APERC
Asia Pacific Energy Research Centre

Scherer coal-fired power plant, U.S

APERC Coal Report 2022

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Foreword

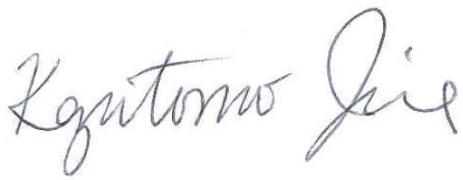
In 2021 in Glasgow, the 26th Conference of Parties (COP26) of the United Nations Framework Convention on Climate Change (UNFCCC) reached a consensus on key actions to reduce greenhouse gas emissions that aimed to limit the increase in global average temperature to 1.5 ºC. Several APEC economies committed to achieving net-zero emissions or carbon neutrality targets around the middle of this century at COP26, expanding the number of committed APEC economies to nineteen. Meanwhile, nine APEC economies signed the Global Coal to Clean Power Transition Statement at COP26 and pledged to transition away from unabated coal power generation in the 2030s for major economies and in the 2040s globally.

Most APEC economies are expected to gradually reduce coal use to meet climate change targets in the power and industrial sectors. However, due to coal supply's affordability and reliability, emerging and developing APEC members, such as China and Southeast Asia economies, may still rely on coal to meet a portion of their growing demand for electricity.

The Russian-Ukraine War has seriously affected coal supply and demand patterns, trading flows and prices since the first quarter of 2022. Thermal coal prices increased to unprecedented levels in March and then again in September while coal trading patterns shifted from traditional to new customers due to trade sanctions on Russia.

The APERC Coal Report 2022 provides updated coal policies and describes recent changes in coal consumption, production, trade, and prices amid the global energy crisis. This report also discusses feasible solutions and technologies for using coal in a cleaner manner, targeting reduced carbon emissions from coal combustion. These solutions and technologies include thermal efficiency, co-firing generation, coal gasification, coal products, hydrogen production, and carbon capture, utilisation and storage (CCUS). CCUS technologies, in particular, could significantly reduce carbon emissions from the large fleet of relatively young coal-fired power plants throughout APEC Southeast Asia economies and China.

This coal report is part of the APERC fossil fuel reports series, published annually in order to supply materials for discussion at the APEC Expert Group on Clean Fossil Energy (EGCFE) in particular and the APEC Energy Working Group (EWG) as a whole. I would like to express my sincere gratitude to the authors and contributors for their time and effort in writing and publishing this report. I am grateful to APEC member economies for providing updated data through the APEC Expert Group on Energy Data and Analysis (EGEDA) and supplying valuable comments.



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Contents

Abbreviations and Acronyms

Abbreviations

EJ	Exajoules
GW	Gigawatts
TWh	Terawatt hour
Mt	Million tonnes
Gt	Gigatonne
PJ	Petajoules
USD	US dollar
AUD	Australian dollar

Acronyms

APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
BECCS	Bioenergy with Carbon Capture and Storage
CCS	Carbon Capture and Storage
CCUS	Carbon Capture, Utilisation and Storage
CBM	Coalbed Methane
CMM	Coal Mine Methane
CN	Carbon Neutrality Scenario
CO_2	Carbon Dioxide
CH_4	Methane gas
CCT	Clean coal technology
EIA	Energy Information Administration
EOR	Enhanced-Oil-Recovery
EPA	US Environmental Protection Agency
FYP	Five-Year Plan
IEA	International Energy Agency
$MMTCO_2E$	Million Metric Tons of Carbon Dioxide Equivalent
REF	Reference senario

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Highlights

APEC coal demand bounced back strongly in 2021 due to global economic recovery after severe COVID-19 waves. Coal markets were already tight before the Russian–Ukrainian conflict outbreak on 24 February 2022 due to the disruption of the coal supply chain and high natural gas prices. Furthermore, the sanctions against Russia due to the Ukraine conflict brought thermal coal prices to a new all-time peak in September 2022, a nine-time higher than in September 2020.

Nineteen APEC economies committed to reaching net zero emissions or carbon neutrality, and nine economies joined clean power transition initiatives.

- While fifteen APEC economies are committed to achieving net-zero emissions or carbon neutrality targets by 2050, China, Indonesia and Russia pledged to attain the climate goal by 2060. Thailand committed to reaching net zero emissions by 2065.
- Nine APEC economies signed the Global Coal to Clean Power Transition Statement at COP26, committed to transitioning away from unabated coal power generation in the 2030s for major economies and in the 2040s globally.

Various technologies and solutions are feasible to decarbonise large coal-firing consumers.

- Fuel switching, thermal efficiency, carbon capture, utilisation and storage (CCUS), clean coal technology and no new coal power are feasible options for reducing the carbon emissions associated with coal usage.
- CCUS technology provides prospects for reducing the opportunity costs of early retirement while meeting emissions reduction goals. Several APEC economies are currently accelerating the development of coal power CCUS facilities.

APEC coal consumption bounced back strongly in 2021, increasing by approximately 5% compared to 2020.

- The United States ramped up its coal consumption in 2021, with a 15% growth relative to the 2020 level.
- China, the world's largest coal consumer, grew by 4.6% in 2021.
- Russia, Japan, Indonesia and Korea consumed more coal in 2021 than the previous year.

APEC coal production rose by 6.1% in 2021 compared to 2020, though the rising trend was not uniform across all economies.

- China, the world's largest coal producer, increased coal production by 5.7% in 2021 compared to the previous year.
- Indonesia's coal production rose 8.9% in 2021, the highest growth among APEC economies.
- The United States and Russia showed an increase in coal production by 8.6% and 8.5% in 2021, respectively.
- Coal production in Australia rose by 2.1% in 2021, whilst Viet Nam declined its coal production by 1.1%.

Coal exports grew in almost thermal coal exporters in 2021, but Australia's coal export dropped dramatically.

- Indonesia increased its thermal coal exports by 27 Mt to 434 Mt in 2021, exporting more than twice as much as Australia.
- The United States increased coal exports by 12 Mt to 36 Mt in 2021.
- Russia's thermal coal exports rose by 6 Mt, while Australia's coal exports dropped by 21 Mt in 2021.

Coal prices surged in the second half of 2021 and 2022 due to high coal demand for economic recovery and Ukraine conflict.

- Thermal coal prices started to rise in the second quarter of the year 2021, reaching a record high level in October 2021.
- The impacts of sanctions against Russia due to the Russia-Ukraine conflict made thermal coal prices to a new all-time peak in September 2022, a nine-time higher than the September 2020 level.
- The Australian premium hard coking coal spot price was approximately USD 400 per tonne in October 2021, climbing to an unprecedented level of USD 630 per tonne in March 2022.

APEC coal policies and developments

Economy	Policies or notable developments
Australia	Australian exports of coal to China have continued to face an unofficial ban (since October 2020). The La Nina weather event brought heavy rain in 2022, disrupting Queensland and New South Wales coal production. A larger share of Australian coal is being diverted to Europe due to Russian sanctions.
Brunei Darussalam	Coal has been imported since 2019 to generate electricity and heat for Hengyi Industries' refinery and petrochemical complex in Pulau Muara Besar. Coal imports are expected to increase due to an increase in the size of the facility.
Canada	Coal-to-gas conversions are accelerating in Alberta, which means coal is likely to be phased out of its electricity mix by 2023, well ahead of the 2030 deadline. The federal Government's phase-out of thermal coal by 2030, together with its 2030 moratorium on thermal coal exports, will restrict thermal coal development over the coming decade. While interest in developing metallurgical coal mining rose in recent years, a provincial recommitment to limit development on mountain slopes and a regulatory rejection of an open-pit mine by Alberta energy on environment grounds will limit metallurgical growth going forward. However, it is still possible that coal production increases from existing mines to meet growing demand from some overseas markets.
Chile	Almost 3.56 GW of coal-fired power plants will shut down before 2025. In 2022, the new Government indicated the intention to accelerate the closure of coal-fired power plants and completely phase out them by 2030. However, the National Electricity Coordinator requested that Bocamanina II, a coal-based power plant, extend its operations beyond its proposed closure date because of a megadrought that has stressed the electricity system. Chile launched the Just Transition Strategy, which contains measures to mitigate the social impact of the closure of coal-based power plants by transforming those areas into other uses, including green hydrogen production.
China	The 14th FYP promotes the "clean and efficient use of coal" and no longer places a cap on coal-fired capacity or consumption. This is largely related to ensuring energy security. As a result, coal and coal-fired power reductions may take a more cautious pace, though President Xi stated in April 2021 that China would strictly limit the increase in coal consumption from 2021 to 2025 and phase it down from 2026 to 2030. Surging economic growth combined with international supply disruptions has seen large drawdowns of coal inventories in the latter half of 2021, leading to blackouts and industrial shutdowns.
Hong Kong, China	HKC plan to stop investing in coal-fired capacity additions now and to phase out coal by 2050.
Indonesia	Indonesia plans to stop developing new coal-fired power plants, except for projects that are already contracted or under construction and for projects integrated with industries oriented to increase the added value of natural resources. It plans to retire its older coal power generation early in its energy transition strategy. Indonesia also plans to implement cofiring for coal-fired power plants using biomass and the production of dimethyl ether fuel from coal. Indonesia still implements the domestic market obligation policy for coal, though the domestic coal ceiling price mechanism is under review.

Japan	In the Sixth Strategic Energy Plan (2021), coal was mentioned as an important energy source with excellence in stable supply and economic efficiency. Coal-fired power is expected to play a role as an adjustment power source amidst the maximum introduction of renewable energy. However, some coal will remain in the power generation mix to ensure electric grid reliability. Japan aims to phase out inefficient coal-fired power plants. Japan committed to no longer providing new state funding for overseas coal projects from the end of 2021 at the G7 summit in Cornwall. However, the Japan Bank for International Cooperation will potentially support coal projects if they include emissions reduction measures.
Korea	The 3rd Energy Master Plan (2019) and the 9th Basic Plan on Electricity Demand and Supply (2020) commit to reducing coal and replacing it with renewables and natural gas. The recent draft of the 10th Basic Plan on Electricity Demand and Supply released in August 2022 maintains the tone of reducing coal power generation within the reasonable scope in consideration of the power situation. Meanwhile, Korea will no longer provide state support to new overseas coal projects.
Malaysia	Malaysia announced its "zero new coal-fired plants" commitment in September 2021 as part of the measures to achieve carbon neutrality by 2050.
Mexico	Original plans to phase out coal-fired generation by 2030 have been retracted, with coal-fired capacity now expected to remain at similar levels for the next decade. According to National Center for Energy Control (CENACE), coal use for electricity generation from CFE's power plants increased in 2022 compared to 2021 levels.
New Zealand	Thermal coal imports have surged in 2020 and 2021 due to lower hydro generation (lower-than-normal rainfall) and unexpectedly low natural gas supply.
Papua New Guinea	There is no production or consumption of coal in Papua New Guinea. However, there are tentative early-stage plans for coal-fired power plants to be built in multiple Papua New Guinea cities.
Peru	The 135 MW Ilo coal-fired power plant was already retired in 2022. Coal is mainly consumed in the cement industry and plays a minor role in the power sector.
Philippines	The Philippines Department of Energy has issued a moratorium (October 2020) on endorsement of greenfield coal-fired power projects.
Russia	Russia's Energy Strategy to 2035 encourages domestic companies to increase production as well as expand coal exports throughout APEC. The 2035 Coal Strategy sets goals to increase production from new fields and improve profitability, safety, and pollution control.
Singapore	The Development Bank of Singapore became the first Singaporean bank to commit to a phase-out of coal exposure by 2039.
Chinese Taipei	Continues to be wholly reliant on thermal coal imports, with coal accounting for the largest share of the economy's electricity generation.
Thailand	The state-owned Electricity Generating Authority has shelved plans to build the 870 MW coal-fired plant in Krabi and the 2 200 MW coal-fired plant in Songkhla, favouring gas-fired facilities instead.

USA	High natural gas prices in 2021 are likely to see electricity generation from coal increase for the first time since 2014. The Biden Administration is in the process of drafting a clean energy program, though opposition from US coal mining states is likely to slow any intended coal phase-out.
Viet Nam	In the new draft Power Development Plan (PDP8), coal-fired power plant capacity increases gradually to 37,4 GW by 2030, which is much lower than in the revised Power Development Plan (PDP7, 2016) due to net zero commitments and no longer expects coal project financing from Korea, Japan, and China.

Chapter 1: APEC coal policies and developments

Coal policies

Decarbonisation

As of August 2022, almost all APEC economies had announced commitments to reach net-zero or carbon neutrality targets at a certain point in this century. While most economies plan to reach the climate target by 2050, China, Indonesia and Russia plan to achieve the goal by 2060 (Net Zero Tracker).

Several APEC economies have reduced or eliminated their proposed coal projects after signing "the Global Coal to Clean Power Transition Statement" at COP26 or joining the "No New Coal Power Compact". At COP26, nine APEC economies signed the Global Coal to Clean Power Transition Statement, wherein they committed to not building any new coal-fired power plants from the 2030s or 2040s, depending on their economic situation. These economies include Brunei, Canada, Chile, Indonesia, New Zealand, the Philippines, Singapore, Korea, and Viet Nam.

APEC economies have different pathways to achieving their net-zero targets, depending on their economic strength, energy mix, and domestic energy resources. Advanced technologies, renewable energy, nuclear energy, and circular carbon solutions for decarbonisation have a large role to play in many APEC economies. However, many APEC economies prioritise ensuring an affordable and reliable energy supply. In the power sector, coal-fired power plants are still the first choice for many developing and emerging APEC economies due to favourable economics and reliable baseload characteristics.

Additional measures to carbon emissions from coal-consuming sectors within APEC economies include:

1. **Fuel switching** – Substitute non-fossil energy or lower-emission fuels such as natural gas, liquid biofuels, biogas and biomethane, and ammonia for some or all of the coal in coal-fired power plants or industrial plants. Increase the dispatch of low- or zero-emissions generation in the power mix.
2. **Thermal efficiency** – Increase the efficiency of heat exchange in the coal-burning processes is an important option to reduce CO_2 emissions from coal-fired power plants and industrial plants. For example, advanced ultra-supercritical coal-fired plants operate at efficiency levels of up to 50%, emitting significantly fewer emissions for each kWh generation.
3. **Carbon Capture, Utilisation and Storage (CCUS)** – Capture CO_2 from coal-burning facilities and store it permanently in geological formations. CCUS technologies can be applied to new builds and can also be engineered for existing facility retrofits.
4. **Clean coal technology (CCT)** – Build integrated gasification combined cycle (IGCC), oxyfuel combustion, and other advanced power generation systems, including underground coal gasification, to produce heat from coal with low carbon emissions (World Nuclear Association, 2021). Hydrogen production from coal with CCS is another application of CCT.
5. **No new coal power** – Deny approvals to new coal-fired power plants and coal power projects that have not yet started construction.

Currently, almost all APEC economies are in the process of fuel switching from coal to cleaner energy or renewable energy. Fourteen economies are improving thermal efficiency in coal-fired power plants to reduce coal consumption. Australia, Canada, China, Indonesia, Japan and the United States are advancing CCUS technology in the coal sector. Ten economies are applying clean coal technology for various purposes, while ten economies committed not to building new coal-fired power plants.

Table 1.1: Current measures to support decarbonising policies in coal combustion users

Economies	Fuel switching	Thermal Efficiency	CCUS	Clean coal technology	No new coal power
Australia[1]	●	●	●	●	
Brunei Darussalam	●				●
Canada	●	●	●	●	●
Chile	●				●
China	●	●	●	●	
Hong Kong, China	●				●
Indonesia	●	●	●	●	
Japan	●	●	●	●	
Korea	●	●		●	
Malaysia	●	●		●	
Mexico	●	●			
New Zealand	●				●
Papua New Guinea					●
Peru	●				●
Philippines	●	●			
Russia	●	●		●	
Singapore	●				●
Chinese Taipei	●	●			●
Thailand	●	●			
USA	●	●	●	●	
Viet Nam	●	●		●	

Source: compiled by the author based on Boom and Bust (2022), Global Energy Monitor, EGEDA, and E3G (2022).

Note: Hong Kong (China), Singapore, Peru, Brunei, and New Zealand have small-scale coal pipelines, while Papua New Guinea is not using coal in its energy system.

Financing and subsidies

Financing for coal-fired generation projects has become more difficult to obtain in many APEC economies due to environmental and climate change pressures. A growing list of insurers, banks, and assets managers have made public statements indicating that they will no longer support new coal-fired power plants or new thermal coal mines (see table A.1 in the Appendix).

Certain restrictions on coal plant financing have already been enacted by Japanese financial institutions and the pace of new restrictions is increasing (Reclaim Finance). In March 2021, the governor of the Japan Bank for

[1] The Hydrogen Energy Supply Chain (HESC) Pilot Project is being developed by the consortium comprising Kawasaki Heavy Industries, J-POWER, Iwatani, Marubeni, AGL and Sumitomo. It is supported by the Victorian, Australian, and Japanese governments. The project will produce hydrogen from brown coal with carbon capture and storage facility.

International Cooperation (JBIC), Maeda Tadashi, announced that the state-owned financial institution would no longer provide funding for coal plant projects overseas.

JBIC's decision will put pressure on the country's private sector banks (such as Mizuho, Mitsubishi UFJ Financial Group, and Sumitomo Mitsui Banking Corporation) to follow suit and end their support for overseas coal plants. Tadashi indicated that the 1.2 GW Vung Ang-2 coal-fired plant in Viet Nam (which JBIC, Export-Import Bank of Korea, and several Japanese commercial banks supported in 2020 with US$1.7 billion in project financing) would be the final overseas thermal coal project to receive public and private funding from Japanese sources (Boom and Bust, 2021).

At their Climate and Environment Meeting in May 2021, G7 leaders stated that unabated coal power generation is the single biggest global source of greenhouse gas emissions, and they committed to end new direct government support for unabated international thermal coal power generation by the end of 2021 (The White House, 2021).

In the APEC region, China, Japan, and South Korea have played a major role in financing coal-fired power plants (see table A.2 in the Appendix), with Indonesia and Viet Nam being major recipients of this financing (see table A.3 in the Appendix).

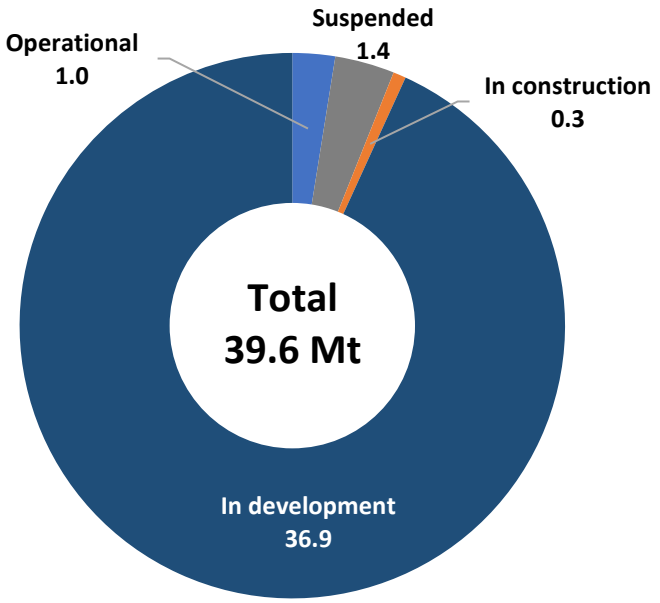
On June 2022, major coal-fired power plant projects in Indonesia and Bangladesh were effectively cancelled after the Japanese Government's announced it would not provide loans to build coal-fired plants in the two countries (Mongabay).

Technologies

Carbon Capture, Utilisation and Storage

Status of CCUS facilities in APEC

Figure 1.1: Thermal power-related CCS capacities in the APEC region, 2022



Source: compiled by the author based on Global CCS Institute (2022).

Key points

- With today's technology, a CCUS facility can capture up to 90% of CO_2 from thermal power plants and permanently store these emissions in subsurface geological reservoirs or utilise them for enhanced oil recovery (EOR) and other purposes.
- CCUS technology is crucial to decarbonising hard-to-abate sectors, such as cement, iron and steel, and chemical production. CCUS technologies also include the development of bioenergy with CCS (BECCS) and direct air capture with carbon storage (DACCS). Multiple climate models show that avoiding the worst impacts of climate change will require these technologies.
- There are currently 19 thermal power-related CCUS projects (coal and gas-fired power plants) in different development stages in APEC, with a total capacity of nearly 40 Mt. Only the Boundary Dam CCUS facility in Saskatchewan (Canada), is currently operational. Captured CO_2 from this facility is used for Enhanced Oil Recovery (EOR), which involves injecting CO_2 into oil reservoirs to recover incremental oil from producing wells.
- Petra Nova is another coal-fired CCUS facility used for EOR in Texas, United States. However, operations were suspended in 2020 due to ongoing operational problems and unfavourable economics.

CCUS subsidies

State support for CCUS research, development, and deployment has the potential to drive down costs, and improve the economic and environmental viability of coal and other fossil fuels. For example, in February 2018, the Unites States spurred improvements in the economics of CCUS by enacting the 45Q tax credit. This tax credit provides a market-based incentive for enterprises to actively develop CCUS technologies. Industrial manufacturers that capture carbon from their operations can earn USD 50 per tonne of CO_2 stored permanently. Alternatively, they can earn USD 35 if the CO_2 is used for additional applications such as EOR.

Stimulus programs targeting power generation can also support CCUS. For instance, under the American Recovery and Reinvestment Act, the US FutureGen project aims to spend USD 1 billion in grant funding which will support the very first CO_2 injection permit for dedicated storage. Flexibility in program design enable CCUS facilities to benefit from these types of programs (IEA, 2020a).

Lessons learned from the initial CCUS power plants in Saskatchewan and Texas, and multiple units in China are leading to cost-saving strategies for a new suite of projects throughout the world. However, the development pipeline for new CCUS facilities is currently lagging behind the required deployment rate needed to meet emissions reductions set out in the Paris Agreement. Additional policy support can help accelerate the development of CCUS and will have follow-on impacts on the global demand and production of coal.

Potential of CCUS for large coal-consuming economies

Demand for coal in APEC advanced economies such as Australia, Canada, New Zealand, Hong Kong, and the United States is rapidly declining. However, coal consumption in China and the Southeast Asian economies (Viet Nam, Malaysia, Indonesia, and the Philippines) is likely to remain robust over the coming decades.

The retirement of mature coal-fired power plants often makes economic sense. But for newer coal power plants, such as the many built-in southeast Asia and China, premature retirement can impose substantial opportunity costs. CCUS technologies provide some of the best prospects for reducing the opportunity costs of early retirement while meeting emissions reduction goals.

The current development of CCUS is tied mostly to power generation. For cement and steel manufacturing sectors that are more difficult to decarbonise, CCUS is crucial for achieving net-zero emissions goals. Successful research, development, and deployment of CCUS technologies for these industrial applications will support future coal demand and supply.

Recently, Indonesia has identified reservoirs of depleted oil and gas, with 2.09 Gt of CO_2 that can be used for CCS and CCUS. It has also identified an estimated 9.68 Gt of CO_2 from saline aquifers. The Government of Indonesia is drafting regulations to accelerate the implementation of CCS and CCUS projects, provide transparent mechanisms to ensure the safety of operations, and promote sustainable CCS and CCUS projects (Asia CCUS Network).

Coal-fired power efficiency

Table 1.2. Technologies and thermal efficiency

Technology	**Efficiency rate**	**Coal consumption** (g/kWh)	**Steam temperature** (°C)	**CO_2 intensity** (gCO_2/kWh)
Integrated Coal Gasification Combined Cycle (IGCC)	46 to 50%	256-272	1300	629-680[2]
Advanced Ultra-supercritical	45 to 50%	230-320	≥700	670-740
Ultra-supercritical (USC)	Up to 45%	320-340	≥600	740-800
Supercritical	Up to 42%	340-380	550-600	800-880
Subcritical	Up to 38%	≥380	≤550	≥880

Source: compiled by the author based on NextBig Future, Joban Power, and MHI.

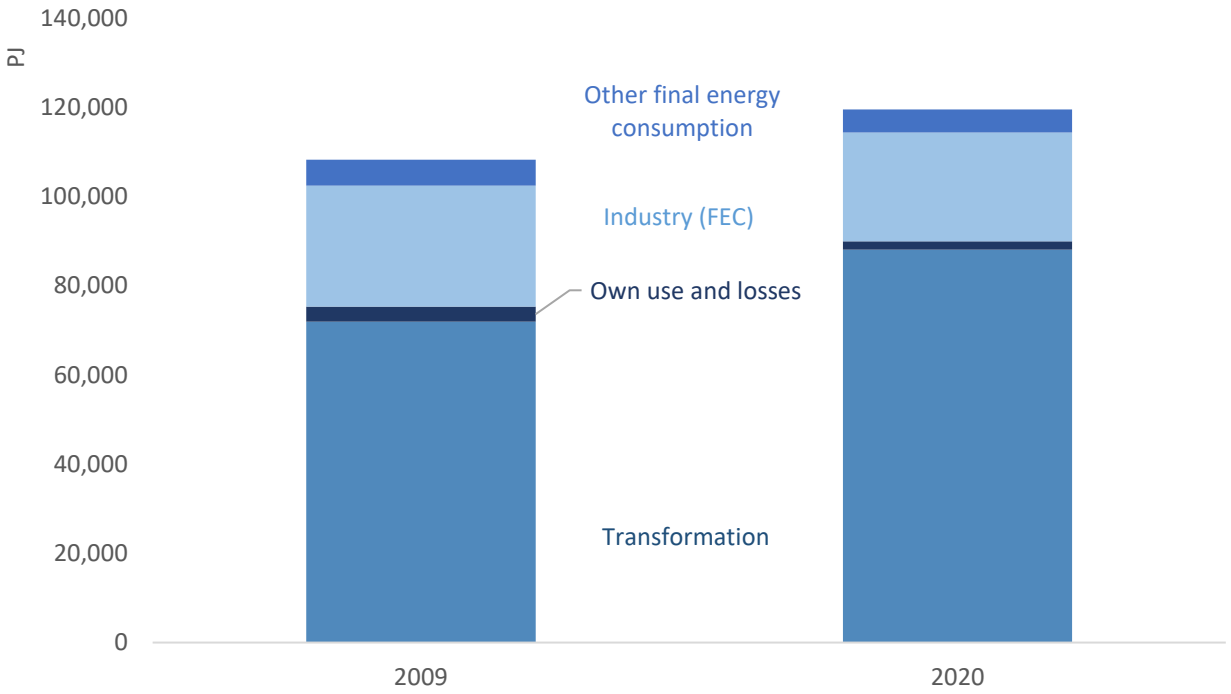
Key points

- Coal-fired power plants generate steam within boilers to spin a turbine. Refinement of the technology has led to ever higher efficiency, with power plants categorised as sub-critical, supercritical, ultra-supercritical, and advanced ultra-supercritical. The thermal efficiency rates are up to 38% for sub-critical, 42% for supercritical, 45% for ultra-supercritical technology and 50% for the newly commercialised advanced ultra-supercritical.
- With increasing numbers of the most efficient coal-fired power plants, the average global efficiency for coal-fired power plants has increased to 40%, up from 32% in 2002 (IEA, 2020b). Higher levels of efficiency contribute to lower greenhouse gas emissions for the same amount of electricity generated. Greater efficiency combined with advanced emission control equipment also leads to lower levels of pollutants such as NOx, SO_2, and particulate matter.
- The RDK8 steam power plant at the Rheinhafen-Dampfkraftwerk electrical generation facility in Karlsruhe, Germany, is currently the world's most efficient coal-fired power plant (GE Steam Power). However, China's Pingshan Phase II, which is under construction, has an efficiency target of 49.8%, which will surpass the 47.5% efficiency of the RDK8.
- The Integrated Coal Gasification Combined Cycle (IGCC) technology began commercial operations on 16 April 2021 at the Nakoso IGCC power plant in Japan's Fukushima prefecture (Power, 2021). The power station generates electricity with superior efficiency while simultaneously achieving greenhouse gas reductions.
- The Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC) technology has the potential to enhance thermal efficiency to 55% by 2025, and it is expected to be commercialised during the 2030s (METI Journal).

[2] CO_2 intensity of the Integrated Coal Gasification Combined Cycle technology is estimated to be a 10-15% lower than that of ultra-supercritical technology.

Coal use in energy sectors

Figure 1.2: APEC coal usage by sectors, 2009 and 2020



Source: compiled by the author based on IEA (2022).

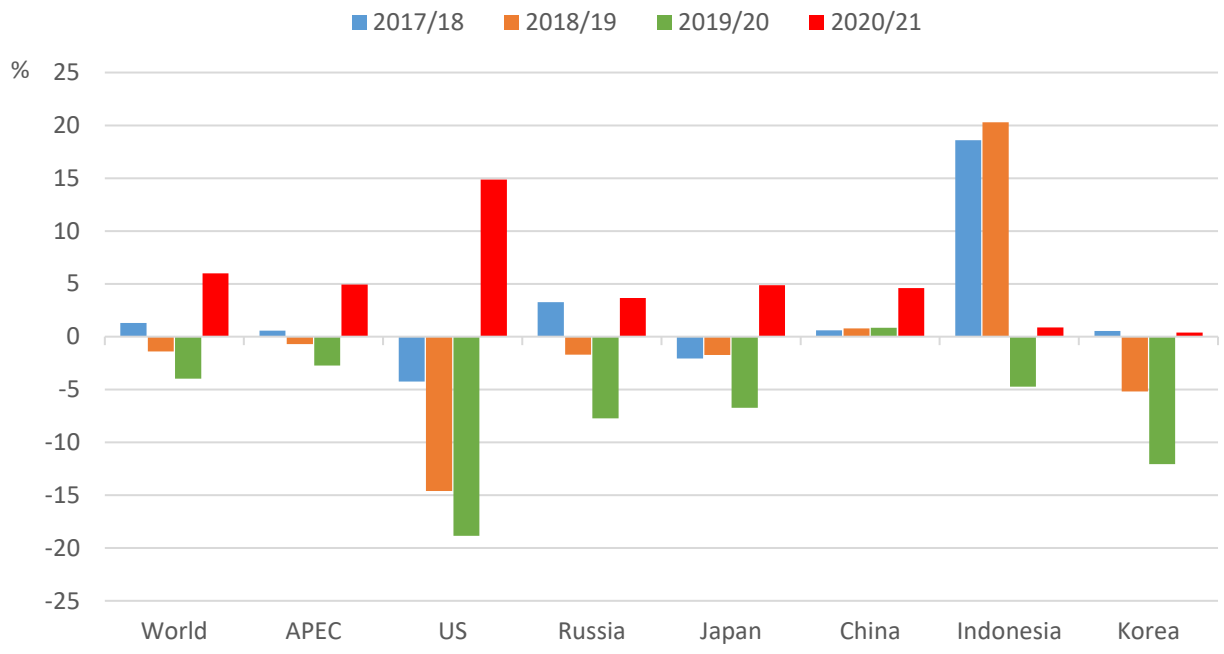
Key points

- Approximately 74% of coal consumed in APEC economies in 2020 was used for power generation. The remaining 26% was consumed by industrial processes, own use and losses, and other final energy consumption applications. The prominence of power sector coal consumption to total levels of coal consumption is set to decline, with most APEC economies moving to alternative power-generating technologies and fuels.
- In the most recent decade, China's rapid economic growth has relied on cement to build cities and infrastructure. While this construction fuelled a very high demand for cement, the capacity of China's cement industry was significantly larger than the demand. In response to this overcapacity, China enacted policies to consolidate and downsize the industry in 2013 (Saunders and Edwards, 2016). This consolidation has meant that the proportion of APEC industry consumption of coal has fallen from 25% in 2009 to 20% in 2020, highlighting the magnitude of China's cement industry relative to all APEC coal consumption.
- Coal's relatively low cost and consistent heating properties make it difficult to replace in many applications in the cement, iron & steel, and chemical products industrial sectors. With the expected fall in the prominence of the power sector's consumption of coal, the industrial sector is set to become a relatively more important sector in markets for coal.

Chapter 2: Coal consumption

World and APEC coal consumption

Figure 2.1: Coal consumption growth rate in the globe and selected APEC economies

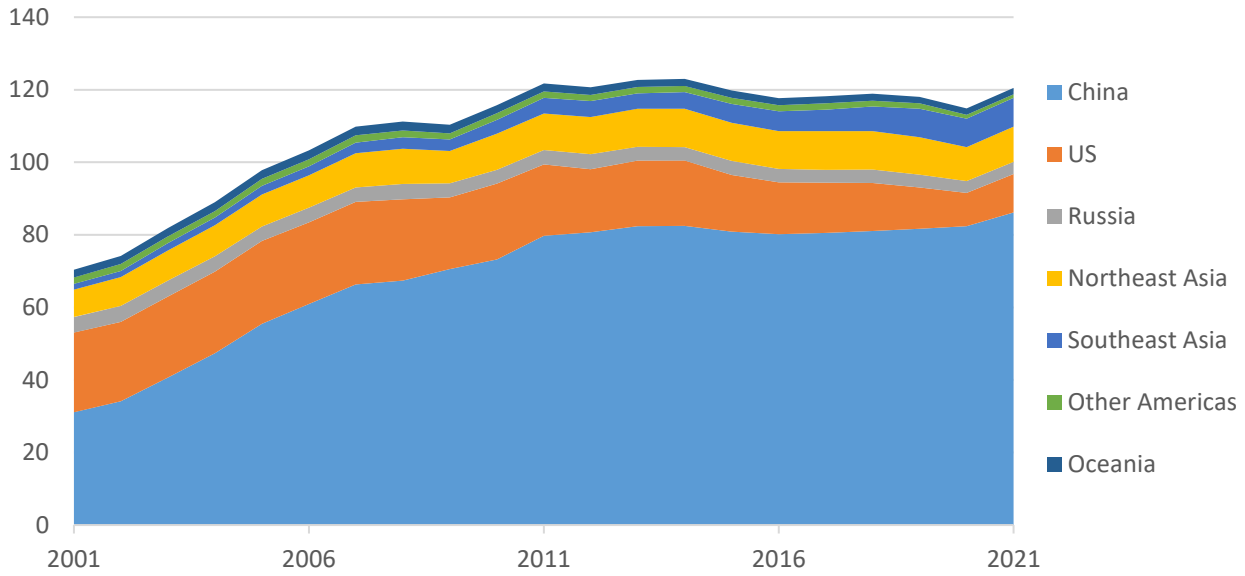


Source: compiled by the author based on BP (2022).

Key points

- Global coal consumption bounced back strongly in 2021, rising by approximately 6% relative to 2020 as the result of global economy recovery after severe COVID-19 waves. Additionally, higher natural gas prices contributed to this rising trend, switching towards coal-fired power generation. Worldwide coal consumption was much higher than in 2019 levels, approaching the previous peak which occurred in 2014.
- APEC coal consumption rebounded by approximately 5% in 2021, driven by the five largest coal consumption economies (China, United States, Japan, Russia, and Indonesia), which accounted for almost 90% of APEC coal consumption.
- The United States' coal consumption rose by approximately 15% compared to the previous year, marking the first growth since 2013. Surging demand for coal usage due to a record high in natural gas prices, which more than doubled compared to the previous year.
- Coal consumption in China, the world's largest coal consumer by far, grew by 4.6% in 2021. It is the largest increase since 2017, as higher demand for power generation and industrial sectors after the first COVID-19 lockdown. Russia, Japan, Indonesia and Korea also consumed more coal than the previous year.
- Many countries worldwide have increased the gas-to-coal switching trend, making global coal consumption exceed 8 billion tonnes in 2022.

Figure 2.2: APEC coal consumption by region, EJ



Source: compiled by the author based on BP (2022).

Key points

- APEC-wide coal consumption reached 120 EJ in 2021, close to its previous peak in 2014.
- China, the largest coal consumer in the APEC and the world, substantially increased its coal consumption over the 2001-2010 period, then gradually rose over the last ten years. In 2021, China's coal consumption accounted for approximately 71% of the total coal consumption in the APEC region.
- The United States consumed approximately 9% of APEC coal, while Russia consumed around 3% of APEC total.
- Northeast Asia, including Japan, Korea, Chinese Taipei, and Hong Kong, accounted for 8% of the total APEC coal consumption in 2021, mainly consumed by Japan and Korea.
- The Southeast Asia economies accounted for 6.6% of APEC coal consumption. Indonesia consumed the most, followed by Viet Nam.
- Oceania, including Australia and New Zealand, accounted for 1.4% of the APEC-wide coal consumption. Australia consumes over 95% of coal consumption in the Oceania region.
- Other Americas, namely, Canada, Chile, Mexico and Peru, consumed less than 1% of APEC coal consumption.

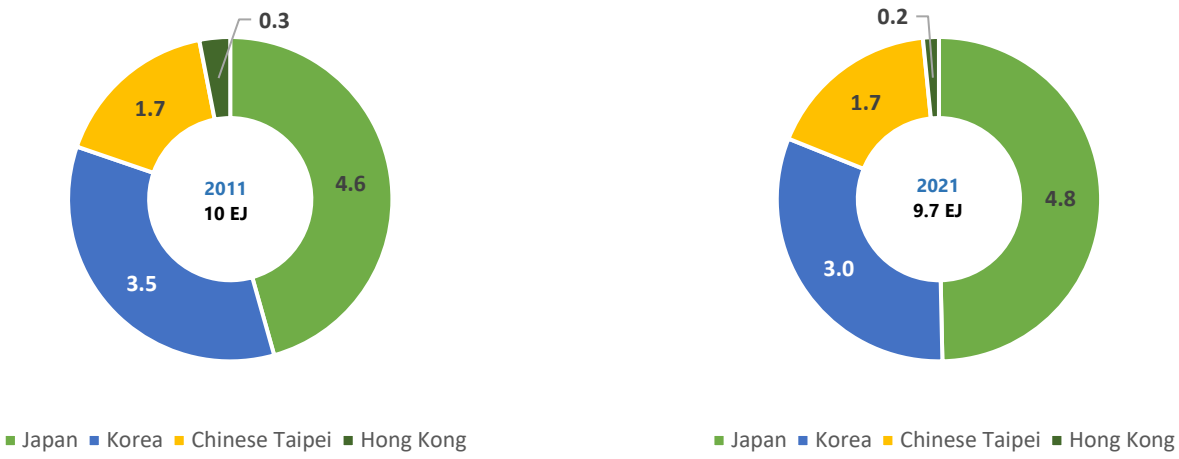
Figure 2.3: Coal consumption in China, USA, and Russia, 2011-2021.

Source: compiled by the author based on BP (2022).

Key points

- China's coal consumption rose 9% over the last decade, from 79.7 EJ in 2011 to 86.2 EJ in 2021. Approximately 64% of that total was used for power generation, and around 24% was used for energy-intensive industries such as steelmaking, aluminium smelting, cement manufacturing and fertiliser production. The power sector in China is still highly dependent on coal. In recent years, coal-fired power generation accounted for approximately two-thirds of total electricity generation in China.
- In contrast, United States' coal consumption fell by 46% over the 2011-2021 period, from 19.7 EJ in 2011 to 10.6 EJ in 2021. Coal consumption has substantially fallen since 2007 as competitive prices of shale gas relative to coal and the widespread deployment of renewable energy despite a temporary surge in coal consumption in 2021. Coal consumption in the United States is expected to continue declining due to coal-to-gas switching in the power sector and the underinvestment of coal mines.
- Russia's coal consumption fell by approximately 13% over the 2011-2021 period to reduce carbon emissions as Russia ratified the Paris Climate Agreement in 2019. Even though coal phase-out is not a priority for Russia, the global low-carbon trend is affecting the Russian coal sector. Additionally, coal consumption has gradually declined for a decade due to the competition with natural gas and Gazprom's gasification of regions (Korppoo, A. et al., 2021).

Figure 2.4: Coal consumption in Northeast Asia, 2011-2021.



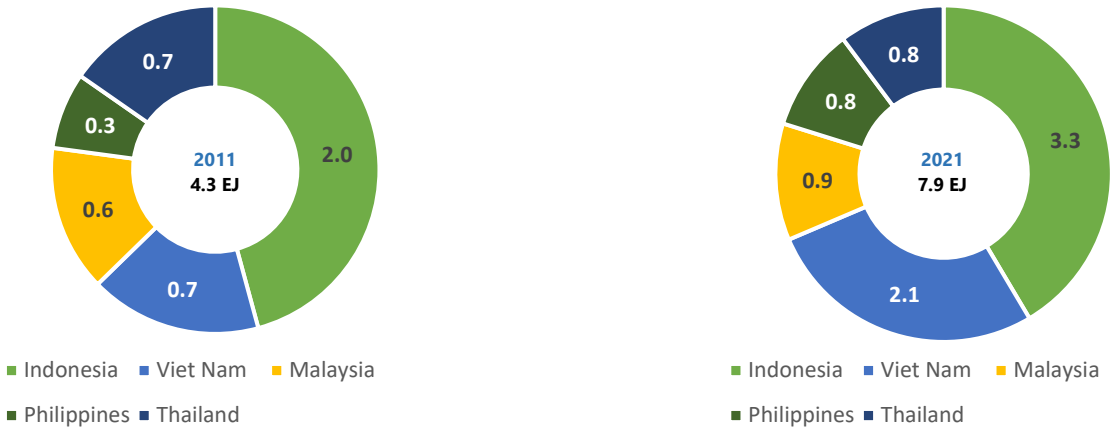
Source: compiled by the author based on BP (2022).

Key points

- Coal consumption in the Northeast Asia economies slightly declined from 10 EJ in 2011 to 9.7 EJ in 2021. Recently, the fall in coal consumption has been seen due to the environmental issues and net-zero commitments of economies in this region.
- Japan was the largest coal consumer in Northeast Asia, with 4.8 EJ in 2021, a 4.3% growth compared to 2011. Although Japan plans to reduce reliance on coal-fired electricity generation, with plans to phase out inefficient coal power plants by 2030, Japan did not sign the Global Coal to Clean Power Transition Statement at COP26 to phase out all coal-fired power plants by the 2030s or 2040s. Coal power technologies are still a significant business for major Japanese power plant makers and power utilities. As a long-time supporter of this industry, the Government is unwilling to change its course to move away from coal (Japan Beyond Coal). However, Japan committed to phasing out coal-fired power and entirely or predominantly decarbonised power sector by 2035 at the 2022 G7 summit (Kiko Network, G7 Germany).
- Korea's coal consumption declined by 14% from 3.5 EJ in 2011 to 3 EJ in 2021, contributing to carbon emissions reduction to reach carbon neutrality by 2050. Improving energy efficiency, increasing the share of renewable energies, and promoting the hydrogen industry will significantly offset coal consumption.
- Chinese Taipei's coal consumption did not rise over the last decade as the Government's efforts to remain and step toward reducing its reliance on coal-fired generation. Power companies have been protested by the local community related to environmental issues such as PM2.5 in the Taichung area, which have one of the top ten giant coal plants in the world[3]. In January 2021, the Parliament of Chinese Taipei adopted a resolution to accelerate the decommissioning of the power plant. The ten 550 megawatt coal-fired units are to be retired by 2035 instead of 2046 as initially planned by Taipower. The subcritical coal units will be preserved as a national security emergency reserve. Four gas-fired power plants will be built on the site to replace the coal units, though a commissioning date for these new plants is unclear (Global Energy Monitor).

[3] PM2.5 refers to particles that have diameter less than 2.5 micrometres (more than 100 times thinner than a human hair) and remain suspended for longer.

Figure 2.5: Coal consumption in Southeast Asia, 2011-2021.

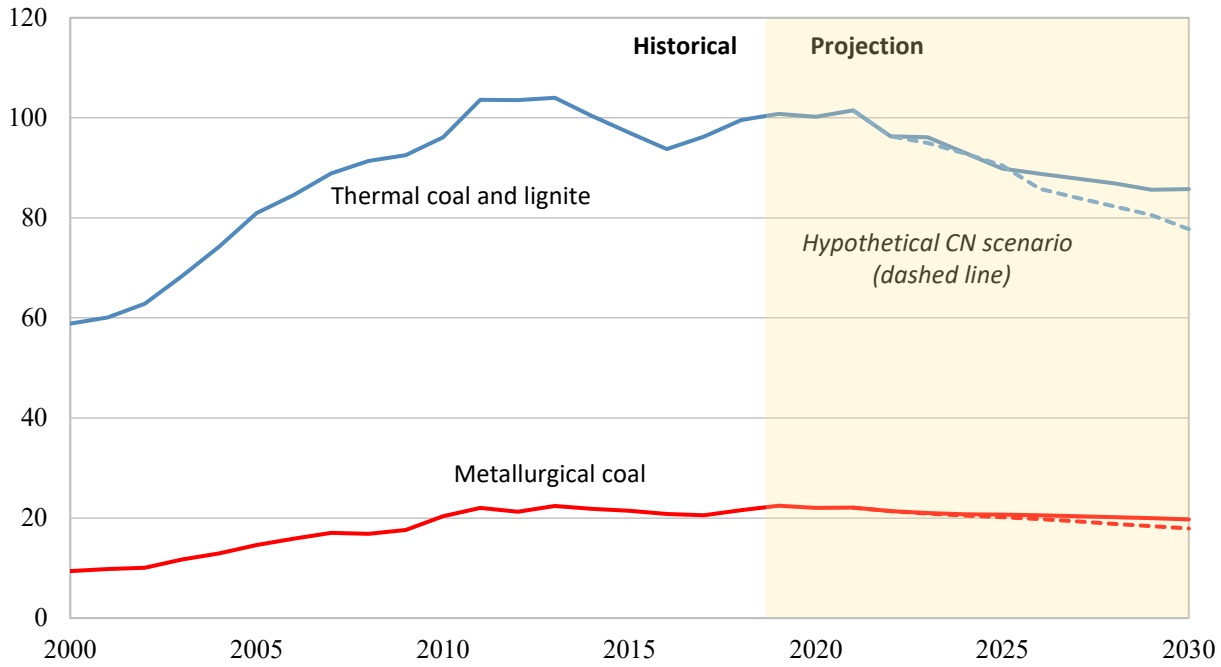


Source: compiled by the author based on BP (2022).

Key points

- Due to rapid economic growth, coal consumption in Southeast Asia almost doubled over the last decade, from 4.3 EJ in 2011 to 7.9 EJ in 2021. Coal is mainly used in the power sector as most economies in Southeast Asia rely on coal-fired power generation.
- Indonesia was the largest coal consumer among Southeast Asia economies, with 3.3 EJ in 2021, 65% higher relative to 2011. Coal is used mainly in the power sector, accounting for around 70% of the total coal consumption in recent years. Given its large coal resources, Indonesia is a major thermal coal producer and exporter worldwide.
- Viet Nam was the second-largest coal-consuming economy in the region in 2021. The coal consumption increased three-fold from 0.7 EJ to 2.1 EJ to meet the high coal demand for coal power and industry sectors over the 2011-2021 period. Approximately 70% of coal is consumed in coal-fired power plants, and the remainders are for industry and other sectors. The electricity generation from coal has increased by approximately six times over the last decade. Viet Nam has started to import a large amount of coal since 2014 to supplement its domestic production.
- Coal consumption in Malaysia rose by 1.5 times over the last decade due to a high increase in coal-fired power capacity. Coal dominates the power sector, which makes up 92% of Malaysia's coal consumption. However, coal also provides heat for industrial processes, particularly cement, iron, and steel.
- Coal consumption in the Philippines rose by 2.7 times over the 2011-2021 period, mainly used for power and industrial sectors. Although fossil fuels are the single biggest source of carbon emissions, coal continues to be supported by both the Government and businesses in the Philippines as it is the cheapest fuel option.
- Thailand's coal consumption rose by 16% over the last decade, the lowest growth among the Southeast Asia economies. Unlike the above economies, Thailand uses just above 50% of total coal consumption for the power sector, while the remainder is used for industrial processes. Coal-fired power capacity is not a main contributor to the total generation mix, and the Government plans to diminish coal use steadily, reaching zero generation with the phase-out of coal-fired power plants in the 2040s.

Figure 2.6: APEC coal consumption: history and outlook, EJ



Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

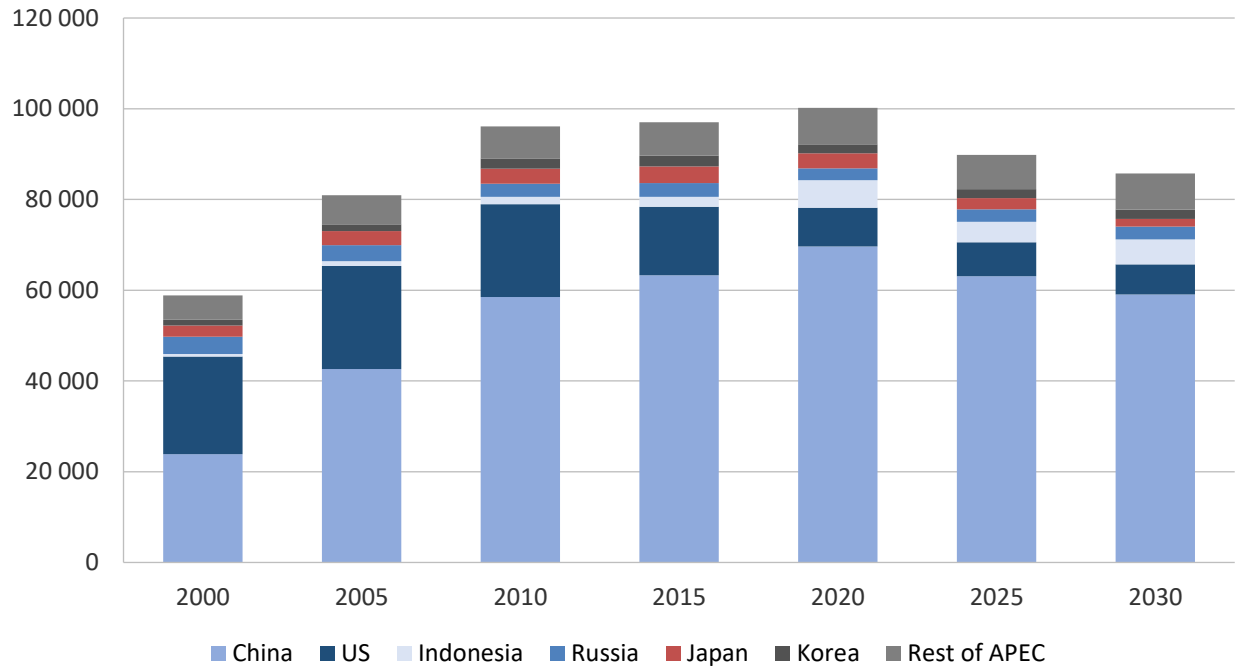
Key points

- While there has been a rebound in APEC thermal coal consumption in the latter half of the 2010s, thermal coal consumption is projected to decline through the 2020s. The pace of decline will be faster in a world that aims to achieve greater emissions reduction. In contrast, metallurgical coal demand will maintain a high plateau, with consumption only decreasing by a small amount in the hypothetical carbon neutrality (CN) scenario.[4]
- Coal phase-down and phase-out policies have been consolidated based on the commitments of APEC economies leaders in late 2021. Nine APEC economies signed the Global Coal to Clean Power Transition Statement at COP26 in Glasgow (COP26), wherein they committed to not building any new coal-fired power plants from the 2030s or 2040s, depending on their economic situation. Several APEC economies committed to phasing out coal by 2030, such as Chile, New Zealand, and Canada. Korea plans to phase out coal by 2050 (E3G, 2022).
- In the next decade, coal consumption decline is expected to mainly occur in the power sector, while metallurgical coal is still significant for heavy industrial sectors such as iron & steel manufacturing.

[4] The medium and long-term projection data was modelled in August 2021. Therefore, it did not cover the recent change in coal consumption due to the Russian-Ukraine conflict.

Thermal coal

Figure 2.7: APEC thermal coal (including lignite) consumption by economy: history and outlook, PJ

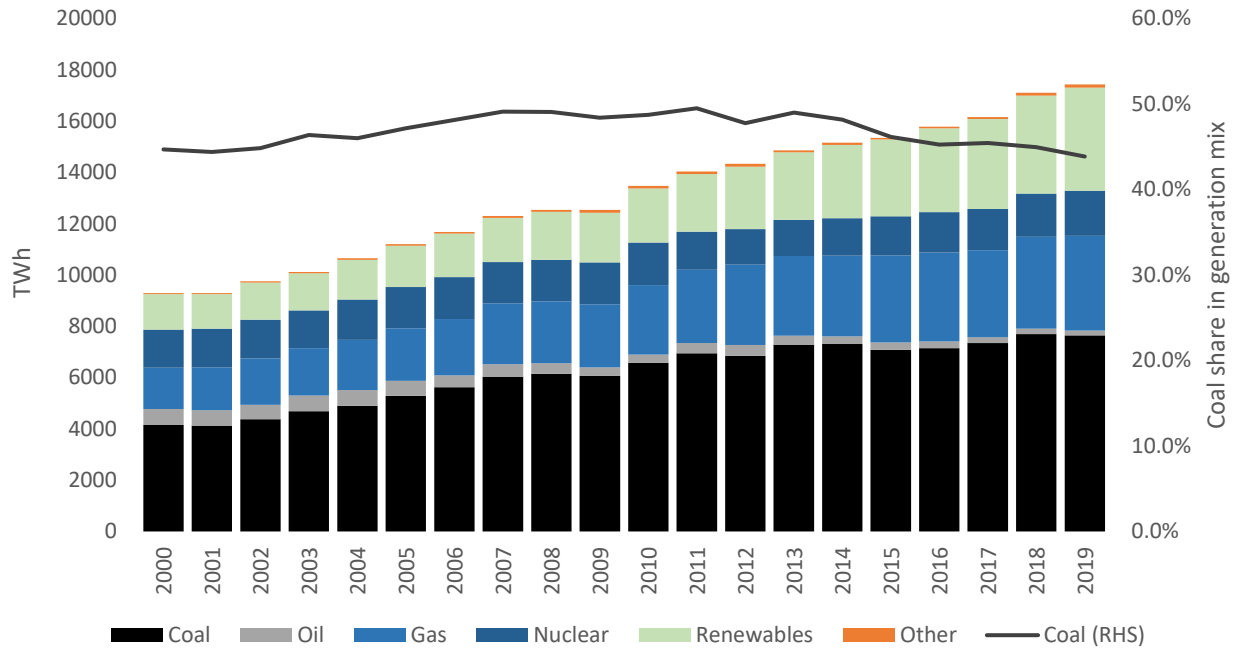


Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

Key points

- In the APEC region, China remains the largest consumer of thermal coal (including lignite), accounting for 70% of APEC thermal coal consumption in 2019. The power sector and electricity demand drive this consumption, though coal-fired heating in the non-power sector has also accounted for a significant portion of this consumption. In recent years, natural gas has replaced coal-fired heating extensively, particularly in Northern China cities. This will contribute to lower levels of thermal coal demand growth moving forward.
- In contrast, the United States' thermal coal consumption share has declined from 36% of APEC thermal coal consumption in 2000 to 11% in 2019 (IEA, 2021). This represents a halving in absolute consumption for the period.
- APEC thermal coal consumption is projected to decline through the 2020s in the reference scenario that has been modelled for the *APEC Energy Demand and Supply Outlook 8th Edition 2022*. While there is likely to be an absolute decline in thermal coal consumption, certain APEC economies in Southeast Asia have posted strong growth in recent years.
- While almost APEC economies are expected to decline their coal consumption through to 2030, thermal coal consumption is projected to rise in Indonesia and Viet Nam by 2030.

Figure 2.8: APEC power generation by fuel and coal share of the APEC power mix

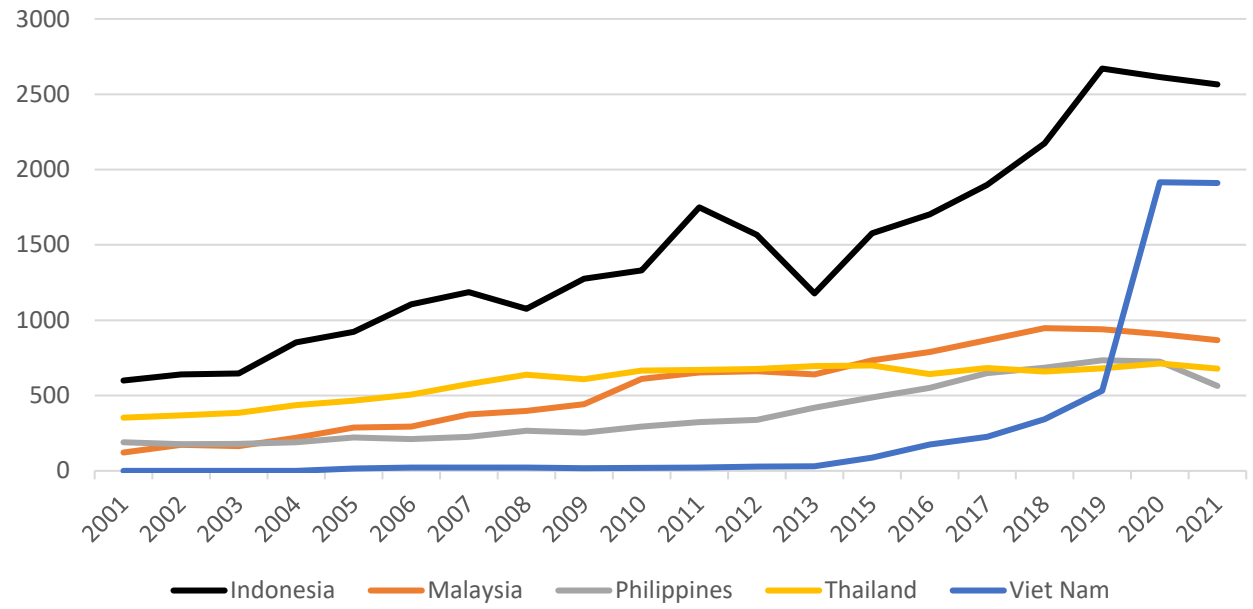


Source: compiled by the author based on EGEDA (2021).

Key points

- Recently, coal is still the largest contributor to the APEC-wide generation mix in the power generation sector. However, the share of total generation has been gradually declining since 2013, most recently accounting for approximately 44% of total power generation in 2019.
- The declining trend of coal share in the generation mix mainly occurred in several APEC economies, such as the United States, Canada, and Australia, while Southeast Asia economies still rely on coal in their power sector.
- In 2021, with the skyrocketing price and energy supply disruption, several APEC economies started increasing coal use in power generation. Electricity generation from coal increased by approximately 16% in the United States in 2021 compared to the 2020 level, followed by Russia (+16.4%), China (+8.5%), Indonesia (+5%) and Chinese Tapei (+3.4%) (BP, 2022).

Figure 2.9: Thermal coal (including lignite) consumption in selected Southeast Asia economies, PJ.



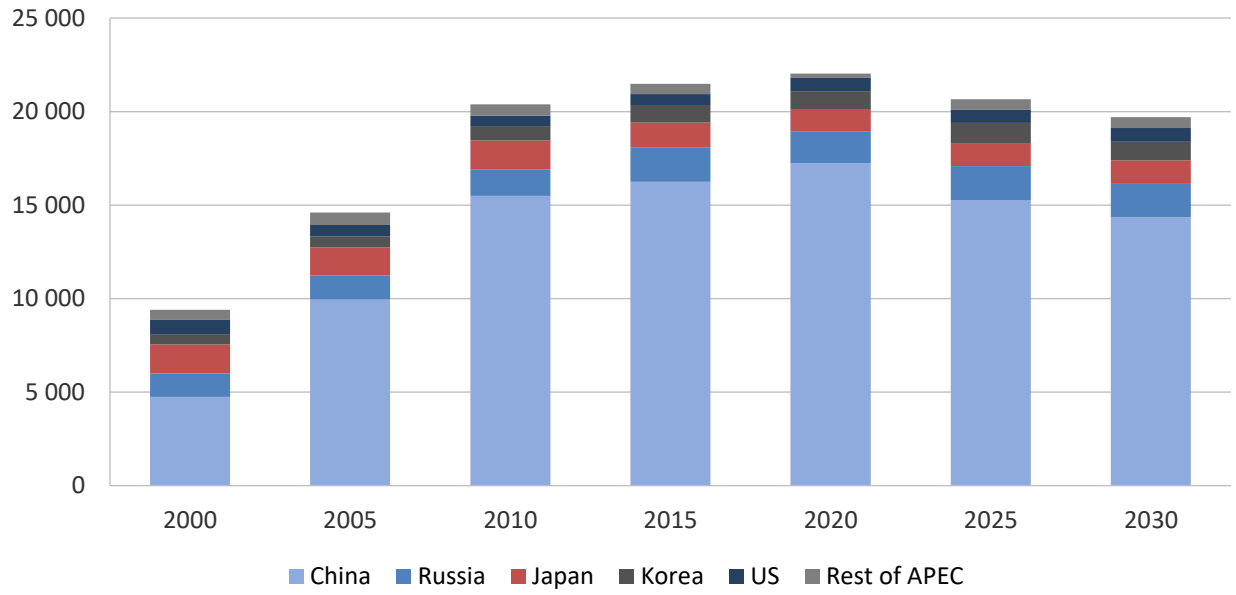
Source: compiled by the author based on IEA (2022).

Key points

- Thermal coal (including lignite) consumption in the Southeast Asia economies has risen noticeably over the last decade, particularly in Indonesia and Viet Nam. While there is likely to be a slight decline in APEC's thermal coal consumption in recent years except in the year 2021, Southeast Aisa economies will likely continue to rely on coal for at least the next decade to meet their growing electricity demand.
- Indonesia's recently released Power Procurement Plan (RUPTL) aims for an additional 13.8 GW of coal-fired capacity to be added to Indonesia's generation fleet by 2027 (Nikkei, 2021).
- In Viet Nam, a new May 2022 draft of the Power Development Master Plan 8 (PDP8) shows an increase in coal-fired capacity up to 37.5 GW by 2030 from the current installed capacity of 21GW. Surging consumption of thermal coal is driven by new coal-fired power plants which have been commissioned in recent years, such as Thai Binh 2 (1200 MW), Vinh Tan 4 (600 MW), Song Hau 1 (1200 MW), Nghi Son 2 (1300 MW).
- These new plans have been made in the context of a spate of announcements in 2020 and 2021 from Viet Nam, Indonesia, and the Philippines about limiting or halting new coal-fired power projects (WRI, 2021). They highlight that there is still considerable uncertainty about the role that thermal coal will play in meeting rapidly rising energy demand in Southeast Asia over the next decade.
- Announcements by Japan, Korea, and China in 2021 to no longer provide state-based financing for overseas unabated coal projects is likely to slow APEC thermal coal growth. In June, Japan government made an announcement to halt financial aid for constructing coal-fired electricity plants in Indonesia (the Indramayu plant) and Bangladesh (the Matarbari plant) in response to international criticism of coal-fired power, a major source of greenhouse gas emissions blamed for global warming (Nikkei Asia).

Metallurgical coal

Figure 2.10: APEC metallurgical coal consumption by economy: history and outlook, PJ



Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

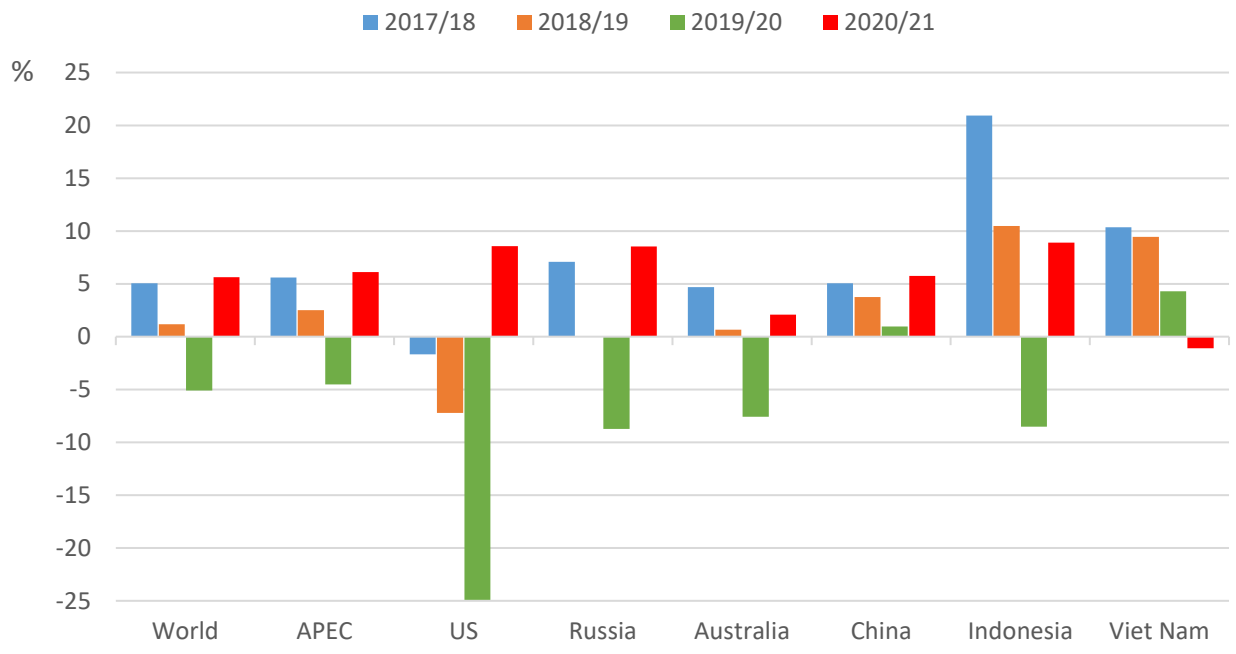
Key points

- China remains the dominant consumer of metallurgical coal in APEC, owing to its global leadership in steel production. Even in the face of a global slowdown in steel production of 0.9% in 2020, China posted steel production growth of 5.2%. This large increase in production when the rest of the world was contracting meant that China accounted for 57% of global steel production in 2020, up from 53% the year before (WSA, 2021).
- China's metallurgical coal consumption increased from 15 500 PJ in 2010 to over 17 000 PJ in 2020, representing 78% of APEC metallurgical coal consumption. Russia was the next largest consumer of metallurgical coal in 2020, though the consumption is an order of magnitude below China's, at 1709 PJ. Japan, Korea, and the US are the next most prominent metallurgical coal consumers in APEC, consuming at levels closer to 1000 PJ in 2020.
- Higher levels of steel production only partly explain China's greater metallurgical coal consumption. Metallurgical coal consumption is also higher in China due to a larger proportion of steel production being reliant on oxygen furnaces than in other APEC steel-producing economies. The proportion of oxygen-based steel production processes in China was 91% in 2020. In contrast, Russia (66%), Japan (75%), Korea (69%), and the United States (29%) relied on oxygen-based processes less, instead consuming higher levels of electricity via electric arc furnaces, which are reliant on scrap metal (WSA, 2021).
- It is expected that China will remain the largest metallurgical coal consumer, accounting for 73% of the APEC metallurgical coal consumption by 2030, followed by Russia and Japan.

Chapter 3: Coal production

World and APEC coal production

Figure 3.1: Coal production growth rate in the globe and of selected APEC economies

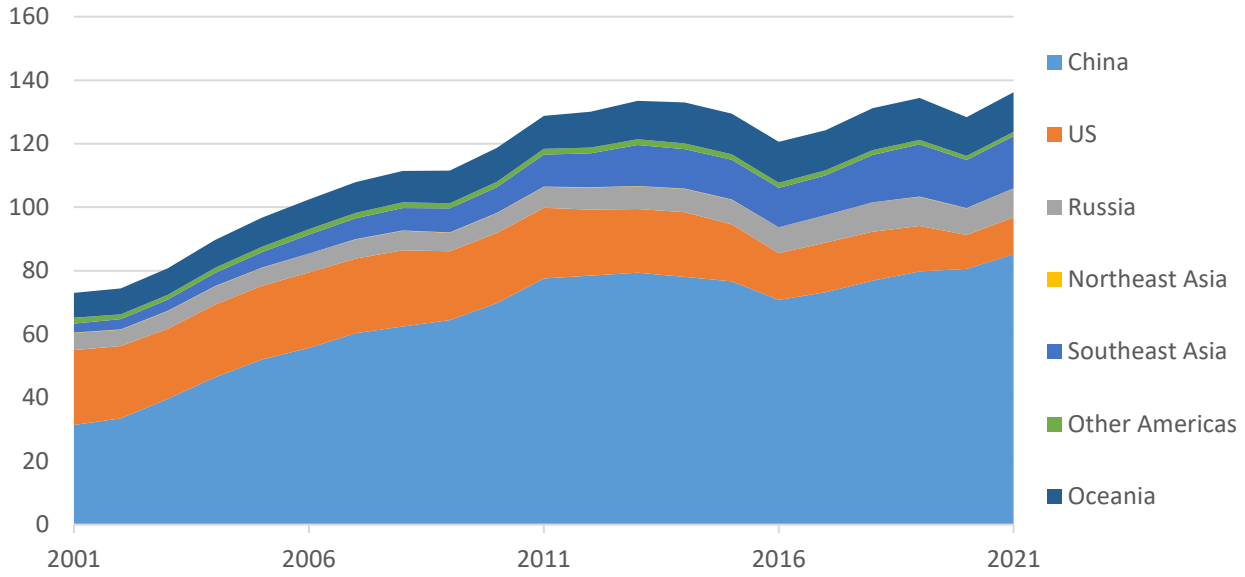


Source: compiled by the author based on (BP, 2022).

Key points

- Global coal production rose by 5.6% in 2021 to meet the high coal demand after rebounding partly from the COVID-19 pandemic. Coal production in 2021 was even a bit higher than the record-high level in 2019 after a dramatic fall in coal production in 2020. In the APEC region, annual coal production rose by 6.1% in 2021 compared to 2020, though the rising trend was not uniform across all economies.
- China, the world's largest coal producer, increased coal production by 5.7% in 2021 compared to the previous year in response to the high demand for domestic coal usage, particularly for power generation. In the third quarter of 2021, China underwent electricity blackouts in several provinces, disrupting the daily lives of tens of millions of people. It was not only cutting off electricity in the residential sector, but energy-intensive industries and manufacturing plants have also been asked to reduce electricity consumption during peak demand or limit the number of working days.
- Indonesia's coal production rose 8.9% in 2021, the highest growth among APEC economies. Most of the increased coal production was for export, while domestic use showed slight growth in 2021.
- Coal production in Australia rose by 2.1%, mainly for export, while domestic use has declined gradually.
- The United States and Russia showed an increase in coal production by 8.6% and 8.5% in 2021, respectively, as the higher domestic demand.

Figure 3.2: APEC coal production by region, EJ

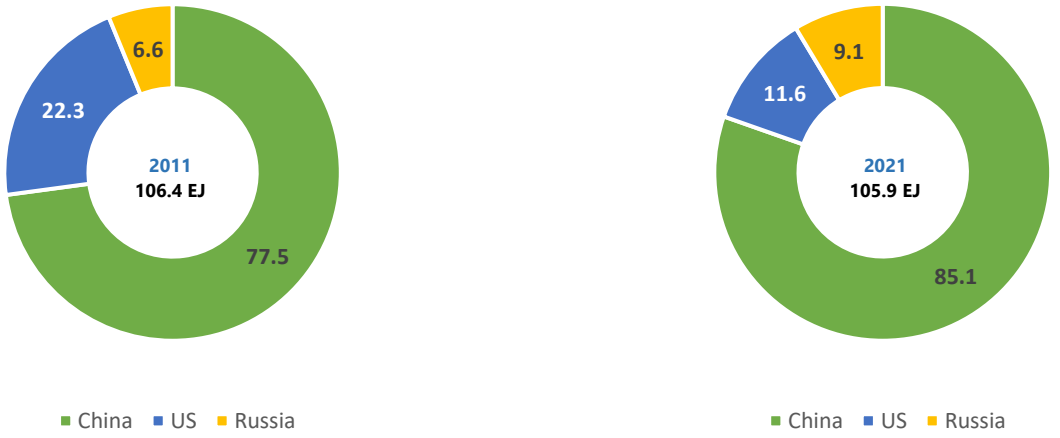


Source: compiled by the author based on BP (2022).

Key points

- APEC coal production showed an all-time high record of 136.2 EJ in 2021, a 6.1% increase relative to the previous year.
- China, the largest coal producer in the APEC and the world, produced 85.1 EJ, accounting for approximately 63% of the APEC coal production in 2021. Although a huge amount of coal production was mined in China in 2021, the domestic coal was still 1 EJ lower than the coal demand. Many coal mines have been closed due to mining safety and land use tights for mining issues in the last five years. In order to offset the coal production shortage from closed coal mines, the Chinese Government boosted the coal production from large-scale coal mines.
- Southeast Asia produced 16.4 EJ in 2021, accounting for 12.5% of the total APEC coal production. Indonesia has dominated coal production in the region for decades, followed by Viet Nam and Thailand.
- Oceania produced 12.5 EJ, accounting for 9.2% of APEC coal production in 2021, while other Americas accounted for less the 1%.
- The United States and Russia were the fourth and fifth coal producers in 2021, accounting for 8.5% and 6.7% of APEC coal production, respectively.

Figure 3.3: Coal production in China, USA, and Russia, 2011-2021.



Source: compiled by the author based on BP (2022).

Key points

- Coal production in China grew substantially over the last decade (2011-2021). Although the growth rate was only 9.8% over the last ten years, the absolute value of coal production was 7.6 EJ, which was close to the total coal consumption of Southeast Asia economies in 2021. China needs more coal volume than domestic mined production. Annually, China has to import coal to fill the demand, which accounts for less than 10% of the total coal consumption.
- In 2021, China's coal production reached a new record high of 85.1 EJ due to high coal demand for both power generation and industries. The coal crisis in the second half of 2021 caused electricity blackouts in four provinces (Liaoning, Hei Longjiang, Jilin and Guangdong), disrupting the daily lives of 10 million people. In response, the authorities asked coal enterprises to rapidly increase the coal production at existing coal mines while reopening the closed coal mines in the Inner Mongolia and Shanxi areas
- Russia was the single fastest-growing economy in coal production over the last decade (+38.6%), with coal production increasing from 6.6 EJ in 2011 to 9.1 EJ in 2021. As the third largest coal-exporting economy, over half of the coal production has been used for exports in recent years.
- In contrast, coal production in the United States fell by almost half in the 2011-2021 period to respond to the declined coal demand except in 2021. U.S. coal production increased by 8.6% in 2021 to meet the strong domestic coal demand amid high gas prices and strong electricity consumption growth.

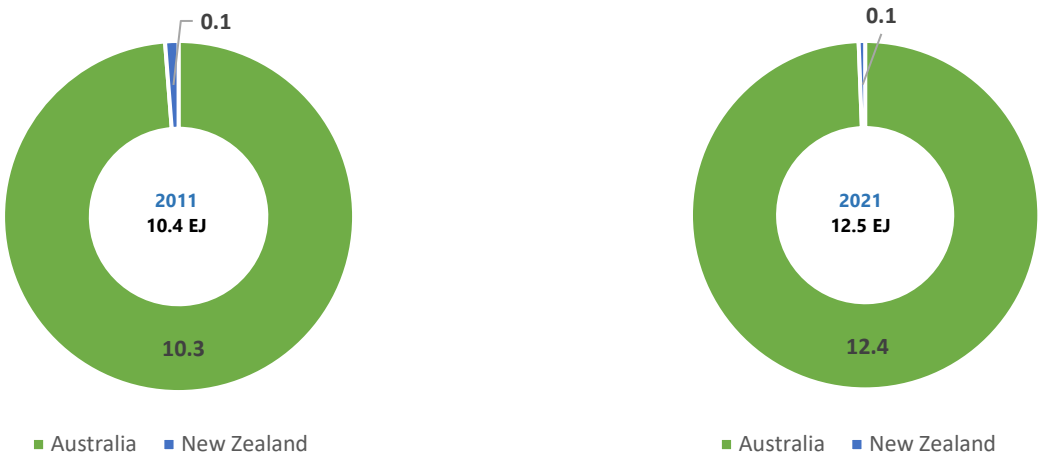
Figure 3.4: Coal production in Southeast Asia, 2011-2021.

Source: compiled by the author based on BP (2022).

Key points

- Southeast Asia showed the fastest growth among regions in APEC (+63.2%), a rise from 10.1 EJ to 16.4 EJ over the 2011-2021 period.
- Indonesia, the largest coal producer and exporter in Southeast Asia, increased its coal production by almost 74%, from 8.7 EJ in 2011 to 15.1 EJ in 2021. Although the growth in coal consumption for domestic use has been seen over the last decade, most of the coal production was for export. In 2021, Indonesia exported 8.6 EJ, accounting for approximately 57% of the total coal production.
- In 2021, Indonesia's coal production grew by 8.9% to 15.1 EJ after a pandemic-induced drop in coal demand in 2020. Although extreme weather occurred in Kalimantan and Sumatra, coal production growth was the highest among APEC economies.
- Viet Nam maintained its coal production over the last decade, mainly mined in the northern provinces and Quang Ninh anthracite coal basin. However, the complex geological conditions and deep coal seams hinder the coal production growth in these coal fields. The Red River Delta coal basin is a newly discovered sub-bituminous coal resource in Viet Nam, but it has not been mined due to technical and economic obstacles.
- Thailand's coal production fell by 41%, from 0.25 EJ in 2011 to 0.14 EJ in 2021.

Figure 3.5: Coal production in Oceania, 2011-2021.



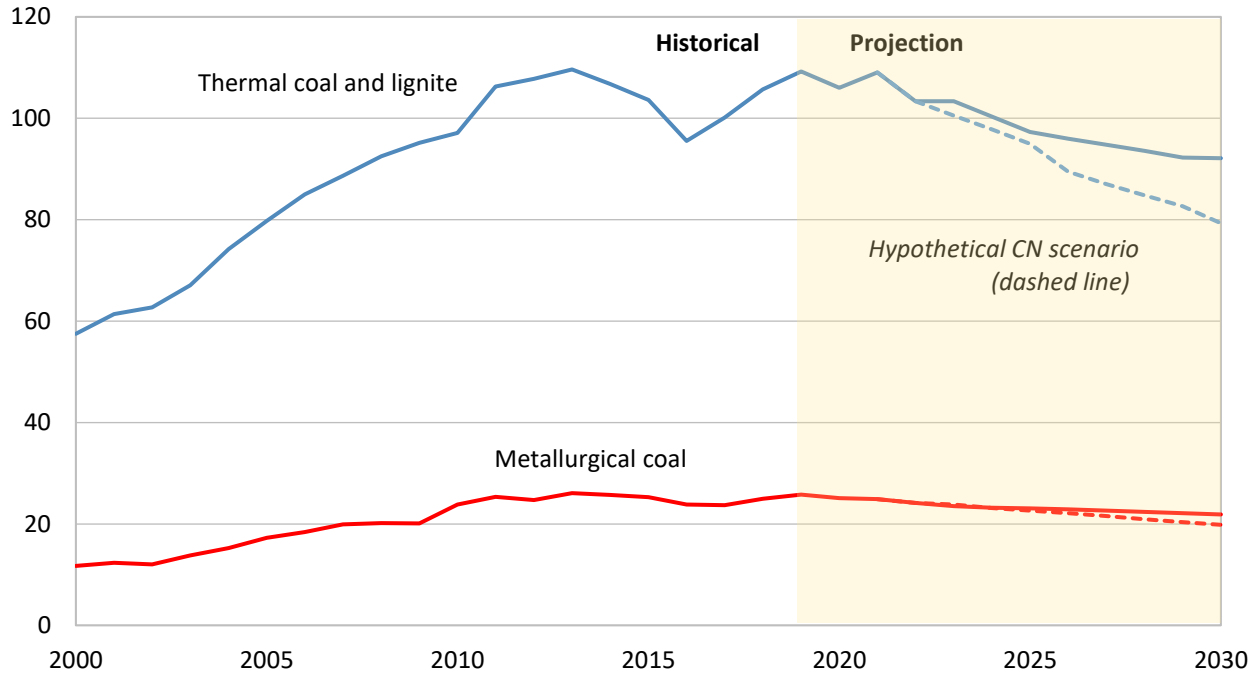
Source: compiled by the author based on BP (2022).

Key points

- In the Oceania region, coal production is dominantly produced by Australia, the largest coal exporter in the APEC. Over the last decade, coal production rose from 10.3 EJ in 2011 to 12.4 EJ in 2021. Only a small portion has been used for domestic, and the remainder was used for exporting. Australia exports most of its coal production, capitalising on its abundant coal resources and strong ongoing coal demand from Asia. Australia exported 9.63 EJ of coal in 2021, about three-quarters of Australia's total coal production. The majority of Australia's black coal basins are in New South Wales and Queensland, while the main brown coal basins are in Victoria.

- Although floods in New South Wales and Queensland disrupted the domestic coal supply chain in 2021, Australia's coal production rose by 2.1% relative to the previous year after global coal demand fell due to the COVID-19 pandemic.

Figure 3.6: APEC coal production: history and outlook, EJ



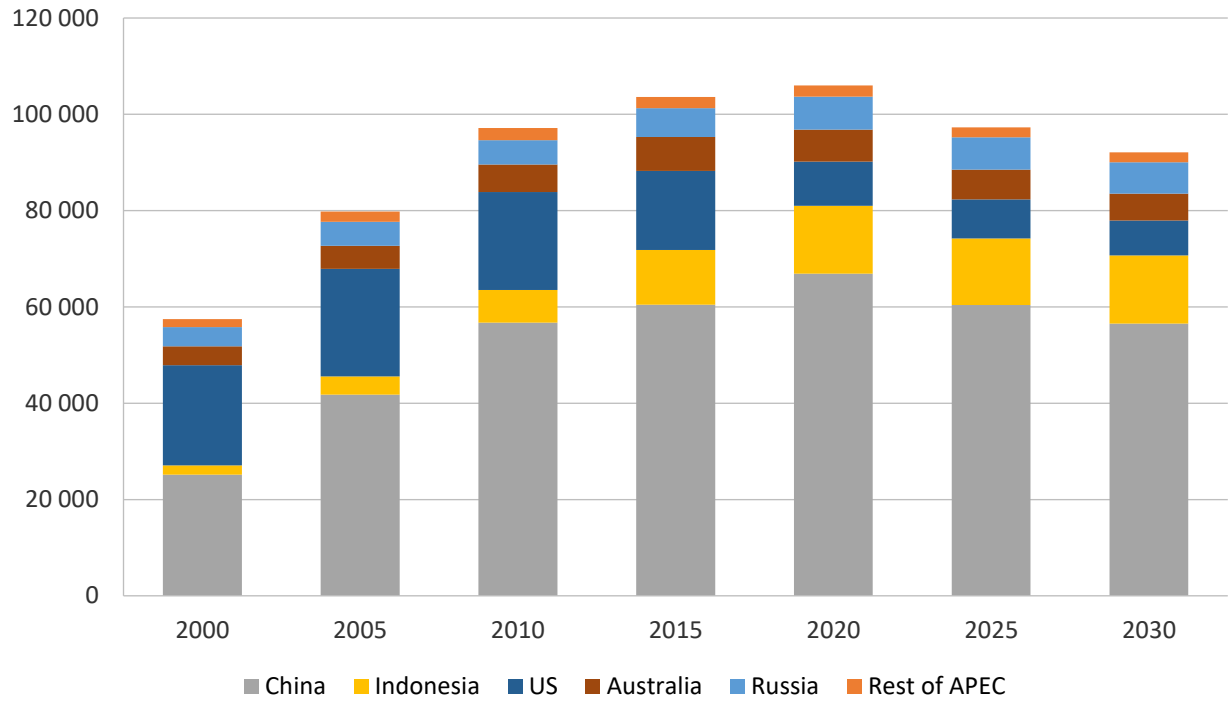
Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

Key points

- APEC-wide coal production is projected to fall by 13% in 2030 relative to 2018. The decline in thermal coal production occurs at a faster pace than for metallurgical coal.
- The difference in the pace of decline is due to many APEC economies developing and deploying fuel-switching strategies (to natural gas and renewables) to achieve greater emissions reduction from electricity generation. However, fuel switching is not viable for metallurgical coal consumption.
- In the CN scenario, APEC coal production falls by 24% for the 2018-2030 period. Assumptions about coal phase-out policies, renewables, fuel switching, and low CO_2 emission coal combustion technologies are more aggressive than in the REF scenario for most APEC economies. This seems to become a reality as 19 over 21 economies in the APEC committed to reaching net-zero or carbon neutrality around the middle of this century.
- Thermal coal production falls faster in the CN scenario than in the REF, while metallurgical coal production remains robust in the medium term due to high steel demand. There is potential to switch to innovative new steel production technologies that do not rely on metallurgical coal, though most of these alternatives will not be available at scale until after 2030.

Thermal coal

Figure 3.7: APEC thermal coal (including lignite) production by economy: history and outlook, PJ



Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

Key points

- APEC thermal coal production is expected to decline by 16%, from 109 EJ in 2019 to 92 EJ in 2030. The largest drops are projected to be in the US, followed by Australia, Russia, and China. In contrast, thermal coal production in Indonesia is forecast to grow.
- With rising concerns over pollution and CO_2 emissions from coal-fired power plants in China, thermal coal production growth is projected to slow noticeably through 2030. China reduced the coal share in the total generation mix from 77% in 2010 to 67% in 2018 (EGEDA, 2021). This decreasing trend is expected to continue during the forecast period, falling to 39% by 2030.
- Indonesia's thermal coal production is expected to grow by 3% over the 2019 to 2030 period. This projected production growth will cement Indonesia as the second-largest producer of thermal coal in APEC.
- In Canada, the Alberta government is investigating the possibility of increasing coal production capacity for export. But the Federal Government has introduced significant policy hurdles for thermal coal development (GOA, 2021). The new policy requires that a sitting Cabinet minister consider the lifecycle emissions impact of thermal coal mining (GOC, 2021). This will limit thermal coal production increases for as long as the Government aims to reduce thermal coal's share in the global energy mix.

Box 1: Coalbed methane and coal mine methane

Methane gas stored naturally in coal beds is known as unconventional natural gas and is catergorised as Coal Mine Methane (CMM) or Coalbed Methane (CBM), based on the emissions associated with mining it.

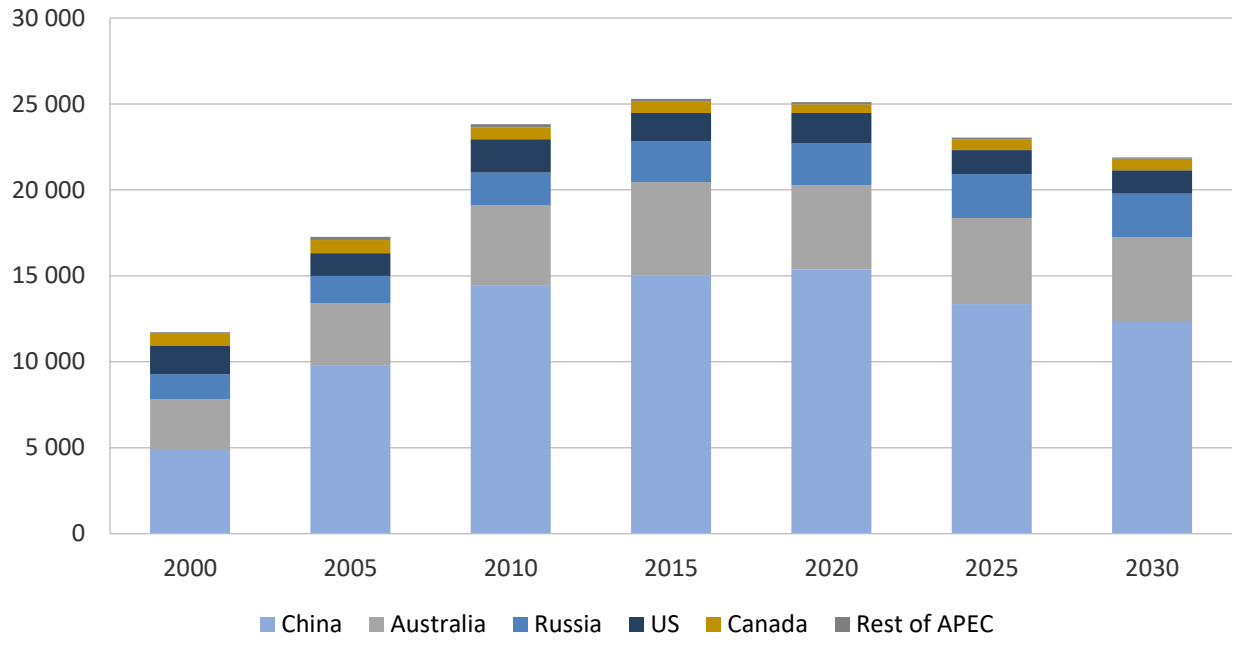
CMM is closely associated with mining activities, being released into the atmosphere both from open-pit and underground coal mines when the coal seam is fractured. In underground coal mines, CMM releases gradually when tunnels or shafts (incline or vertical shafts) contact coal seams for the first time due to the depressuring process. Methane gas is mostly emitted when the coal lumps are detached by blasting or cutting from their original coal seams. In this process, 90% of the methane gas is emitted due to enlargement of the coal matrix's internal surface. It can be diverted to the surface via a large-scale ventilation system. Residual methane gas contained in the coal matrix (around 10%) continues to be released during transportation, coal preparation, and storage processes until an equilibrium is achieved. In open-pit coal mines, methane is also emitted during the mining process and is directly released into the atmosphere. Methane from open-pit coal mines is generally not measured or recovered.

CBM is extracted from coal seams that are not being exploited for coal at the time of production. CBM is drained from coal seams prior to mining activities or in coal seams that are not expected to be mined for coal. The hydrocarbon components in CBM consists predominantly of methane gas (CH_4), although it can contain other elements such as ethane (C_2H_6), carbon dioxide (CO_2) or water (H_2O). Because the CBM production process is not influenced by mine air, methane concentration in CBM is purer than methane sourced from CMM. However, the CBM extraction rate is constrained due to the low permeability of coal seams. Various methods to enhance coal seam gas permeability are used to increase the CBM production rate. CMM differs from CBM in that CBM can be completely recovered and used without leakage into the atmosphere during the production process.

"Methane emissions from the coal mining industry accounts for around 9% of global methane emissions"

Metallurgical coal

Figure 3.8: APEC metallurgical coal production by economy: history and outlook, PJ



Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

Key points

- In the APEC region, metallurgical coal production is projected to decline from 25 EJ in 2019 to 22 EJ in 2030, led by declines in the United States (-34%), Canada (-18%) and China (-13%). Australia and Russia are projected to post a small reduction in metallurgical coal production by 2030.
- In the short-term, demand for metallurgical coal used in blast furnace steelmaking continue to rise due to strong growth in steel production. Meanwhile, the substitution of metallurgical coal with other fuels in the steelmaking industry is still constrained by technological issues. Therefore, metallurgical coal production is expected to decline in the medium and long term but at a lower pace than thermal coal.
- Almost all of China's metallurgical coal production is used by its domestic steel industry. A softening steel production outlook drives the projected decreasing trend out to 2030 over the medium to longer term. However, China is still expected to be the largest metallurgical coal producer in the APEC and the world in 2030, accounting for 56% of the total APEC metallurgical coal production.
- Metallurgical coal production in Australia is estimated to rebound strongly in 2022. However, in the medium- to long-term, both Australian and Russian metallurgical coal production is expected to post small declines.

Box 2: Coal mine methane emissions in APEC and worldwide

Methane emissions related to mining activities originate from four sources: underground coal mines (drained methane and ventilation air methane), open-pit coal mines, post-mining processes (transportation, preparation, and storage), and abandoned or closed mines.

CMM from underground coal mines has dominated mine-related emissions, accounting for two-thirds of all CMM emissions. However, only 10% is being recovered by gas drainage systems. This means that almost all CMM is emitted into the atmosphere via mine ventilation systems (EPA, 2021a). The main reason for high CMM emissions from underground coal mines is that underground mining methods often tap deep coal seams with high in-situ gas content. Underground coal mines often have higher CMM emissions than open-pit mines.

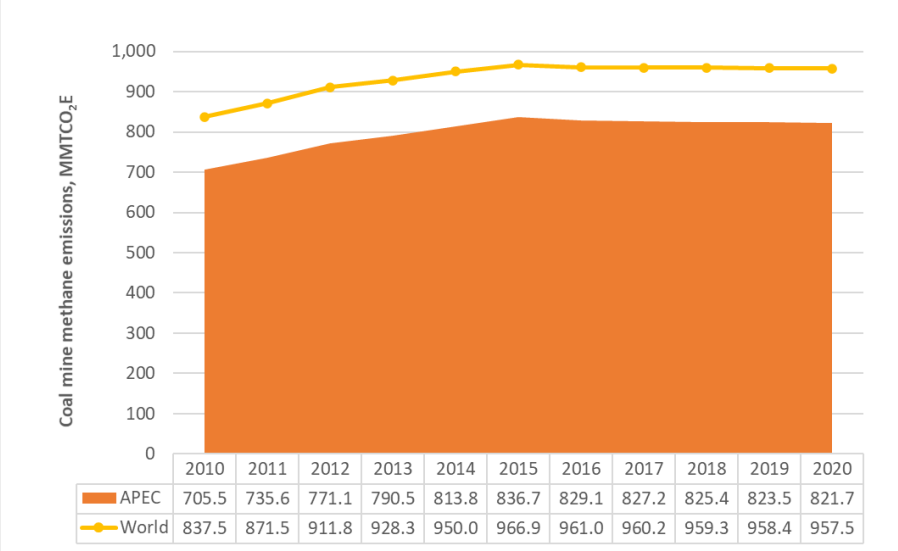
CMM from open-pit coal mines contribute 12% of total CMM emissions via direct exposure to the atmosphere. There is currently no method to recover CMM from open-pit coal mines (EPA, 2021a).

CMM emissions from post-mining operations account for 11% of total CMM emissions (EPA, 2021a). Although most of the methane is emitted during coal mining, a small amount of methane gas, called "residual gas", is continuously released into the atmosphere after mining activities (transportation, preparation, and storage). This residual gas is usually around 10% of a coal seam's gas capacity (William, 1997). However, not all residual gas will be released into the atmosphere depending on the coal particle size and desorption rate.

Abandoned or closed mines still liberate CMM after mining activities are terminated, contributing to around 12% of total CMM emissions (EPA, 2021a). The CMM leaks from the shafts, roadways, cracks, and fractures of nearby closed coal mines to the surface.

In APEC, methane emissions from the coal mining industry account for roughly 85% of global CMM. This emissions share remained stable over the period between 2010 and 2020 (Figure B.3.1). APEC economies emitted 705 million metric tons of carbon dioxide equivalent ($MMTCO_2E$) from coal mining activities (including underground and open-pit coal mines operations) in 2010. This has increased to a peak of 837 $MMTCO_2E$ in 2015, before moderating to 822 $MMTCO_2E$ in 2020.

Figure B.2.1: APEC-wide and global coal mine methane emissions, 2010-2020



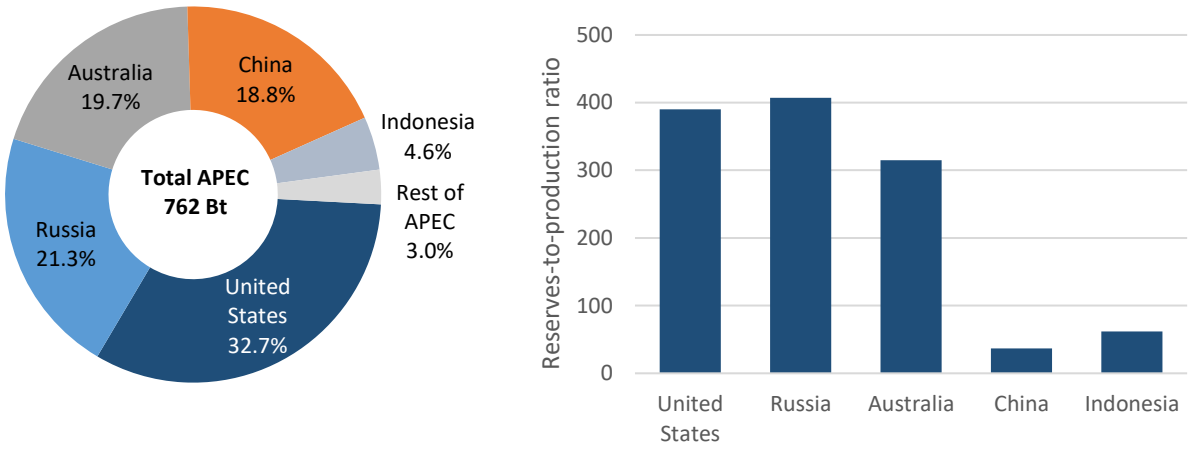
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
APEC	705.5	735.6	771.1	790.5	813.8	836.7	829.1	827.2	825.4	823.5	821.7
World	837.5	871.5	911.8	928.3	950.0	966.9	961.0	960.2	959.3	958.4	957.5

Source: compiled by the author based on Global Methane Initiative data.

The top-five CMM emitters in APEC accounted for 99% of total APEC CMM emissions in 2020. China led the CMM emissions with 660 $MMTCO_2E$, followed by the United States and Russia, each with 59 $MMTCO_2E$. Australia released 24 $MMTCO_2E$, while Mexico emitted 10.0 $MMTCO_2E$ in that same year.

APEC coal reserves

Figure 3.9: APEC coal reserves and R/P ratio of the top five APEC coal producers[5], 2020



Source: compiled by the author based on BP (2021) and U.S. EIA (2021).

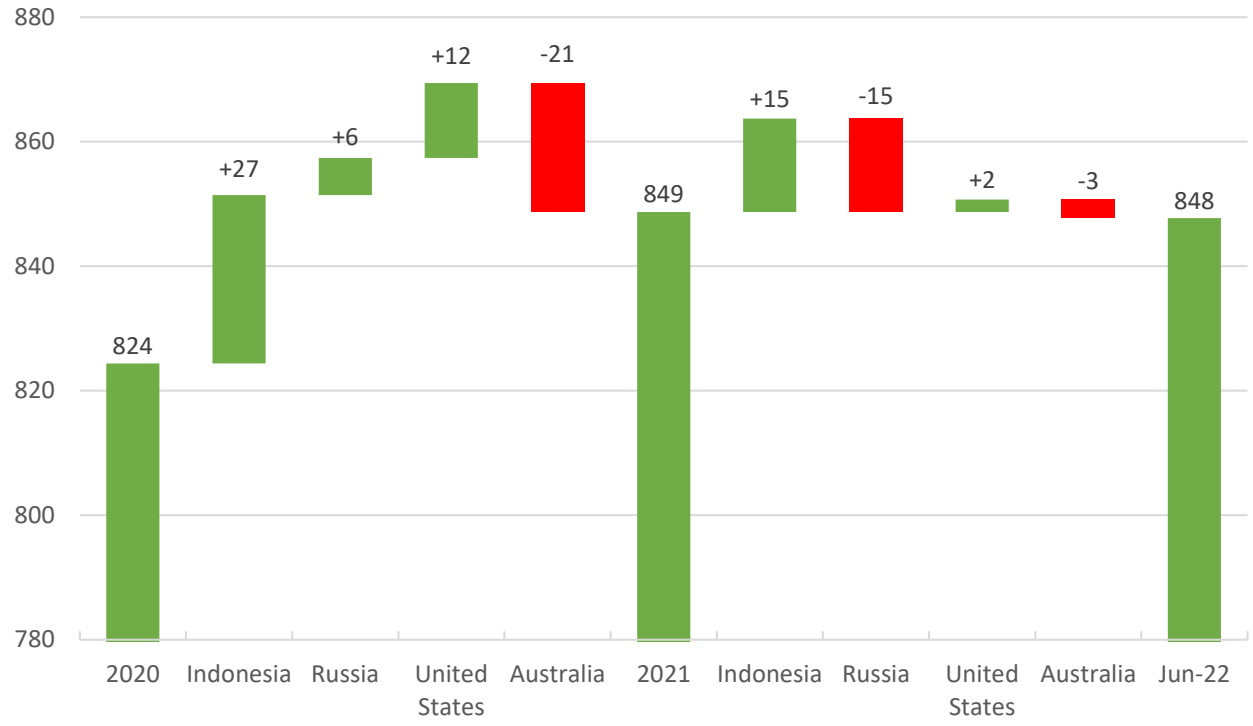
Key points

- APEC economies accounted for 71% of global coal reserves in 2020 (BP, 2021), with 762 billion tonnes (Bt). The United States, Russia, Australia, China, and Indonesia hold over three-quarters of proven coal reserves, which is 97% of APEC-wide reserves.
- The vast coal reserves is located in the United States (249 Bt, 32.7%), distributed among three main regions, namely, the Appalachian, the Interior, and the Western regions.
- Russia ranked second in proven coal reserves behind the United States (162 Bt, 21.3%). Its major coal reserves include the Donetskii coal fields in Moscow, the Pechora basins in Western Russia, and the Kuznetski, Kansk-Achinsk, Irkutsk, and South Yakutsk basins in Eastern Russia.
- Australia holds the third rank on a global and APEC basis (150 Bt, 19.7%). Australia holds black coal (including anthracite, bituminous and sub-bituminous) and brown coal (lignite). Black coal reserves are in New South Wales, Queensland, South Australia, Tasmania and Western Australia, while brown coal is found in South Australia, Western Australia, Tasmania, Queensland and Victoria (Geoscience Australia).
- China's 143.2 Bt of proven coal reserves accounted for over 18.8% of total APEC coal reserves. Deposits of anthracite, bituminous, sub-bituminous and lignite are mainly located in the north and north-west regions.
- Indonesia holds approximately 35 Bt, accounting for 4.6% of APEC's total proven coal reserves, with deposits mostly located in South Sumatra, East Kalimantan, and South Kalimantan.
- The United States, Russia, and Australia have reserves that are multiple hundreds of years of current production. China's very high current production levels, combined with lower reserves, mean the R/P is significantly lower.

[5] The reserves-to-production (R/P) ratio is a method used to provide context for the size of coal reserves. The value represents the number of years that current reserves would last if the production remained constant.

Chapter 4: Coal trade

Figure 4.1: Change in thermal coal exports at major APEC coal exporters, 2020-2022, Mt

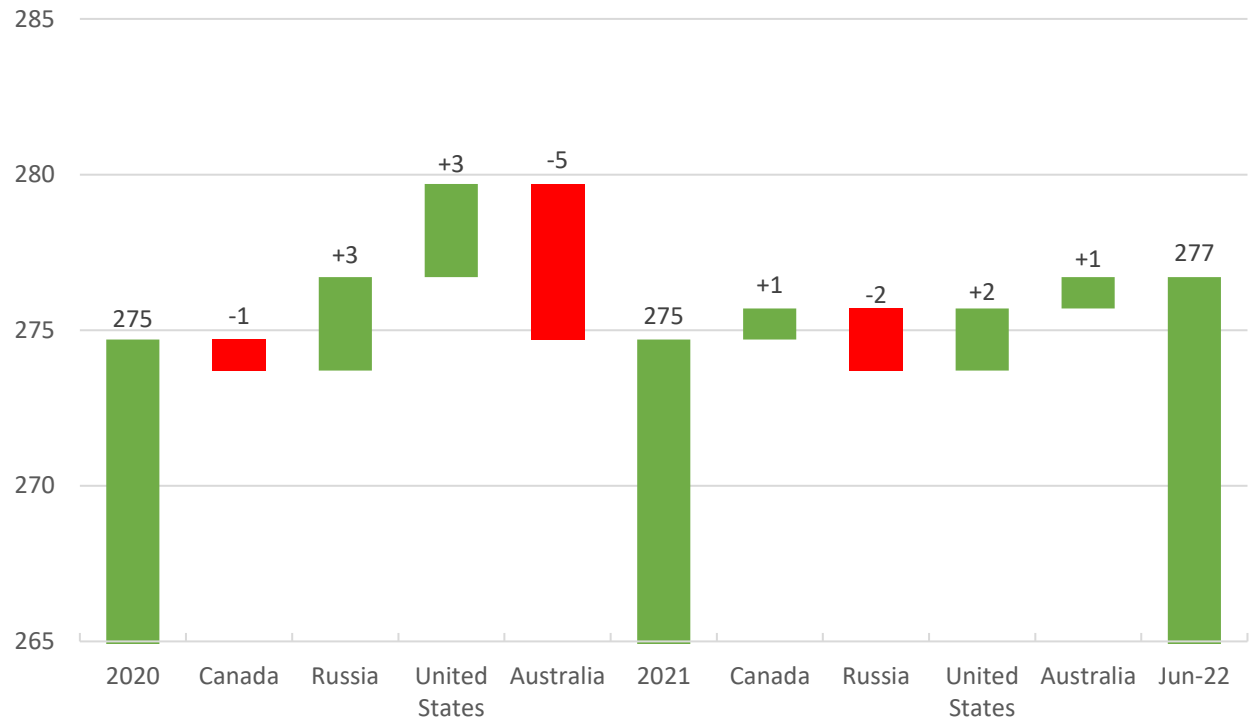


Source: compiled by the author based on IEA (2022a) and IEA (2022b).

Key points

- A rapid economic recovery led to a surge in coal demand worldwide in 2021. While many countries had to be met by higher imports, others increased domestic coal production. Indonesia, Australia, Russia, and the United States have been major thermal coal exporters in the APEC region, accounting for approximately 98% of thermal coal exports.
- In 2021, Indonesia increased its thermal coal exports by 27 Mt to 434 Mt, exporting more than twice as much as Australia (199 Mt). The United States increased coal exports by 12 Mt to 36 Mt. Russia's thermal coal exports rose by 6 Mt, while Australia's coal exports dropped by 21 Mt in 2021.
- Trading flows had already shifted since 2020, when China banned Australia's coal imports, but it substantially changed after February 2022 due to the Ukraine conflict. Russia showed the biggest drop in coal exports in the first half of 2022 (-15 Mt) due to international sanctions and coal import bans from Western countries. Australia's coal exports declined by 3 Mt in the first six months of 2022 because of the floods in New South Wales and Queensland, which led to a declaration of force majeure at the Port Kembla Coal Terminal (Australian Government, 2022).
- In the first six months of 2022, Indonesia to increase exports by 15 Mt and the United States to boost its coal exports by 2 Mt. However, the coal market seems to remain extremely tight due to high coal demand in Europe.

Figure 4.2: Change in metallurgical coal exports at four major APEC coal exporters, 2020-2022, Mt

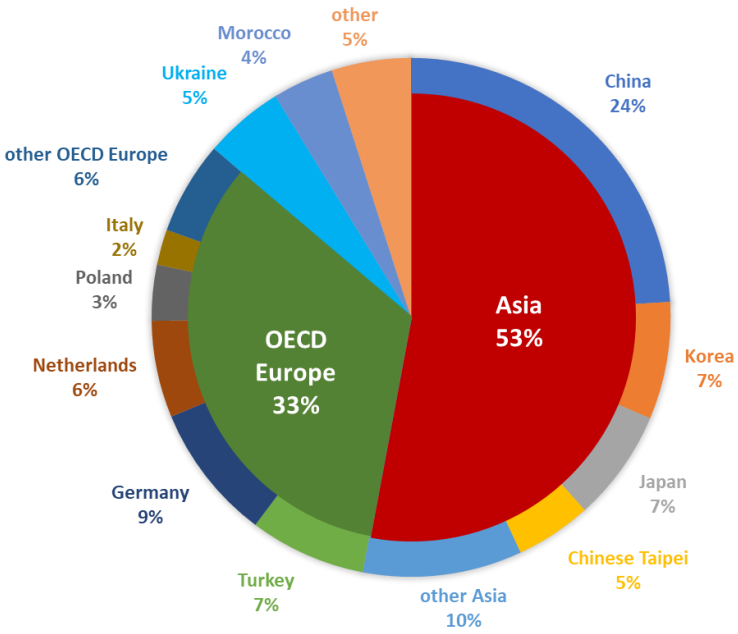


Source: compiled by the author based on IEA (2022a) and IEA (2022b).

Key points

- In 2021, the lower metallurgical coal production in some Australian coal mines (-5 Mt) and Canada (-1 Mt) was mostly offset by higher exports from Russia (+3 Mt) and the United States (+3 Mt).
- Australia's metallurgical coal exports dropped dramatically in 2021 due to an unofficial Chinese ban on Australian coal. Although Australia shifted to other economies, this volume did not offset the export volume loss from China's market (IEA, 2022).
- Canada metallurgical coal exports dropped by 1 Mt in 2021 due to lower metallurgical coal production. However, it slightly increased in 2022, driven by the reopening of a 2 Mt metallurgical coal mine in Western Alberta, which was closed in response to the COVID-19 pandemic (IEA, 2022).
- In the first half of 2022, high gas prices are expected to continue to push up demand for metallurgical coal imports, particularly in Japan, Korea and Chinese Taipei. Therefore, the increase in metallurgical coal exports was seen in Canada (+1 Mt), the United States (+2 Mt) and Australia (+1 Mt).
- After the Russian-Ukraine conflict started in February 2022, Western countries refused to buy Russian coal, causing metallurgical coal exports to fall by 2 Mt in the first half of 2022 and might become more serious after European sanctions take their full effect.
- Although Russia has shifted the metallurgical coal trading flow to China, India and other Southeast countries, the metallurgical coal export volume would not offset the loss of markets in European, Japan and Korean.

Figure 4.3: Russia's coal exports by destination, 2021



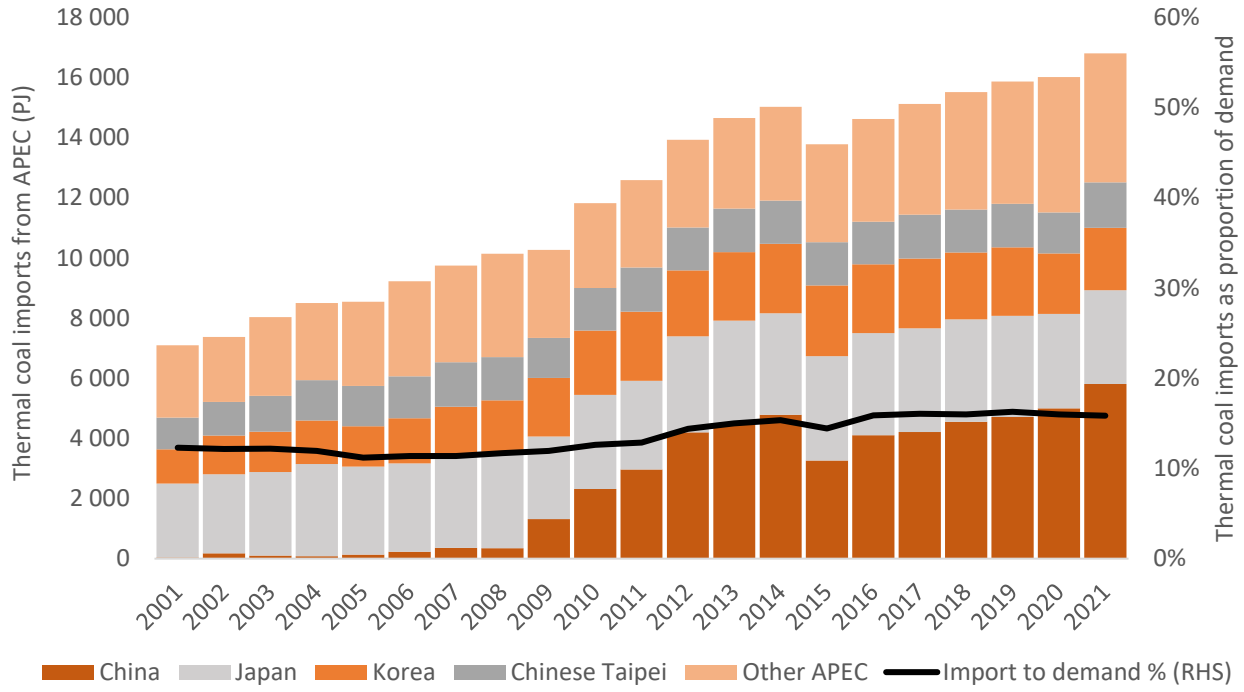
Source: compiled by the author based on EIA (2021), Hellenic Shipping News Worldwide, and CoalAge.

Key points

- In 2021, Russia exported 235 Mt of coal, 7% higher than the 2020 level. Around 90% of the coal exported was thermal coal. Most Russian coal customers were from Asia, accounting for 53% of the total Russian coal export. OECD Europe accounted for a third of Russian coal export.
- Nevertheless, since the Russia-Ukraine conflict in February of this year, the Russian coal export flow has changed dramatically to avoid international sanctions and coal import bans. The United States banned Russian coal imports on March 9, 2022. The European countries and the United Kingdom reduced Russia's coal imports and will entirely ban them in August and the end of this year. Japan and Korea plan to reduce their Russian coal imports gradually. Therefore, Russia has to search for new customers to offset the drop in coal export.
- In 2022, Russian coal export to OECD Europe declined dramatically due to sanctions. While almost OECD Europe countries stopped or reduced their purchasing of Russian coal, Turkey remained the coal import from Russia. Russian coal exports to China, India and Southeast Asian countries have risen enormously.

APEC thermal coal trade

Figure 4.4: Thermal coal imports and proportion of thermal coal imports to thermal coal consumption, APEC economies, 2001-2021

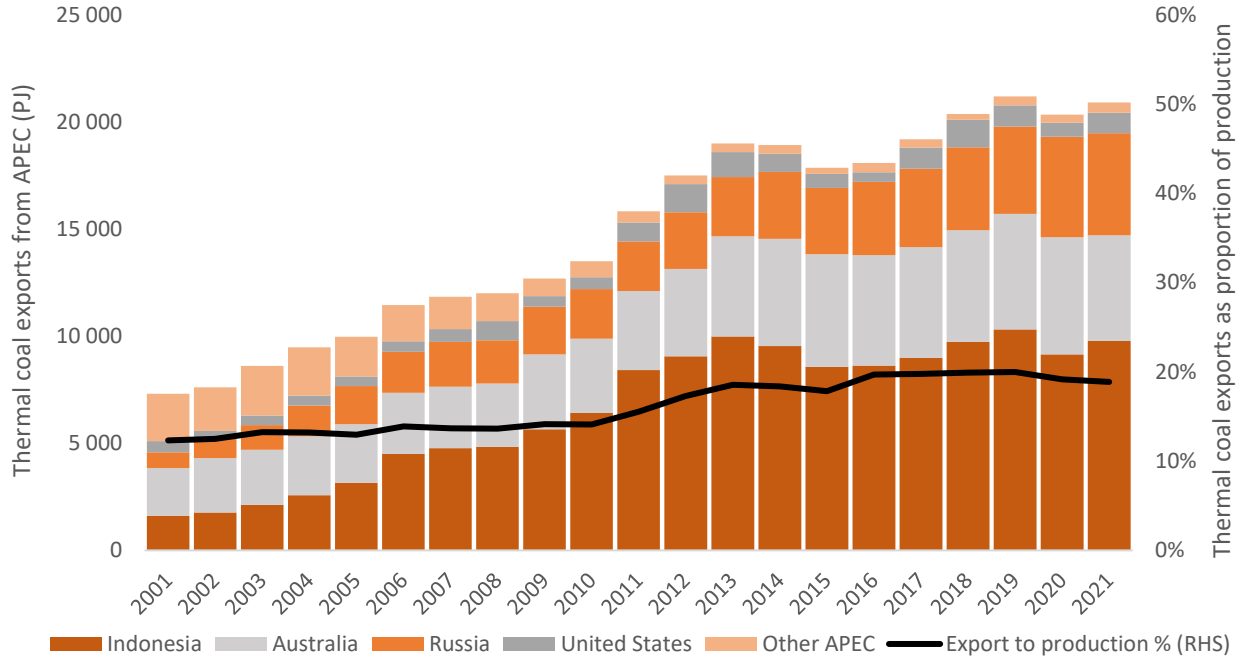


Source: compiled by the author based on IEA (2022).

Key points

- APEC economies have increased imported quantities of thermal coal since 2015, even though imported volume barely increased in 2020 due to the impacts of the pandemic. However, 2021's thermal coal imports rebounded after COVID-19 measures were lifted partly.
- China has significantly ramped up its thermal coal imports since 2009 when it could no longer satisfy its domestic production demand. Japan, Korea, and Chinese Taipei have consistently imported thermal coal for over two decades.
- APEC thermal coal imports as a proportion of APEC thermal coal consumption reached 16% in 2021, steadily increasing from 12% in 2001. This shows that APEC thermal coal-consuming economies have increasingly relied on overseas sources to meet their demand.

Figure 4.5: Thermal coal exports and proportion of thermal coal exports to thermal coal production, APEC economies, 2001-2021



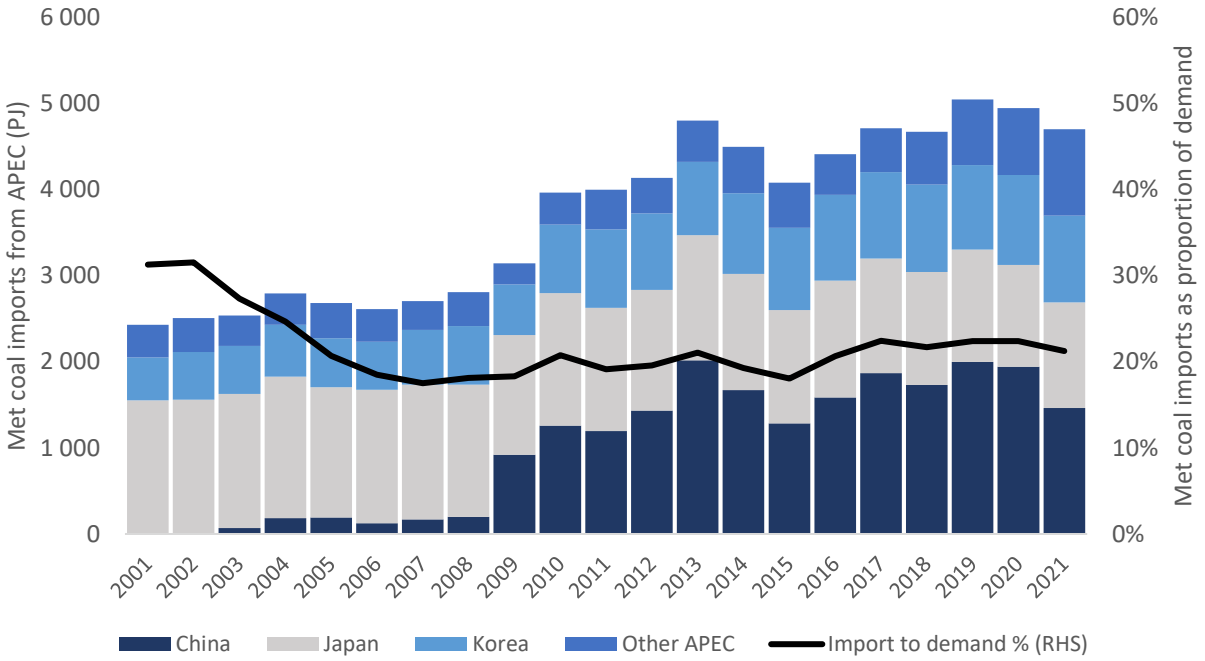
Source: compiled by the author based on IEA (2022).

Key points

- APEC thermal coal imports were 16.7 EJ in 2021, which is significantly lower than the 20.9 EJ of thermal coal exports from APEC thermal coal producers. Indonesia has ramped its thermal coal exports significantly over the last two decades, accounting for 47% of APEC thermal coal exports in 2021. Australia is the next most prominent thermal coal exporter, accounting for approximately 24% of APEC thermal coal exports in the same year.
- These exports were predominantly headed to other APEC economies, though significant volumes were also destined for non-APEC economies, such as India. Notably, China imposed import bans on Australian thermal coal at the end of 2020, and so the proportion of thermal coal that would typically be headed to China, moved instead to alternative markets. China relied on alternative thermal coal producers to meet its supply requirements. This presents challenges in situations where supply is constrained, such as the case in the latter half of 2021, exacerbated by rapidly increasing demand. China has allowed multiple Australian thermal coal shipments to clear customs in September 2021(FT, 2021).
- APEC thermal coal exports as a proportion of APEC thermal coal production maintained a level of 19% in 2021. This has increased from 12% in 2001, though it shows that most APEC thermal coal production is consumed domestically (81%). This APEC-wide statistic is mostly driven by China's pattern of overwhelming domestic consumption.

APEC metallurgical coal trade

Figure 4.6: Metallurgical coal imports and proportion of metallurgical coal imports to metallurgical coal demand, APEC economies, 2000–2019

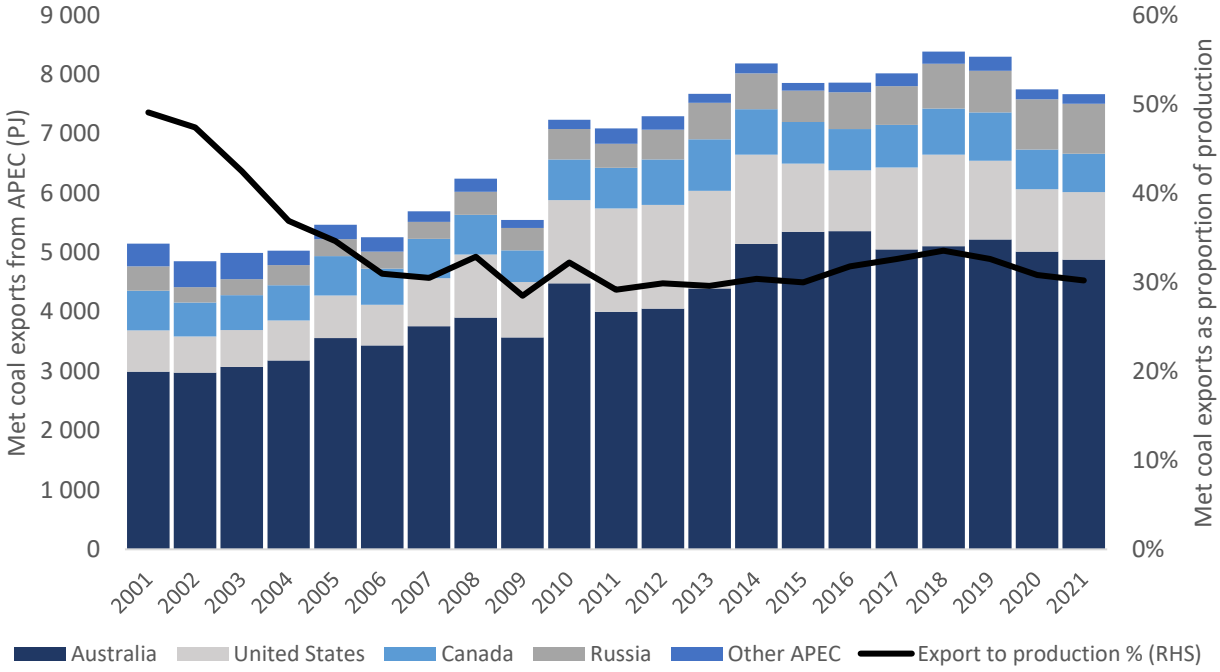


Source: compiled by the author based on IEA (2022).

Key points

- The metallurgical coal trade is significantly lower than the thermal coal trade on an energy content or weight basis. Historically, the market for thermal coal has been at least three to four times larger. Consistently higher prices for metallurgical coal mean that traded quantities more than suggest the value of metallurgical coal exports. Metallurgical coal imports peaked at 5.0 EJ in 2019 and declined to around 4.7 EJ in 2021.
- China is the largest metallurgical coal importer, having had to significantly ramp up its metallurgical coal imports in 2009, given that its domestic resources were insufficient to meet the needs of its rapidly growing steel industry. However, a big drop in metallurgical coal import was seen in 2021 due to the banning coal import from Australia and limited supply from Mongolia as surging COVID-19 cases in Mongolia (China Macro Economy; Argus, 2022)
- Japan is still a major metallurgical coal importer, accounting for a quarter of APEC metallurgical coal imports. However, the volume of metallurgical coal imported by Japan has declined from a two-decade peak of 1.6 EJ in 2004 to 1.2 EJ in 2021 (Japan's metallurgical coal consumption was even larger before 2000).
- Korea is the other major APEC metallurgical coal importer, with 1.0 EJ imported in 2021. APEC metallurgical coal imports as a proportion of APEC metallurgical coal consumption have fluctuated near 20% for over a decade, having fallen from 32% at the beginning of the millennium.

Figure 4.7: Metallurgical coal exports and proportion of metallurgical coal exports to metallurgical coal production, APEC economies, 2000–2019



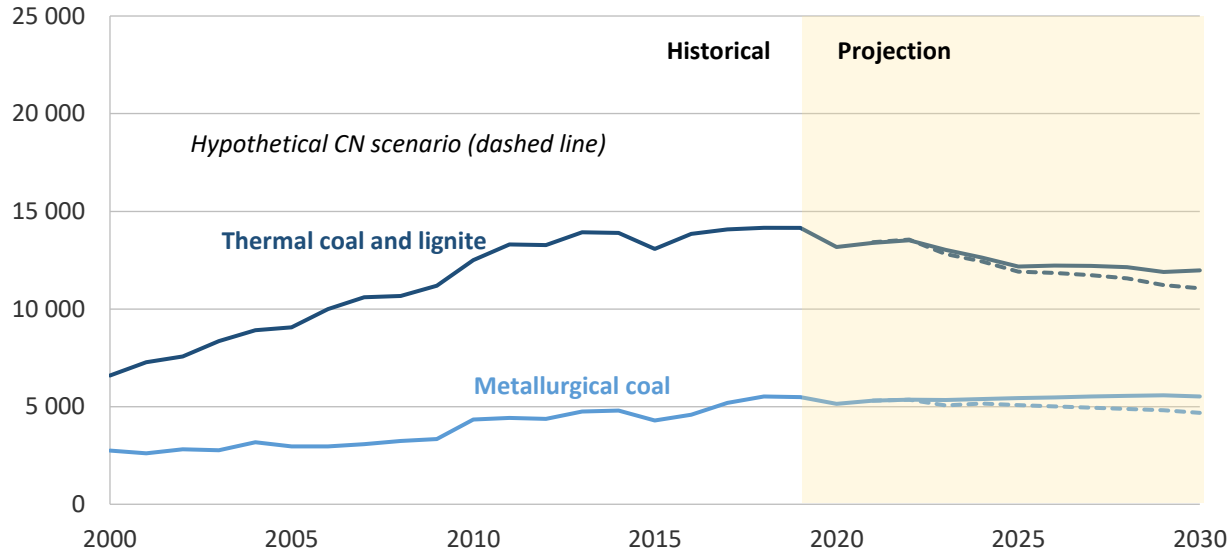
Source: compiled by the author based on IEA (2022).

Key points

- APEC metallurgical coal exports moderated to 7.6 EJ in 2021, down from 8.3 EJ in 2019. Australia is by far the largest metallurgical coal exporter. The United States, Russia and Canada are the next most prominent metallurgical coal exporters, accounting for 15%, 11%, and 8.5% of APEC metallurgical coal exports in 2021, respectively.
- In 2021, Australia exported 4.8 EJ of metallurgical coal, accounting for approximately 64% of APEC metallurgical coal exports. Even with smaller export volumes, metallurgical coal export earnings were approximately AUD 24 million in 2021 compared with AUD 16.5 million in thermal coal export earnings (Australian Government, 2022).
- APEC metallurgical coal producers exported 30% of their production in 2021. This portion is down from a high of almost 50% of production is destined for export near the beginning of the millennium.

APEC coal trade projections

Figure 4.8: APEC coal imports: history and outlook, PJ

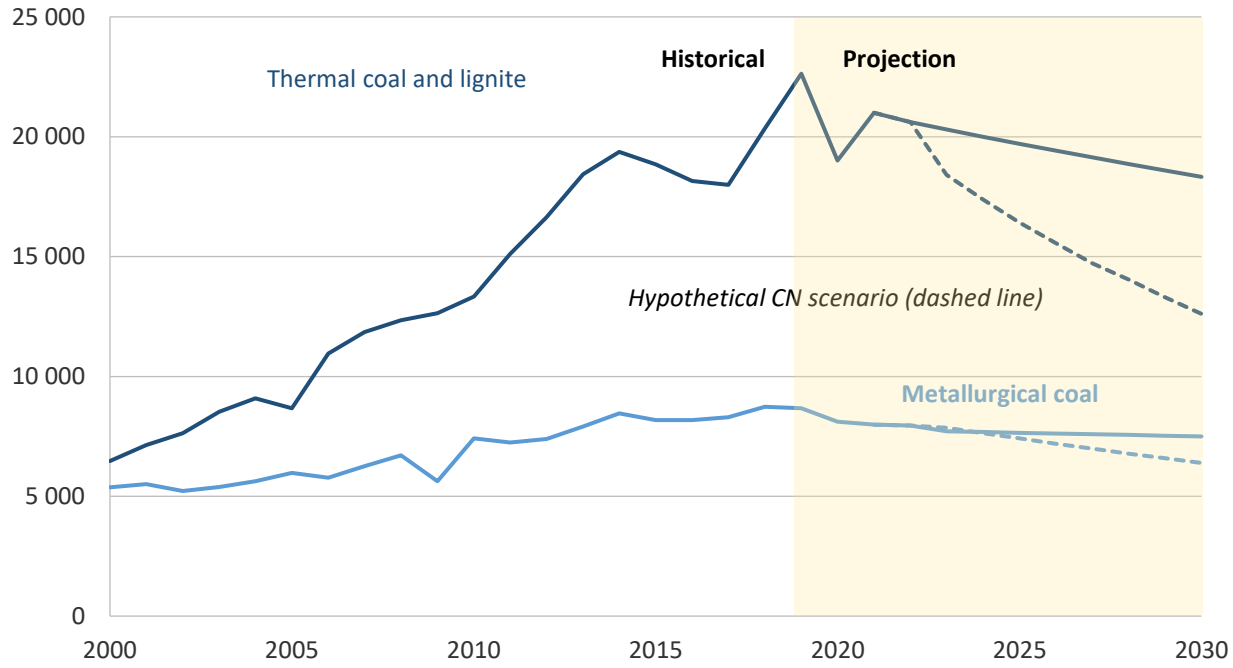


Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

Key points

- Coal import and export volumes were expected to rebound to pre-pandemic levels in 2021. However, the current large coal price spikes brought on by surging economic growth and supply disruptions mean that the magnitude of the rebound is uncertain.
- Moving beyond the short-term volatility brought on by the pandemic, the APEC Energy Demand and Supply Outlook 8th Edition 2022 estimates that thermal coal imports will decline slowly while metallurgical coal imports will increase slowly out to 2030. Assumed robust steel production explains metallurgical coal's resilience. The decline in thermal coal imports aligns with the planned move away from thermal coal power generation in many APEC economies.
- In a hypothetical CN scenario, APEC thermal coal imports will fall away more rapidly. APEC metallurgical coal imports will also fall due to greater material efficiency (less demand for steel) and improved scrap utilisation (recycling). While thermal coal consumption will fall, there is support from southeast Asia APEC economies, such as Thailand, Viet Nam and Malaysia, that will continue to rely on thermal coal imports to meet the supply for newly constructed coal-fired power plants.
- Regulations and policies related to coal mining activities are also likely to support coal imports. In some APEC economies, carbon taxes, environmental protection legislation, and post-mining flora rehabilitation significantly increase the cost of domestic coal production. For these economies, imported thermal coal may be the most cost-competitive supply source, even when domestic reserves are significant.

Figure 4.9: APEC coal exports: history and outlook, PJ



Source: compiled by the author based on EGEDA (2021) and APEC Outlook 8th (2022).

Key points

- APEC coal exports are significantly larger than APEC coal imports. Figure 4.9 shows that there will be a similar slow decline in APEC thermal coal exports in the REF scenario, as APEC thermal coal producers begin to slow their production due to declining global demand. APEC metallurgical coal exports will maintain a more robust level to meet supply requirements for large steel-producing economies.
- In the hypothetical CN scenario, thermal coal exports are expected to fall dramatically out to 2030. The assumed rapid movement away from coal-fired power in this scenario means that there is less demand for overseas supply. Metallurgical coal exports decline marginally due to material efficiency and use of a higher proportion of scrap in steel production mentioned above.

Chapter 5: Prices and costs

Figure 5.1: Newcastle benchmark thermal coal spot prices, January 2018 to January 2023

Source: compiled by the author based on Trading Economics.

Key points

- Following the initial COVID shock in early 2020, subsequent soft demand meant that prices dipped below USD 50 per tonne.
- In 2021, the COVID pandemic led to a significant increase in global demand for goods, partly driven by the absence of consumer access to services, such as travel and hospitality. China's immense industrial sector has responded by increasing production through most of 2021, which has led to an accompanying very large increase in thermal coal demand to power the industrial output. Therefore, thermal coal prices started to rise and reached a peak in October.
- In 2022, the impacts of sanctions against Russia due to the war drove thermal coal prices to surge at another record high of USD 420 per tonne on 9 March 2022, just two weeks after Russia kicked off the war. With the measures to stabilise the global energy markets from developed countries, thermal coal spot prices softened briefly in April. However, Newcastle benchmark thermal coal spot prices surged again to the next record high of about USD 425 per tonne in May due to coal transportation disruption in Australia.
- In September 2022, an all-time record high of thermal coal spot prices occurred, reaching USD 450 per tonne, a nine-time higher than the prices in September 2020. Strong thermal coal demand from APEC Northeast Asia economies such as Japan, Korea and Chinese Taipei made the price surge. In addition, extreme weather in Australia in 2022 hindered the coal transportation route from coal mines to seaborne port, causing a decline in coal export volume.

Figure 5.2: Australian premium hard coking coal spot price, January 2018 to January 2023

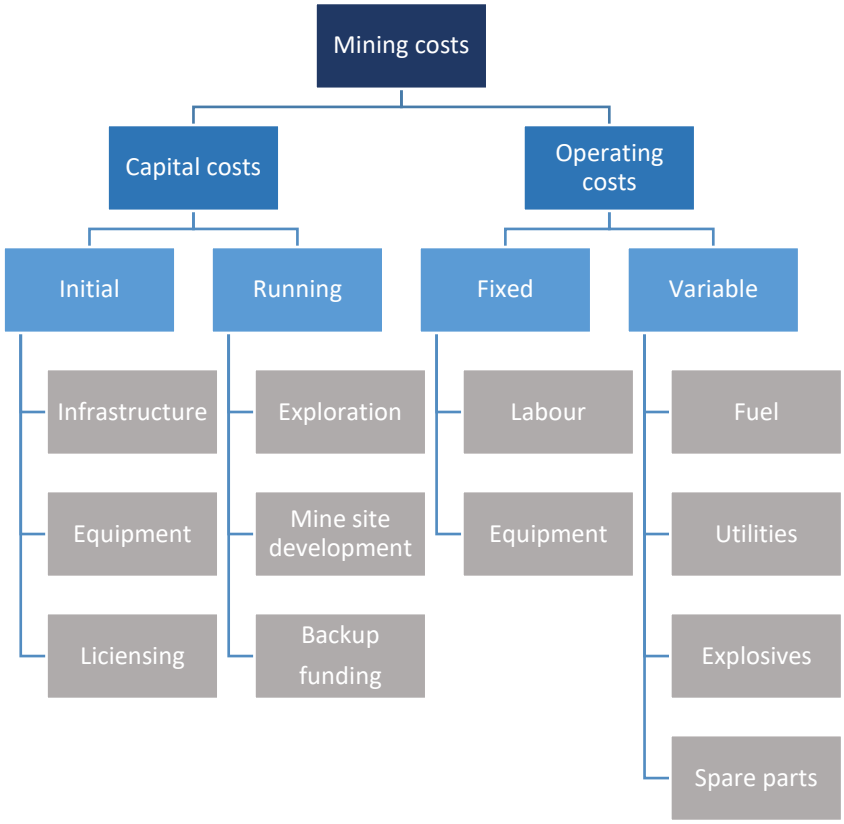
Source: compiled by the author based on Barchart.

Key points

- Australian premium hard coking coal spot price has declined gradually since early 2018 to close to USD 100 per tonne at the end of 2020.
- By the beginning of July 2021, metallurgical coal spot prices had increased to over USD 200 per tonne. Part of this increase was due to strong European and Chinese demand, and part was from diminished supply. Prominent sources such as Australian premium-hard Peak Downs and Goonyella have been in short supply, which has led to rapidly rising prices in the face of continued strong demand (S&P Global, 2021).
- With the energy crisis coming to a head in China in September 2021, the Government compelled multiple steel producers to limit production temporarily. This had the dual impact of meeting the challenge of the energy crisis at the expense of economic growth, and reducing emissions and pollution, to meet environment commitments by the Government. The fall in steel production has yet to translate to lower metallurgical spot prices, which spiked at around USD 400 per tonne at the beginning of October 2021.
- In early 2022, the Australian coking coal spot prices climbed up again, even before the Russian-Ukraine war. With the impact of the war and volatile energy prices, coking coal prices surged to an unprecedented level of about USD 630 per tonne on 21 March 2022. Coking coal prices then eased somewhat and remained at around USD 500 per tonne until the end of May.
- In June 2022, coking coal prices dropped again due to the weak demand from China's steelmaking industry. As a result, the Australian coking coal spot prices declined to USD 200 per tonne in August 2022.
- In the last quarter of 2022, coking coal spot prices rebound at a small extent to around USD 300 per tonne, partly due to a met-to-thermal coal switch and high demand at the end of the year.

Coal supply costs

Figure 5.3: Mining cost structure

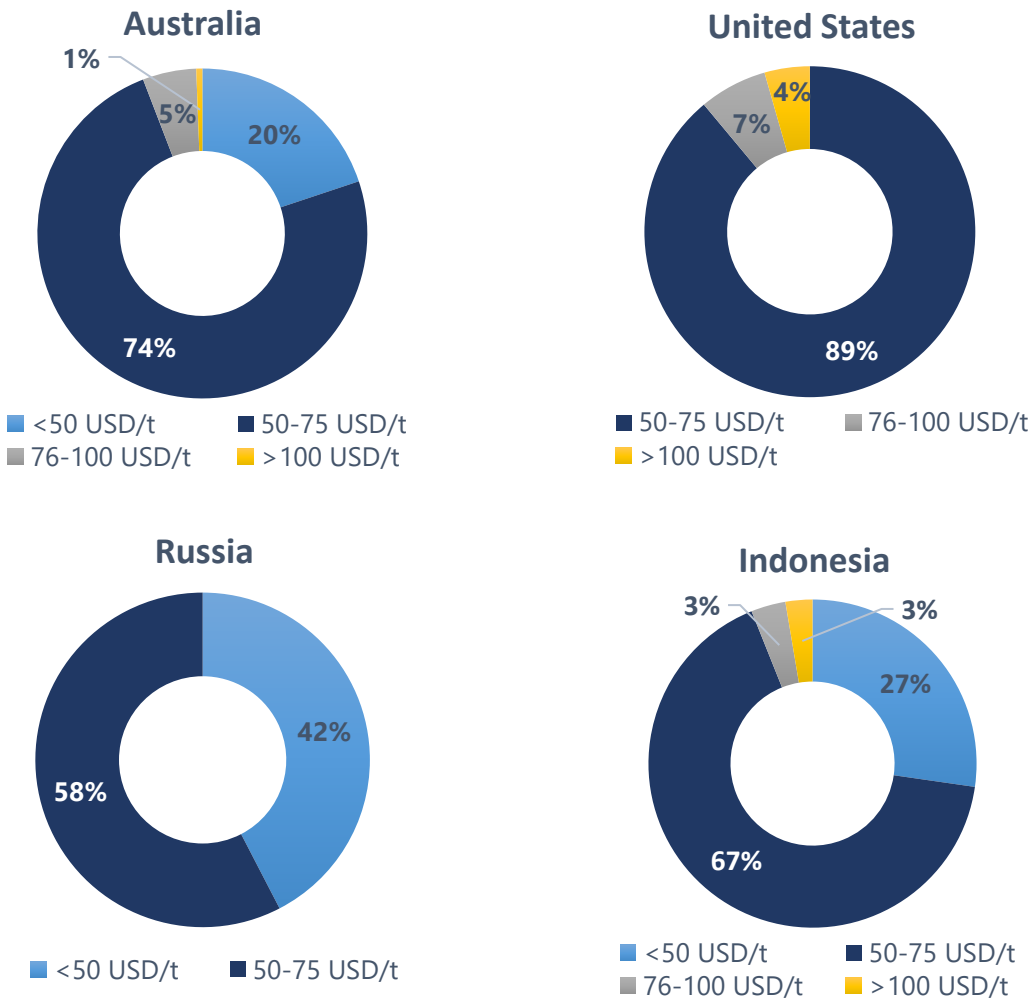


Key points

- The cost of producing coal comprises two components: capital costs and operating costs. Capital costs can be further subdivided into initial costs and running costs. Initial costs relate to the purchase of mining-related equipment, construction, environmental compliance, and licensing rights. In contrast, running costs involve mine site development, exploration, and backup funding.
- Operating costs include fixed costs, such as labour and equipment, and variable costs, such as fuel, utilities, explosives, and spare parts. These are the day-to-day running expenses for a coal mine.
- Individual cost categories vary depending on mining methods, technology, labour expenses, and input commodities prices.

Thermal coal

Figure 5.4: The share of high CV coal production by supply cost, 2019



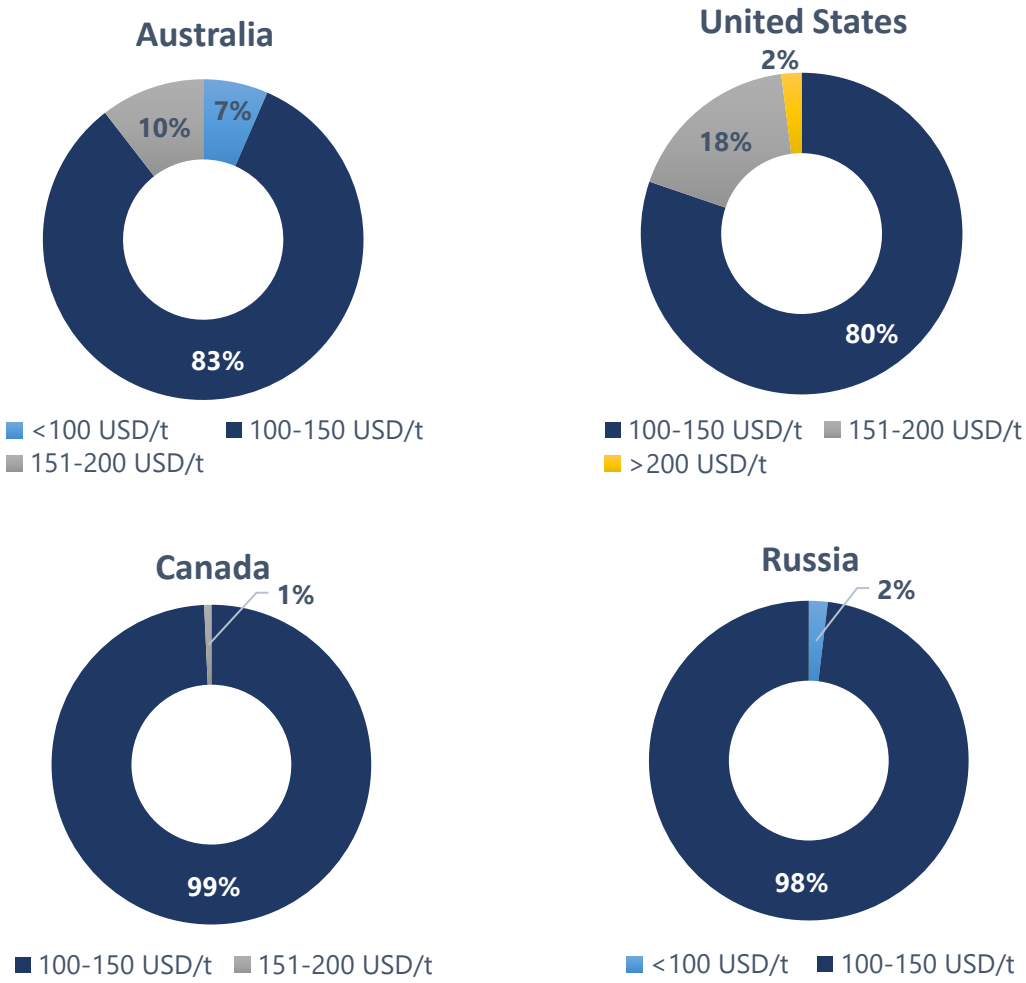
Source: compiled by the author based on IEA (2020b).

Key points

- Production costs for high CV thermal coal in 2019 ranged from USD 35.5 to USD 150 per tonne, depending on the economy. Over half (58%) of Russia's high CV thermal coal production was produced at a cost between USD 50 and USD 70 per tonne, with the remainder (42%) costing less than USD 50 per tonne.
- Australia had a wider range of potential costs, though most (94%) high CV thermal coal production was produced for USD 75 per tonne or less. Indonesia could also produce 94% of its high CV thermal coal for USD 75 or less. Unlike Australia, Russia, and Indonesia, the US is unable to produce any of its high CV thermal coal for less than USD 50 per tonne. The US also had the highest proportion of mines with costs greater than USD 75 per tonne (11%).

Metallurgical coal

Figure 5.5: Supply costs in main APEC metallurgical coal producers, 2019



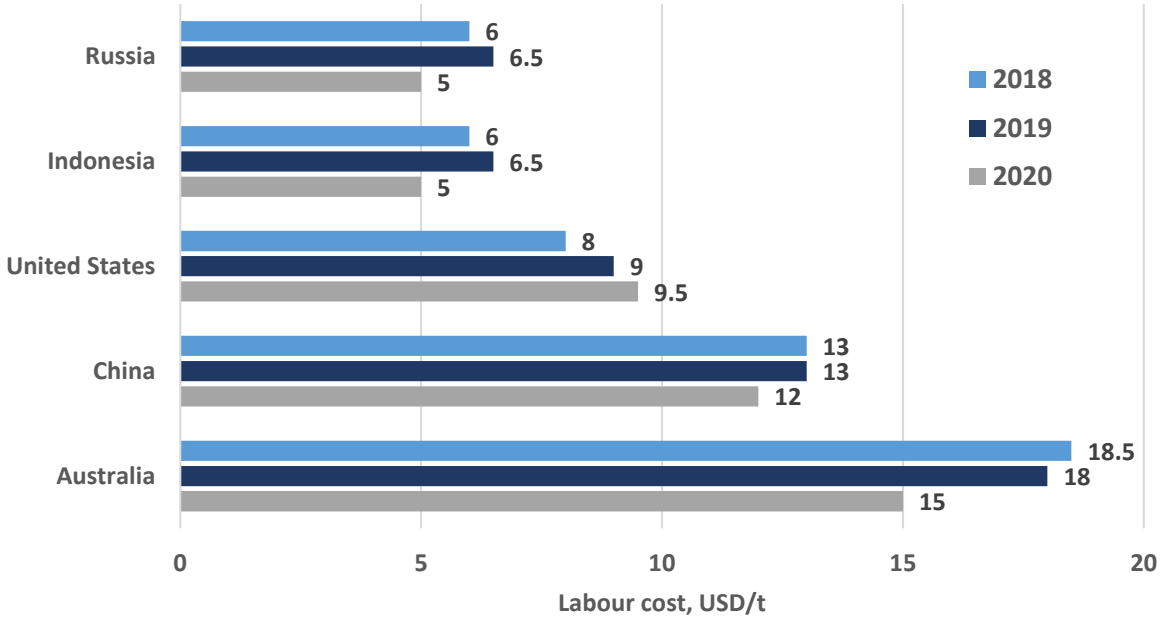
Source: compiled by the author based on IEA (2020b).

Key points

- Metallurgical coal production costs ranged from USD 87 to USD 250 per tonne, free on board (FOB), in 2019. Labour, fuels, materials, taxes, royalties, inland transportation, and maintenance are all influential in the cost structure. The mining method (such as underground mining or opencast mining), location, and geological conditions, are also important cost determinants.
- The above charts show the metallurgical coal production costs for Australia, the US, Canada, and Russia (IEA, 2020b). Mining costs largely fall into the USD 100 to USD 150 per tonne range. The US has the lowest proportion of suppliers able to produce coal at these costs (80%), followed by Australia (83%), Russia (98%) and Canada (99%). The fact that most production costs fall in a similar band reflects that the market for metallurgical coal is relatively competitive. If costs were significantly higher for certain producers, those higher-cost producers would eventually exit the market, leaving only those producers that can produce at a competitive cost. This analysis only looks at currently viable producers.

Input factors influence supply costs

Figure 5.6: Average labour cost in main coal-producing economies in APEC region, 2018-2020



Source: compiled by the author based on IEA (2020b).

Key points

- Many inputs costs such as fuel costs, steel, explosives, and rubber products, are common for all mining and industrial enterprises. According to IEA data, explosives and tyre prices plateaued between 2018 and 2020, whereas steel products and diesel fuel costs were more volatile. Diesel costs are particularly influential, especially at opencast mines, due to the large amounts of fuel required to haul coal and overburden. Low diesel prices at the beginning of 2020 were a moderating cost factor in the face of low spot prices and lower output brought on by the pandemic (IEA, 2020b).
- Average labour costs vary from USD 5 to USD 18.5 per tonne in Australia, China, the United States, Indonesia, and Russia. Labour costs were relatively stable in 2018 and 2019, though reduced substantially in all APEC economies in 2020, except for the United States.
- Australia had the highest average labour cost in APEC in 2018 and 2019, with this falling by 17% in 2020 to USD 15 per tonne. China's labour costs were the second-highest in 2020, falling to USD 12 per tonne. Russia and Indonesia had identical labour costs and were the cheapest of the main APEC coal producers: USD 5 per tonne in 2020. The United States has seen a continuation in rising labour costs in 2020 to USD 9.5 per tonne.
- Australia had the highest labour cost proportion, accounting for 31% of total mining costs in 2019. Indonesia had the lowest labour cost-share, at 20% of total mining costs. While costs are influential in determining competitiveness, factors such as reliability of supply and production quality can justify a higher cost structure.

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Appendices

Table A.1: Selected APEC financial and investment institutions committed to reduce or end involvement in coal supply and coal-fired power plants.

Economy	Institutions
Australia	QBE Insurance Group.
China	State Development & Investment Corporation.
Japan	Marubeni, Mitsui, Itochu, Sojitz, Mitsubishi UFJ (MUFG), Sumitomo Mitsui Financial Group (SMFG), Japan Bank for International Cooperation (JBIC).
Korea	Teachers Pension System, Government Employees Pension System, Export-Import Bank of Korea.
Singapore	Oversea Chinese Banking Corp, United Overseas Bank.
Unites States	Chubb Ltd.

Source: compiled by the author based on IEA (2019) and Boom and Bust (2021).

Table A.2: Selected financing economies for coal-fired power plants in the APEC region

Economy	Institutions
China	Industrial and Commercial Bank of China (ICBC), China Development Bank, Export Import Bank of China (Chexim), Bank of China (BOC), China Construction Bank (CCB), Power China, China Export & Credit Insurance Corporation (Sinosure), Agricultural Bank of China (ABC), SPIC, China Silk Road Fund, CEIC, Energy China, Bank of Communications, Shanghai Electric, China Three Gorges, Sino Mach.
Japan	Marubeni, Mitsui, Itochu, Sojitz, Mitsubishi UFJ (MUFG), Sumitomo Mitsui Financial Group (SMFG), Japan Bank for International Cooperation (JBIC), Nippon Export and Investment Insurance (NEXI), Japan International Cooperation Agency (JICA).
Korea	Export-Import Bank of Korea (Kexim), Korea Trade Insurance Corporation (K-Sure), KEPCO, Korea Development Bank.
Rusia	Russian Development Bank (VEB)

Source: compiled by the author based on Global Energy Monitor.

Table A.3: Selected recipient economies for coal-fired power plants in the APEC region

Economy	Institutions
Indonesia	Japan Bank for International Cooperation (JBIC), Export Import Bank of China (Chexim), China Development Bank, Nippon Export and Investment Insurance (NEXI), CEIC, Energy China, Bank of China (BOC), Industrial and Commercial Bank of China (ICBC), Export-Import Bank of Korea (Kexim), Japan International Cooperation Agency (JICA), China Construction Bank (CCB), Korea Trade Insurance Corporation (K-Sure), Korea Development Bank, SPIC.
Viet Nam	Japan Bank for International Cooperation (JBIC), Export Import Bank of China (Chexim), China Development Bank, Nippon Export and Investment Insurance (NEXI), Bank of China (BOC), Industrial and Commercial Bank of China (ICBC), Export-Import Bank of Korea (Kexim), Japan International Cooperation Agency (JICA), China Construction Bank (CCB), Korea Trade Insurance Corporation (K-Sure), China Export & Credit Insurance Corporation (Sinosure), KEPCO.
Australia	Industrial and Commercial Bank of China (ICBC), Agricultural Bank of China (ABC), Bank of China (BOC), Bank of Communications.
Philippines	Power China, Shanghai Electric, Bank of China (BOC)
Chile	Japan Bank for International Cooperation (JBIC), Nippon Export and Investment Insurance (NEXI), Export-Import Bank of Korea (Kexim).
United States	Industrial and Commercial Bank of China (ICBC)

Source: compiled by the author based on Global Energy Monitor.