3	Chemical
Yulin Integrated Coal Liquefication	China	-	4	Chemical
Baotou Steel	China	2025	0.5	Iron and steel
Huaneng Longdong Energy Base	China	2025	1.5	Power and heat
Xinjiang Jinlong Shenwu	China	2025	2	Power and heat
CPNC coal power Baijiantan Karamay (Xinjiang)	China	2027	2	Power and heat
CEIC-CNPC CCUS-EOR demonstration (Ningxia) Phase 1	China	2025	0.4	Other fuel transformation
CEIC-CNPC CCUS-EOR demonstration (Ningxia) Phase 2	China	2026	0.5	Other fuel transformation
CTSCo Project	Australia	2026	0.11	Power and heat

General annex

Tables

Table 1: Total coal consumption (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	7100	7246	7308	7384	7461	6.1%	2.1%	1.0%
China	4883	4939	4940	4970	5005	6.0%	1.1%	0.4%
India	1245	1315	1363	1392	1422	10.0%	5.6%	2.6%
Japan	166	155	146	141	135	-10.1%	-6.3%	-4.5%
ASEAN	457	491	520	544	567	9.8%	7.6%	4.9%
North America	417	398	377	368	355	-16.1%	-4.7%	-3.7%
United States	386	368	351	343	331	-17.2%	-4.7%	-3.5%
Central and South America	51	50	47	44	42	-1.2%	-0.8%	-6.0%
Europe	555	510	494	463	419	-16.3%	-8.1%	-6.3%
European Union	354	312	293	273	244	-22.6%	-11.8%	-7.9%
Eurasia	368	366	373	382	385	-0.2%	-0.4%	1.7%
Africa	185	191	193	198	203	-3.8%	3.1%	2.0%
Middle East	11	9	9	8	8	-0.4%	-14.6%	-6.3%
World	**8687**	**8771**	**8801**	**8847**	**8873**	**2.5%**	**1.0%**	**0.4%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 2: Thermal coal and lignite consumption (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	6192	6353	6434	6531	6619	6.5%	2.6%	1.4%
China	4146	4219	4244	4302	4348	6.3%	1.7%	1.0%
India	1173	1241	1284	1308	1335	10.6%	5.7%	2.5%
Japan	126	119	111	107	104	-11.5%	-5.9%	-4.5%
ASEAN	433	463	487	509	530	9.8%	6.9%	4.7%
North America	396	378	357	348	336	-16.9%	-4.6%	-3.9%
United States	371	354	335	328	317	-17.8%	-4.7%	-3.6%
Central and South America	32	32	28	26	24	0.1%	0.1%	-10.0%
Europe	493	448	434	404	361	-17.4%	-9.1%	-7.0%
European Union	301	260	242	223	195	-25.2%	-13.5%	-9.1%
Eurasia	288	290	298	306	313	2.4%	0.6%	2.5%
Africa	182	188	189	194	199	-3.9%	3.1%	1.9%
Middle East	7	5	4	4	3	-16.9%	-23.5%	-12.4%
World	**7590**	**7695**	**7745**	**7813**	**7853**	**2.6%**	**1.4%**	**0.7%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 3: Metallurgical coal consumption (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	909	893	875	853	843	3.5%	-1.7%	-1.9%
China	737	720	696	668	657	4.1%	-2.2%	-3.0%
India	72	74	79	84	87	2.2%	3.1%	5.4%
Japan	39	36	35	34	32	-5.2%	-7.5%	-4.5%
ASEAN	24	29	32	34	37	9.7%	19.1%	8.7%
North America	21	19	21	20	19	5.4%	-5.2%	-1.2%
United States	15	14	16	15	14	0.2%	-5.4%	-0.3%
Central and South America	18	18	18	18	18	-3.4%	-2.4%	0.5%
Europe	62	61	60	59	58	-5.7%	-0.9%	-1.6%
European Union	53	52	51	50	49	-4.4%	-2.2%	-1.9%
Eurasia	79	76	75	75	73	-8.5%	-4.2%	-1.6%
Africa	3	4	4	4	4	6.1%	6.5%	4.4%
Middle East	4	4	4	4	4	41.0%	-1.5%	-0.2%
World	**1097**	**1076**	**1056**	**1034**	**1019**	**2.0%**	**-1.9%**	**-1.8%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 4: Total coal production (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	7085	7262	7241	7272	7320	5.9%	2.5%	0.3%
China	4610	4653	4655	4654	4650	3.4%	0.9%	0.0%
India	1020	1099	1155	1212	1269	9.7%	7.7%	4.9%
Australia	459	458	436	428	423	6.0%	-0.3%	-2.6%
Mongolia	76	105	97	89	90	106.7%	37.5%	-5.0%
Indonesia	775	805	750	738	731	12.6%	3.9%	-3.2%
North America	579	516	485	466	450	-2.1%	-11.0%	-4.4%
United States	524	463	436	424	410	-2.8%	-11.7%	-3.9%
Central and South America	73	69	75	69	65	3.0%	-5.6%	-2.0%
Europe	414	393	382	358	323	-18.7%	-5.3%	-6.3%
European Union	278	243	228	212	190	-20.7%	-12.5%	-7.9%
Eurasia	581	566	559	562	563	0.2%	-2.6%	-0.2%
Russia	439	427	416	416	412	0.6%	-2.8%	-1.2%
Africa	258	261	261	261	261	0.9%	1.0%	0.0%
Middle East	2	2	2	2	2	0.0%	1.8%	0.0%
World	**8993**	**9068**	**9005**	**8989**	**8984**	**3.4%**	**0.8%**	**-0.3%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 5: Thermal coal and lignite production (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	6224	6401	6394	6438	6488	6.6%	2.8%	0.5%
China	3973	4033	4033	4033	4033	4.4%	1.5%	0.0%
India	1016	1094	1151	1207	1264	9.6%	7.7%	4.9%
Australia	298	295	280	275	270	11.6%	-0.8%	-2.9%
Indonesia	769	799	745	733	726	12.7%	3.9%	-3.2%
North America	487	421	394	379	364	-4.0%	-13.6%	-4.7%
United States	464	399	375	366	353	-4.1%	-13.9%	-4.0%
Central and South America	65	61	66	60	57	4.1%	-5.8%	-2.1%
Europe	401	380	370	345	311	-19.1%	-5.3%	-6.5%
European Union	265	231	216	200	178	-21.2%	-12.9%	-8.4%
Eurasia	459	445	443	448	452	0.5%	-3.0%	0.5%
Russia	321	310	305	306	305	1.1%	-3.4%	-0.5%
Africa	250	252	252	251	252	0.8%	1.0%	-0.1%
World	**7886**	**7960**	**7920**	**7922**	**7923**	**3.7%**	**0.9%**	**-0.2%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 6: Metallurgical coal production (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	862	861	847	834	832	1.1%	-0.1%	-1.1%
China	637	620	622	621	618	-2.0%	-2.7%	-0.1%
India	4	4	5	5	5	35.7%	7.0%	7.0%
Australia	161	162	156	153	153	-3.1%	0.6%	-1.9%
Indonesia	6	6	5	5	5	1.3%	0.0%	-5.7%
North America	92	95	91	87	86	9.6%	3.1%	-3.1%
United States	60	63	61	58	57	8.8%	5.3%	-3.3%
Central and South America	9	8	8	8	8	-4.0%	-4.8%	-1.2%
Europe	13	13	13	13	13	-6.4%	-2.6%	0.0%
European Union	12	12	12	12	12	-5.9%	-2.8%	0.0%
Eurasia	122	120	116	114	111	-0.8%	-1.0%	-2.7%
Russia	118	116	111	109	106	-0.8%	-1.2%	-2.9%
Africa	9	9	9	9	9	6.6%	2.5%	1.8%
Middle East	2	2	2	2	2	0.0%	0.0%	0.0%
World	**1107**	**1107**	**1085**	**1067**	**1061**	**1.4%**	**0.0%**	**-1.4%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 7: Total coal imports (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	1261	1324	1212	1171	1151	17.0%	5.0%	-4.6%
China	481	527	453	425	415	54.6%	9.6%	-7.6%
India	248	250	220	205	195	5.8%	1.1%	-8.0%
Japan	167	163	152	146	140	-8.3%	-2.1%	-5.1%
Korea	119	117	111	108	105	-4.5%	-2.1%	-3.4%
ASEAN	170	186	192	202	211	21.8%	9.1%	4.4%
North America	14	15	13	15	15	-5.4%	7.9%	-0.8%
United States	3	3	3	3	3	-39.3%	0.0%	0.0%
Central and South America	30	32	30	29	28	-9.1%	7.1%	-4.9%
Europe	146	119	120	113	104	-17.3%	-18.3%	-4.3%
Eurasia	31	28	28	28	29	-18.0%	-7.5%	1.0%
Africa	20	20	20	20	21	4.9%	1.7%	1.2%
Middle East	9	8	7	7	6	-6.4%	-12.9%	-7.7%
World	**1510**	**1546**	**1431**	**1382**	**1353**	**10.4%**	**2.4%**	**-4.3%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 8: Thermal coal and lignite imports (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	986	1033	945	918	898	16.3%	4.8%	-4.6%
China	369	408	355	348	339	56.4%	10.4%	-6.0%
India	176	177	146	127	114	2.3%	0.3%	-13.7%
Japan	129	128	118	111	108	-8.6%	-0.6%	-5.4%
Korea	97	93	90	87	86	-5.5%	-4.4%	-2.6%
ASEAN	146	155	159	168	175	23.7%	6.1%	4.0%
North America	9	10	9	10	10	-3.1%	14.7%	0.8%
Central and South America	19	21	18	17	16	-11.5%	11.1%	-8.8%
Europe	93	67	70	64	55	-23.4%	-28.2%	-6.3%
Eurasia	25	22	22	22	23	-18.5%	-11.7%	0.1%
Africa	19	20	20	20	20	5.8%	1.7%	1.2%
Middle East	6	5	4	4	3	-23.9%	-17.8%	-12.4%
World	**1157**	**1178**	**1088**	**1055**	**1025**	**9.5%**	**1.8%**	**-4.5%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 9: Metallurgical coal imports (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Asia Pacific	275	291	267	252	253	19.4%	5.7%	-4.5%
China	112	119	97	77	76	49.0%	7.0%	-13.9%
India	71	74	74	79	81	15.7%	3.0%	3.4%
Japan	38	36	35	34	32	-7.3%	-7.0%	-4.0%
Korea	22	24	21	21	20	-0.2%	8.3%	-6.7%
ASEAN	24	30	32	34	37	11.3%	27.4%	6.3%
North America	5	5	5	5	4	-8.8%	-3.1%	-4.1%
Central and South America	11	11	11	12	12	-4.8%	0.5%	1.7%
Europe	52	52	50	49	49	-3.6%	-0.5%	-1.9%
Eurasia	5	6	6	6	7	-15.6%	13.7%	4.4%
Africa	1	1	1	1	1	-16.7%	1.0%	0.8%
Middle East	3	3	3	3	3	85.4%	-2.4%	-0.3%
World	**352**	**368**	**343**	**327**	**329**	**13.5%**	**4.5%**	**-3.7%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 10: Total coal exports (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Australia	353	361	347	341	341	4.2%	2.1%	-1.9%
Mongolia	71	88	80	71	71	123.9%	25.0%	-6.9%
Indonesia	521	557	488	474	453	10.6%	6.9%	-6.7%
United States	91	98	89	85	83	16.7%	7.2%	-5.4%
Colombia	57	58	57	52	50	1.6%	0.5%	-4.9%
Russia	211	199	185	180	178	2.6%	-5.9%	-3.7%
South Africa	74	70	70	66	64	4.1%	-5.1%	-2.9%
World	**1502**	**1547**	**1432**	**1381**	**1353**	**9.5%**	**3.0%**	**-4.4%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 11: Thermal coal and lignite exports (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Australia	202	208	200	197	196	12.4%	2.7%	-2.0%
ASEAN	526	564	497	484	465	10.8%	7.2%	-6.2%
Indonesia	515	551	483	469	448	10.8%	7.0%	-6.7%
United States	45	47	42	40	38	25.2%	5.9%	-6.8%
Colombia	56	56	55	50	48	2.1%	0.5%	-5.0%
Russia	162	149	139	136	133	-0.2%	-8.0%	-3.7%
South Africa	73	69	69	65	63	3.9%	-5.2%	-3.0%
World	**1151**	**1178**	**1088**	**1054**	**1024**	**9.3%**	**2.3%**	**-4.6%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Table 12: Metallurgical coal exports (Mt), 2023-2027

Region/country	2023	2024	2025	2026	2027	2022-23	2023-24	CAAGR 2024-2027
Australia	151	153	147	144	145	-4.9%	1.3%	-1.8%
Mongolia	54	66	57	49	49	108.8%	22.3%	-9.4%
Indonesia	6	6	5	5	5	0.0%	0.0%	-5.8%
United States	46	50	47	44	44	9.6%	8.5%	-4.2%
Colombia	2	2	2	2	2	-13.2%	0.0%	0.0%
Russia	49	49	45	43	44	13.4%	1.0%	-3.5%
South Africa	1	1	1	1	1	22.8%	0.0%	0.0%
World	**351**	**369**	**344**	**327**	**329**	**10.2%**	**5.2%**	**-3.7%**

Notes: CAAGR = compound average annual growth rate. Data for 2023 are preliminary; 2024 are estimated; 2025 to 2027 are forecasts.

Coal mining projects: Export

Country	Company	Project	Type	Earliest start-up	Full capacity (Mtpa)	Resource	Status
Australia	Adani	Carmichael Coal Project Stage 2	E		18	TC	LA
Australia	Anglo American/ Exxaro	Moranbah South	N	2025	18	CC	LA
Australia	Baralaba Coal	Baralaba South	E	2028	2.5	PCI	LA
Australia	Bengal Energy	Dysart East	N	2025	1.2	CC	LA
Australia	BHP	Blackwater South	E	2029	8	CC	LA
Australia	BHP Billiton/ Mitsubishi Alliance	Saraji East	N	2025	11	CC	LA
Australia	BHP Billiton/ Mitsubishi Alliance	Caval Ridge Extension	E	2025	15	CC	MA
Australia	BMA	Goonyella-Riverside and Broadmeadow Extension (Red Hill) Mine	E	2029		CC	LA
Australia	Bowen Coking Coal	Isaac River	N	2025	0.5	CC	MA
Australia	Centennial Coal	Angus Place West	N	2024	2	TC	LA
Australia	Centennial Coal	Mandalong Southern Extension	E		6	TC	LA
Australia	Centennial Coal	Newstan Mine Extension Project	E	2027	1.6	TC, CC	LA
Australia	Coronado Global	Curragh Extension	E	2025	1.75	TC, CC	MA
Australia	Cuesta Coal	Moorlands	N	2027	1.9	TC	LA
Australia	Delta Coal	Chain Valley Extension	E	2025	2.1	TC	MA
Australia	Fitzroy Resources	Carborough Downs	N	2025	5	CC	LA
Australia	Glencore	Bulga (Mod 3 and Mod 7)	E	2029	6.6	TC	MA
Australia	Glencore	Mangoola Coal Continued Operations Project	E	2025	5	TC	MA
Australia	Glencore	Mount Owen (Glendell Mine) Extension Project	E	2025	7	TC, CC	LA
Australia	Glencore	Rolleston Expansion Project	E	2026	5	TC	LA
Australia	GVK	Kevin's Corner	N	2028	10.6	TC	LA
Australia	Idemitsu	Boggabri Coal Extension	E	2029	8.6	TC, CC	LA
Australia	Korea Resources Corp	Wallarah 2 Coal Project	N	2027	4	TC	LA
Australia	Lake Vermont Joint Venture	Lake Vermont Meadowbrook Project	E	2027	5.5	CC	LA

Country	Company	Project	Type	Earliest start-up	Full capacity (Mtpa)	Resource	Status
Australia	MACH Energy Australia	Mt Pleasant Optimisation Project	E	2026	10.5	TC	MA
Australia	Magnetic South	Gemini Coal Mine	N	2026	1.9	CC	LA
Australia	Magnetic South	Walton	N	2025	1.6	PCI	LA
Australia	Malabar Coal	Maxwell Project	N	2025	3.6	TC, CC	MA
Australia	New Hope	Bengalla mine	E		3.4	TC	LA
Australia	New Wilkie Energy	Wilkie Creek	R	2029	4	TC	LA
Australia	Peabody	North Goonyella	R	2026	5	CC	LA
Australia	Pembroke Resources	Olive Downs South Stage 2	E	2027	9	CC	MA
Australia	Pembroke Resources	Willunga/Vermont East	E	2028	4	TC, CC, PCI	LA
Australia	Qcoal/ JFE Steel	Byerwen Coal Project Stage 2	E	2028	2.2	TC, CC	LA
Australia	Shandong Energy Group	Hillalong	N	2026	4.2	TC, CC	MA
Australia	South32/ Aquila Resources	Eagle Downs	N	2025	4.5	CC	LA
Australia	Stanmore	Isaac Plains Complex – Underground extension	E	2028	1.2	CC	MA
Australia	Stanmore	Wards Well/ Lancewood	N	2028	10	CC	LA
Australia	Stanwell	Meandu King 2 East Project	E	2025	5	TC	MA
Australia	Thungela Resources/ Mayfair Corporations Group/ Audley Energy	Ensham Life of Mine Extension Project	E	2028	4.5	TC	LA
Australia	Whitehaven Coal	Gorman North Coal Project	E	2026		TC	LA
Australia	Whitehaven Coal	Narrabri Stage 3	E	2026	9	TC	MA
Australia	Whitehaven Coal	Winchester South	N	2027	17	TC, CC	MA
Australia	Yancoal	Moolarben CHPP upgrade	E	2027	2	TC	LA
Australia	Yancoal	Mt Thorley	R	2029	2	TC, CC	LA
Australia	Yancoal / Glencore	Hunter Valley Operations Continuations Project	E	2026	42	TC, CC	LA
Australia	Yancoal/ Glencore	Ravensworth Underground Mine	E	2026	3	CC	MA
Botswana	Maatla	Mmamabula Coal Project	N	2025	1.2	TC	MA
Botswana	Tlou Energy	Boomslang Project	N			TC	LA

Country	Company	Project	Type	Earliest start-up	Full capacity (Mtpa)	Resource	Status
Canada	Allegiance Coal/ Itochu	Tenas	N	2028	0.75	CC	LA
Canada	Atrum Coal	Groundhog	N		0.9	TC	LA
Canada	Conuma Coal Resources Ltd	Wolverine-Hermann Amendment Project	N	2025	1	CC	LA
Canada	Conuma Coal Resources Ltd	Quintette	N	2025	3.5	CC	MA
Canada	HD Mining	Murray River	N		6	CC	LA
Canada	North Coal	Michel Coal Project	N	2026	2	CC	LA
Canada	NWP	Crown Mountain	N	2026	2	CC, PCI	LA
Canada	Pacific American Coal	Elko	N		1.25	CC	LA
Canada	Summit Coal	Summit Mine 14	N	2025	1.3	CC	LA
Colombia	Ronin Resources	Vetas	E			CC, PCI	LA
Indonesia	Adaro	Bukit Enim Energi	N			TC	LA
Indonesia	Adaro	Juloi	N	2025		CC	LA
Indonesia	Adaro	Kalteng	N	2025		CC	LA
Indonesia	Adaro	Sumber Barito	N	2025		CC	LA
Indonesia	Cokal	Tambang Benua Alam Raya (TBAR) project	N	2025	2	CC, PCI	MA
Indonesia	Geo Energy Group	Surya Tambang Tolindo			0.124	TC	LA
Indonesia	MEC Coal	Tekno Orbit Persada	N		5	TC	LA
Mongolia	Aspire Mining	Nuurstei Coking Project	N	2025	1	CC	LA
Mongolia	Aspire Mining	Ovoot	N	2025	4	CC	MA
Mongolia	Erdenes Tavan Tolgoi	Tavan Tolgoi Extension	E	2026	10	CC	LA
Mongolia	Saker Resources	Shinejinst	N	2025	3	CC	LA
Mozambique	SAIL	Benga Extension	E	2025	4.5	CC	LA
Mozambique	Talbot Group/ Nippon Steel/ POSCO	Revuboe	N	2026	7	TC, CC	LA
New Zealand	Bathurst Resources	Escarpment	R		0.9	CC	MA
Poland	Prairie Mining	Jan Karski Project	N		6.3	CC	LA
Russia	AEON	West-Taymyr Industrial Cluster	N	2025	5	CC	LA
Russia	A-Property	Elga Expansion	E	2025	25	TC, CC	MA
Russia	Industrial Metallurgical Holding	Tikhova Stage 2	E	2026	1.3	CC	LA

Country	Company	Project	Type	Earliest start-up	Full capacity (Mtpa)	Resource	Status
Russia	Kolmar	Inaglinsky-2	E		8	CC	MA
Russia	SUEK	Chernogorsky	E	2025	3.5	TC	MA
Russia	SUEK	Pravoberezhny	E	2025	1	TC	LA
Russia	Tigers Realm Coal	Amaam North Project F coal mine	N	2025	0.65	TC, CC	MA
South Africa	Black Royalty Minerals	Koornfontein OC	R		3	TC	LA
South Africa	Canyon Coal	Gila coal mine	N		1.8	TC	LA
South Africa	Canyon Coal	Riversdale Anthracite Coal	N		0.3	TC	LA
South Africa	Canyon Coal	Sukuma coal mine	N	2025	7.2	TC	LA
South Africa	Canyon Coal	Thuso coal project	N	2025	1.8	TC	MA
South Africa	Canyon Coal	Ukwenama coal mine	N	2025	0.6	TC	LA
South Africa	Canyon Coal	Umzila coal mine	N	2025	3.6	TC	MA
South Africa	Glencore/ Shanduka	Argent Colliery	N		1.2	TC	LA
South Africa	Kangra Coal	Kusipongo	N		1.5	TC	LA
South Africa	MC Mining	Makhado Phase 1	N	2025	1.1	TC, CC	MA
South Africa	MC Mining	Makhado Phase 2	E	2028	1.2	TC, CC	LA
South Africa	Templar Capital	Optimum Coal Mine	R		11	TC	LA
South Africa	Thungela Resources	Khwezela extension	E	2030	4.6	TC	LA
South Africa	Thungela Resources	Mafube Life Extension	E	2025	3.1	TC	MA
South Africa	Universal Coal	Eloff coal project	E		2.4	TC	MA
Ukraine	Lubel Coal Company	Lubel	N		5.2	CC	LA
United States	Alliance Coal LLC	River View Henderson Portal 1	N	2025	0.8	TC	MA
United States	Ramaco Carbon	Brook Mine	N	2025	0.25	TC	MA
United States	Ramaco Resources	RAM Mine	N	2025	0.5	CC	LA
United States	Warrior Met Coal	Blue Creek No. 1	E	2026	4.3	CC	LA

Notes: N = New project. E = Expansion. R = Reopening. TC = Thermal coal. CC = Coking coal. PCI = Pulverised coal injection

Abbreviations

AI	artificial intelligence
ASEAN	Association of Southeast Asian Nations
BEV	battery electric vehicle
BOF	basic oxygen furnace
CCGT	combined-cycle gas turbine
CCUS	carbon capture, utilisation and storage
CHP	combined heat and power
CIL	Coal India Ltd
CO_2	carbon dioxide
CO_2-eq	carbon dioxide equivalent
CTL	coal-to-liquids
CTX	coal-to-chemicals
CV	calorific value
dwt	dead weight tonnage
EAF	electric arc furnace
EIA	Energy Information Administration
EOR	enhanced oil recovery
ESG	environmental, social and governance
FOB	free on board
FY	financial year
GDP	gross domestic product
HPAL	high-pressure acid leach
IPCC	Intergovernmental Panel on Climate Change
LNG	liquefied natural gas
MDO	mining developer cum operator
met	metallurgical
PCI	pulverised coal injection
PRC	peak rated capacity
PV	photovoltaic
RKEF	rotary kiln-electric furnace
ROM	run-of-mine
SDN	Specially Designated Nationals and Blocked Persons
SSCL	Singareni Collieries Company Ltd
y-o-y	year-on-year

Units of measure

GJ	gigajoule
Gt	gigatonne
Gt/yr	gigatonnes per year
GW	gigawatt
GWh	gigawatt hour
kcal/kg	kilocalorie per kilogramme
kg	kilogramme
km	kilometre
MBtu	million British thermal units
Mt	million tonnes
Mtpa	million tonnes per annum
MWh	megawatt hour
t	tonne
tpa	tonnes per annum
TWh	terawatt hour

Definitions

Coal: A solid, combustible fossil sedimentary rock. Coal comes from buried vegetation transformed by the action of strong pressure and high temperatures over millions of years.

Coal rank: The degree of transformation from the original plant source. It is loosely related to the age of the coal and is mainly determined from random reflectance of the vitrinite, one of coal's organic components. The ranks of coal, in decreasing order of transformation from high to low, are: anthracite, bituminous coal, sub-bituminous coal, lignite and peat. This report distinguishes between hard coal (anthracite, bituminous and sub-bituminous coal) and lignite, while peat is not considered.

Coal classification: Refers to a range of coal age, composition and other properties. Many classifications are used around the world with the main parameter being the coal rank, supplemented by its intended use, i.e. thermal or metallurgical applications.

Coal quality: Represents a variety of properties exhibited by coal when it is used. Calorific value and impurity content are the main parameters defining the quality of thermal coal, whereas caking properties, resistance and impurity content are the distinguishing characteristics for coking coal.

Thermal (or steam) coal: Refers to hard coal used for purposes other than metallurgy in this report.

Coking coal: High-quality coal to produce coke used in blast furnaces to make pig iron. Coking coal and metallurgical coal are terms sometimes used interchangeably.

Semi-soft coal: High-quality steam coal mixed with coking coal to produce coke for blast furnaces.

Pulverised coal injection (PCI) **coal**: A high-quality steam coal injected into a blast furnace to reduce coke consumption.

Metallurgical coal: Refers to coking coal, semi-soft coal and pulverised coal Injection coal in this report. Although anthracite is often used for metallurgical purposes, it is classified as thermal coal in this report.

Run-of-mine coal: Raw coal as it is mined before any processing.

Tonne of coal equivalent (tce): A unit of energy widely used in the international coal industry. It is defined as 7 million kilocalories (kcal). Therefore, the relationship between tce and physical tonnes depends on the net calorific value of the coal. One tonne of coal with a net calorific value of 7 000 kcal per kilogramme (kcal/kg) represents 1 tce.

Coal mining: A technique used to remove coal from a natural deposit. Coal deposits in the Earth's crust occur at various depths and seam configurations, which determine the mining method used. Generally, deep deposits are mined underground and shallow deposits are exploited through opencast mines. The strip ratio largely determines whether an opencast mine is profitable or not.

Strip ratio: The overburden or waste material removed, usually expressed as cubic metres per tonne of coal extracted. High strip ratios make opencast mining unprofitable.

Opencast mining: A method in which the overburden is first drilled, then blasted, and when the deposit is accessible, coal is removed in a similar way to the overburden. To remove the coal, power shovels, conveyor belts and trucks may be used, as well as some extremely large machinery such as draglines and bucket wheels. Opencast mining is usually less labour-intensive than underground mining, but has higher consumable costs, e.g. for tyres, diesel and explosives. Generally, opencast methods imply greater environmental impact than underground mining.

Underground mining: A method in which access to coal seams is gained through underground shafts, galleries and tunnels. Although there are many ways to mine an underground deposit, coal is usually stripped by automatic shearers or continuous mechanical miners using either short/long walls or room-and-pillar exploitations. Underground mining is generally more labour-intensive and requires higher capital investments than opencast mining.

Coal washing/upgrading: A process in which impurities (i.e. ash, moisture) are partially removed from raw coal to produce a higher-quality coal.

Regional groupings

Africa: Algeria, Angola, Benin, Botswana, Cameroon, Republic of the Congo (Congo), Côte d'Ivoire, Democratic Republic of the Congo, Egypt, Eritrea, Ethiopia, Gabon, Ghana, Kenya, Libya, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, South Africa, South Sudan, Sudan, United Republic of Tanzania (Tanzania), Togo, Tunisia, Zambia, Zimbabwe and other African countries and territories.

Asia Pacific: ASEAN regional grouping and Australia, Bangladesh, the People's Republic of China and Hong Kong (China), Chinese Taipei, India, Japan, Korea, Democratic People's Republic of Korea (North Korea), Mongolia, Nepal, New Zealand, Pakistan, Sri Lanka, and other Asian countries and territories.

Central and South America: Argentina, Plurinational State of Bolivia (Bolivia), Brazil, Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Suriname, Trinidad and Tobago, Uruguay, Bolivarian Republic of Venezuela (Venezuela), and other Central and South American countries and territories.

China: The People's Republic of China and Hong Kong.

Eurasia: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Russian Federation (Russia), Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

Europe: European Union regional grouping and Albania, Bosnia and Herzegovina, Iceland, Gibraltar, Kosovo, Montenegro, Norway, Republic of North Macedonia, Serbia, Switzerland, Republic of Türkiye and the United Kingdom.

European Union (EU): Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain and Sweden.

Middle East: Bahrain, Islamic Republic of Iran (Iran), Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Syrian Arab Republic (Syria), the United Arab Emirates and Yemen.

North America: Canada, Mexico and United States.

ASEAN: Brunei Darussalam, Cambodia, Indonesia, Lao People's Democratic Republic (Lao PDR), Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.

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