APERC Coal Report 2021

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Foreword

The COVID-19 pandemic and the subsequent widespread lockdowns have triggered the most significant reduction in global energy demand since World War II. But the rapid administering of vaccines throughout APEC and the world has meant that most economies are rebounding to levels of economic growth and energy consumption that were in place before the pandemic.

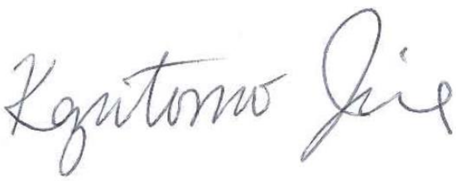
Like all energy commodities, APEC demand for coal has taken a large fall, and production has also weakened in response. These falls represented an acceleration of trends that were already occurring for coal in many APEC economies, as part of a transition away from the most emissions intensive fuel. However, 2021 saw a rapid surge in coal consumption, to the point where supply was inadequate to meet demand, causing an energy crisis that was hampering economic recovery, in multiple APEC economies.

The APEC region is home to the world's largest coal-producing and coal-consuming economies, with China alone accounting for over half of global coal consumption. Thermal coal, for power generation, accounts for roughly four-fifths of all coal consumption. While metallurgical coal, used for steel production, accounts for the remainder.

Multiple alternative generation technologies mean that thermal coal will become a smaller and smaller share of the total market for coal in the coming decades. However, emerging APEC economies, such as China, Indonesia, Viet Nam, and Thailand are still likely to meet much of their growing demand for power via coal-fired generation for at least the coming decade.

Eventually, diminishing prospects will be more widespread; multiple APEC economies have recently announced their commitments to net-zero carbon emissions. Clean coal technologies such as integrated gasification combined cycle (IGCC), flue gas desulphurisation, low nitrogen oxide burners, high-efficiency, low-emission (HELE), coal-to-hydrogen with carbon capture, utilisation and storage (CCUS) may be able to play a role in a rapidly decarbonising world. Certainly, CCUS technologies will be important to reduce emissions from the large fleet of relatively young coal-fired power plants throughout APEC economies in Asia.

This coal report is part of the APERC fossil fuel reports series, published annually. 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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Abbreviations and Acronyms

Abbreviations

EJ	Exajoules
GW	Gigawatts
TWh	Terawatt hour
Mt	Million tonnes
PJ	Petajoules
USD	US 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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Executive Summary

The far-reaching impacts of COVID-19 continue to unfold, with the end of 2021 being a particularly tumultuous time for thermal and metallurgical coal, as well as other energy commodities. In the face of lockdowns and diminished demand for services, global demand for goods has boomed, and with it, the demand for power. The surge in industrial production, most notably in China, has seen significant growth in energy demand, heightened further by a hot northern hemisphere summer.

On the coal supply side, Indonesia and Australia have experienced notable disruptions due to flooding in the first half of 2021. In China, mining safety measures and environmental commitments have also contributed to diminished production since the end of 2020. These supply disruptions accompanied by surging power demand have led to large drawdowns in energy commodity inventories through the latter half of 2021. Circumstances have deteriorated to the point of multiple power blackouts in China, with subsequent forced industrial shutdowns to meet the challenge of insufficient supply.

The net impact of these market conditions has seen both thermal coal and metallurgical coal prices spike to unprecedented levels. However, as of October 2021, production and supply is rapidly returning, meaning that the elevated price levels are already beginning to abate. A cold winter or additional supply shocks could lead to an extension of the high price levels.

In 2021, Korea, Japan, and China all made commitments to cease to finance coal projects abroad. These announcements add to the growing move away from the use of thermal coal in the power mix. However, developing APEC economies are likely to rely on coal for a significant portion of their energy demand for at least another decade. The average age of coal-fired power plants in Asia is young, and in the case of Indonesia and Viet Nam, recently released power development plans aim to significantly increase coal-fired generation capacity. The extent to which these plans are realised remains to be seen, especially in the context of rapidly shrinking sources of finance.

In addition to diminished sources of finance, net-zero commitments and planned coal-fired power plant phase-outs will speed a transition away from coal. However, careful planning is required to ensure that the phase-outs do not unnecessarily expose economies to vulnerabilities in their power systems. There may be a large role for carbon capture technology to facilitate reliable power generation while meeting emissions goals. Lessons learnt from the Boundary Dam, Petra Nova, and other CCS facilities in APEC will be important, particularly in the context of lowering the emissions of difficult-to-decarbonise industry.

Thermal coal use will continue to, or begin to, decline through the 2020s and 2030s in most APEC economies. Whereas metallurgical coal demand will remain more robust, given that it is a fundamental input into virgin steel production. The largest APEC metallurgical coal exporting economies of Australia, the US, Canada, and Russia are likely to continue to derive significant economic benefit from metallurgical coal, even in a rapidly decarbonising world. The largest APEC thermal coal exporter economies of Indonesia, Australia, and Russia will be less able to derive economic benefit from their remaining thermal coal reserves.

APEC coal policies and developments

Economy	Policies or notable developments
Australia	Australian exports of coal to China have faced an unofficial ban since October 2020. A limited number of cargoes cleared Chinese customs in September 2021, in the face of the unfolding energy crisis.
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 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 has introduced significant policy hurdles for thermal coal development. However, certain provinces are still investigating the possibility of increasing coal production capacity for export.
Chile	Almost 3.63 GW of coal-fired power plants will shut down before 2025 (65% of total coal electricity capacity). Coal-fired power plants will completely cease by 2040 at the latest.
China	14th FYP (2021 to 2025) is promoting the 'clean and efficient use of coal', and no longer places a cap on coal-fired capacity or consumption. 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. In September 2021, Xi Jinping announced that China will no longer build coal-fired power plants abroad. Full details are yet to be disclosed.
Hong Kong, China	HKC plan to stop investing in coal-fired capacity additions and to phase out coal by 2050.
Indonesia	The Indonesian government is encouraging production of dimethyl ether fuel from the downstream coal industry, and is also planning to retire and replace some of the older coal-fired power facilities. The 2021 – 2030 Electricity Supply Business Plan includes 13.8 GW of new coal-fired power plants.
Japan	The New International Resource Strategy (2020) reaffirms the importance of coal for Japan. Japan committed to no longer provide 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 provide support for coal projects if they include emissions reduction measures.
Korea	The 3rd Energy Master Plan (2019) and 9th Basic Plan on Electricity Demand and Supply (2020) commits to reducing nuclear and coal, replacing them with renewables and natural gas. Korea will no longer provide state support to new overseas coal projects.

Malaysia	The Energy Commission is planning for new coal-fired power plants to meet Malaysia's growing energy demand and replace retiring coal-fired power plants.
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.
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 PNG. However, there are tentative early-stage plans for coal-fired power plants to be built in multiple PNG cities.
Peru	The 135 MW Ilo coal-fired power plant will cease operations by 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 CT'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 through to 2050. However, it is slower than in the revised Power Development Plan (PDP7, 2016). Coal imports are assumed to increase to meet the rising coal demand from the industry and power sectors. Commitments from Korea, Japan, and China to no longer provide financing for coal projects presents a challenge for Viet Nam's coal plans.

Chapter 1: APEC coal policies and developments

Impacts of COVID-19

The COVID-19 pandemic has had an immense global impact. Social distancing, travel bans, and varying forms of lockdowns and curfews, designed to slow the spread of the virus have had large flow-on impacts on global energy consumption.

On the demand side, global coal consumption fell by approximately 4% in 2020 relative to 2019, the largest drop since World War II (BP, 2021). The fall in consumption was more pronounced in coal-fired power plants than in industrial processes. In the APEC region, annual coal consumption fell by 2.8% in 2020 (BP 2020, 2021). However, China, Malaysia, Viet Nam, and Thailand all posted increases in 2020.

In the United States, the reduction in electricity consumption after the first declaration of social distancing pushed coal use down by around 30% in Q1 2020. Coal's share in the generation mix fell below 20% for the first time since the widespread development of coal-based electricity generation. Large coal importers, Korea and Japan, each saw coal consumption declines of 12% and 7% in 2020.

Despite widespread falls across many economies, coal consumption in China increased by 0.6% in 2020. Thailand and Viet Nam also posted small increases in coal consumption by 1.9% and 1.7%, respectively, due to new coal-fired power plants and increased industrial use.

On the supply side, annual APEC coal production fell by 4.2% in 2020 (BP, 2021) in response to the weakened demand conditions. As an example of the response of coal producers, Peabody Energy suspended production at its Wambo thermal and semi-soft coking coal mine in New South Wales, Australia, for 59 days to better align production with weak demand in June 2020. Production at AMCI Group's 3.5 million tons per year Carborough Downs mine in Queensland's Bowen Basin was also halted (Argus Media).

In coal-related investment, many coal-fired power projects in APEC have been postponed due to workforce or supply chain issues. Independent Power Producers in Indonesia declared force majeure and announced multiple coal power project delays (Global Energy Monitor).

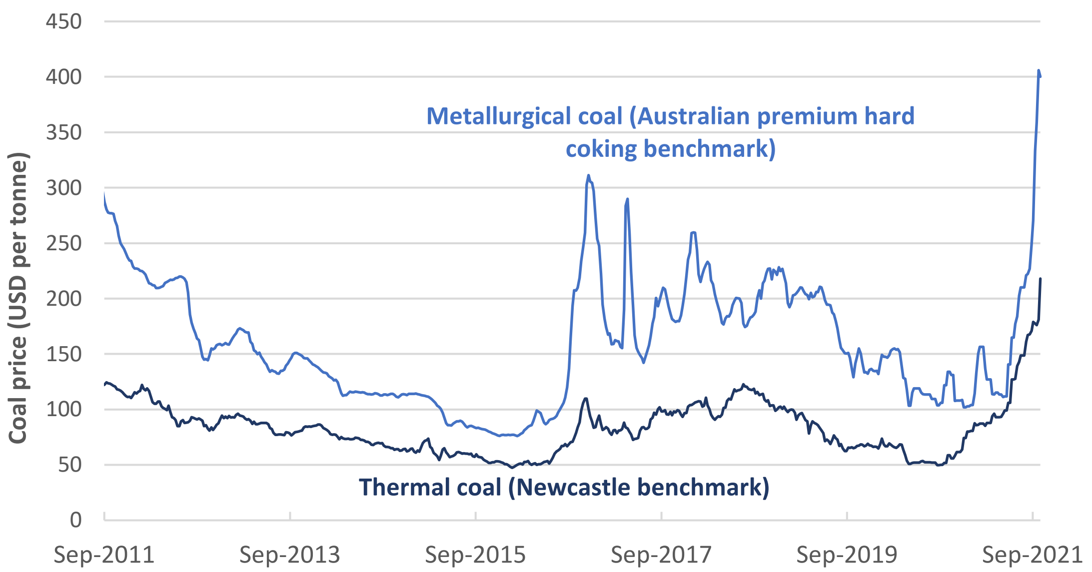
The Philippines government announced that construction of the 668 MW Dinginin power station in Central Luzon would be delayed because Chinese engineers who were to be part of the plant's testing and commissioning processes were subject to a COVID-related travel ban. The Philippines authorities also announced that it had temporarily halted construction on multiple power projects, including the proposed Atimonan coal-fired power station in Quezon province (Global Energy Monitor).

Asset sales have also been impacted by the pandemic. Canada's Brookfield Asset Management has delayed the USD 2 billion sales of its Dalrymple Bay coal terminal in Queensland, Australia. Brookfield cited the volatility of financial markets and travel bans on bankers, financiers, and lawyers needed to list and sell the export terminal (Financial Post, 2021).

The COVID pandemic has had clear short-term impacts for coal markets, with reduction in demand for electricity leading to lower demand for thermal coal. However, in many APEC economies, industrial output has remained robust, with industrial coal consumption increasing amidst the uncertainty. What remains unclear are the follow-on impacts of the pandemic. Coal consumption may return to a trajectory that would have occurred had the pandemic never occurred. There is also a chance that coal consumption patterns have permanently shifted. Both Korea and Japan declared no new state financing for overseas coal projects in 2020. China also made a similar announcement in September 2021 (UN News, 2021). However, these developments were likely to have occurred, even without the pandemic.

One of the most significant impacts of the pandemic has been the increase in coal price volatility, which reached a zenith in the latter half of 2021. Surging economic growth, particularly in China, combined with reduced international supply, such as in Australia and Indonesia, have led to a large drawdown in inventories of thermal coal and metallurgical coal in some APEC economies. A hot 2021 northern hemisphere summer, and a scramble to replenish inventories before the winter, has seen both thermal coal and metallurgical coal prices spike to unprecedented levels, as shown in Figure 1.1. The shortage of thermal coal has led to blackouts in China, and forced shutdowns of multiple industries, to meet the challenge of the unfolding lack of supply.

Figure 1.1: Coal spot prices, September 2011 to September 2021



Source: globalCOAL, Fastmarkets, Trading Economics.
Notes: Newcastle benchmark is the price for seaborne thermal coal in the Asia-Pacific region

The current price spikes are anticipated to be transitory. Futures markets show that thermal coal and metallurgical coal delivery prices in 2022 and beyond are at much lower levels than current spot market prices. There has been some appreciation in the share prices of coal-producing companies, though not to the same magnitude as the spikes observed in spot markets. This all points to the fact that the recent large ramp in prices is expected to abate. However, if there are additional supply shocks or the winter is particularly cold, then there is a chance that elevated price levels remain through to 2022. Prices are discussed in more detail in Chapter 5.

Coal policies

Decarbonisation

As of August 2021, nine APEC economies had announced net-zero policies, with eight[1] planning to reach net-zero emissions by 2050. China plans to achieve carbon neutrality by 2060. Three additional APEC economies[2] plan to reach net-zero emissions at an unspecified time this century.

APEC economies have different approaches 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, ensuring affordable and reliable energy supply is often prioritised by many APEC economies. In the power sector, coal-fired power plants are still the first choice for many emerging APEC economies due to favourable economics and reliable baseload characteristics.

Current measures to promote decarbonisation in coal-consuming sectors within APEC economies involve:

1. **Fuel switching** – Occurs at the facility level where non-fossil energy or lower-emission fuels such as natural gas, liquid biofuels, biogas and biomethane, and ammonia substitute for coal in coal-fired power plants or industrial plants. At a more overarching level, coal-fired electricity generation is supplanted by low- or zero-emissions generation technology.
2. **Thermal efficiency** – Increasing 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 less emissions for each kWh of generation.
3. **Carbon Capture, Utilisation and Storage (CCUS)** – CO_2 captured from coal consuming facilities can be stored permanently in geological formations to reduce CO_2 emissions. CCUS technologies can be applied for new builds and can also be engineered for existing facility retrofits.
4. **Clean coal technology (CCT)** – Integrated gasification combined cycle (IGCC), oxyfuel combustion, and other advanced power generation systems including underground coal gasification can be used 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. **Electrification** – Certain industrial sectors (such as steel making) can switch to electricity dependent processes rather than coal dependent processes.
6. **No new coal power** – Commitment to no new coal-fired power plants and coal power projects in the pre-construction pipeline (announced, pre-permit and permitted).

[1] Canada, Chile, Hong Kong, Japan, South Korea, New Zealand, Papua New Guinea and United States.

[2] Australia, Indonesia and Singapore.

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

Economies	Fuel switching	Thermal Efficiency	CCUS	Clean coal technology	Electrification	No new coal power
Australia[3]	✓	✓	✓	✓	✓	
Brunei Darussalam	✓	✓				✓
Canada	✓	✓	✓			✓
Chile[4]	✓					✓
China	✓	✓		✓		
Hong Kong, China	✓					✓
Indonesia	✓	✓			✓	
Japan	✓	✓		✓	✓	✓
Korea	✓	✓				✓
Malaysia[5]	✓	✓			✓	✓
Mexico	✓	✓				
New Zealand	✓	✓			✓	✓
Papua New Guinea	✓	✓				
Peru	✓	✓				✓
Philippines	✓	✓				
Russia	✓	✓		✓		
Singapore	✓					✓
Chinese Taipei	✓	✓			✓	✓
Thailand	✓	✓				
USA	✓	✓	✓	✓	✓	✓
Viet Nam	✓	✓				

Sources: APERC, Boom and Bust (2021), Global Energy Monitor, EGEDA, E3G (2021).

Notes: Economies committed to no new coal-fired power plants include Chile, Malaysia, Canada, New Zealand and Peru. Economies without any coal power projects in the pre-construction pipeline include Brunei, Chinese Taipei, USA, Japan, Korea, Hong Kong (China) and Singapore.

Pollution

In addition to the challenge of decarbonisation, coal mining and end-use consumption also present challenges for the environment and human health.

[3] 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.

[4] Chile committed to no new coal without carbon capture and storage in its agreement with the major electricity generation companies of June 2019.

[5] Malaysia committed to no new coal in the presentation of its Energy Transition Plan 2021-2040, June 2021.

Coal mining activities can release particulate matter and harmful gases (such as CH_4, SO_2, NO_2, CO), heavy metals, waste coal, and overburden dump (also known as culm, gob, or boney). Particulate matter released during coal or waste rock transport can cause severe respiratory system damage, while gases and heavy metals lead to smog, acid rain, elevated levels of environmental toxins, and numerous dangerous respiratory, cardiovascular, and cerebrovascular effects. Runoff from waste coal sites can also pollute local water supplies (Global Energy Monitor).

Beyond mining, if not mitigated, coal-fired power plants release particulate matter from the chimney or bottom ash, while CO_2, SO_2 and NO_2 are products of coal combustion released in the flue gas. Water used as a coolant also causes thermal pollution if it is returned to the environment at a higher temperature, which can have negative impacts on oxygen supply and ecosystem composition (Pollution Issues).

Almost all APEC economies enforce environmental laws, acts or regulations to control pollutants from coal mining activities and coal consumption. Some economies have unique legal frameworks to guide and control environmental pollution throughout the nation, while other economies control their pollutants by using both economy-wide legal documents and local governmental regulations. See Appendix A.1 for details of these regulations.

Beneficial environmental outcomes can be enacted at all points of the coal supply chain. However, companies and governments may choose not to limit all the adverse effects. An example will be seen with the upcoming 2022 Winter Olympics in Beijing. To achieve the desired reduction in pollution, China is instituting caps on industrial output in parts of north China that are close to the event (Washington Post, 2021). In effect, there is a trade-off between what costs to incur on an ongoing basis to limit pollution from coal production and consumption.

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 in Appendix A.2).

In 2020, the Australian general insurer QBE (which manages USD 23.5 billion worth of assets) announced that it had completed its divestment of thermal coal-related businesses (mining, transport, and power). QBE anticipates that there will be a significant negative financial impact on thermal coal assets from environmental and social demands. Another Australian insurance company, Suncorp, also announced that it will phase out its investments and insurance exposure to thermal coal by 2025. All Australian based insurance companies have now effectively committed to removing coal from their investment portfolios (APERC Coal Report, 2020).

Black Rock committed to remove any companies generating more than 25% of revenues from thermal coal production from its active investment portfolios (Boom and Bust, 2021).

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 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 economy'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) will 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 Appendix A.3), with Indonesia and Viet Nam being major recipients of this financing (see Appendix A.4).

Japan now has a collective agreement with G7 members to cease financing coal-fired power plants by the end of 2021, unless there are emissions reductions measures attached to the project. South Korea had already agreed to end the practice (The Guardian, 2021). These announcements left China as the remaining major source of financing for coal-fired plants in developing economies. However, in September 2021, President Xi Jinping announced that China would also cease to build coal-fired power plants as part of the Belt and Road initiative (UN News, 2021). The details of the end to China's financial support have yet to be released, but the trend of diminished financial support for coal-fired generation is clear.

Financing and support for thermal coal is waning, but there are still pockets of support being provided by APEC members. The Australian government invested AUD 1.2 billion in the 2020-2021 period, mainly for subsidising exploration, refurbishing coal ports, railways, and power stations and funding "clean coal" research (The Australia Institute, 2021). In Southeast Asia, Indonesia, Viet Nam, Thailand, Malaysia, and the Philippines continue to indirectly support coal-fired generation through electricity price subsidies (IEA, 2017).

Technologies

Carbon Capture, Utilisation and Storage

Status of CCUS facilities in APEC

CCUS technology has the potential to play a vital role in reducing the CO_2 emitted from coal-consuming plants in the power and industrial sectors. CCUS technology can be applied to existing or new coal-fired power plants.

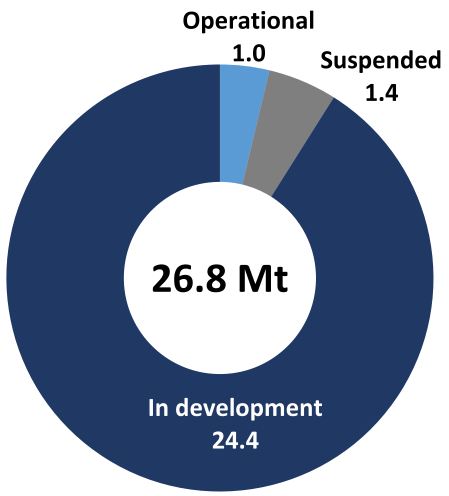
With today's technology, a CCUS facility can capture up to 90% of CO_2 from coal-fired facilities, and store these emissions permanently in subsurface geological reservoirs or utilise them for purposes such as enhanced oil recovery (EOR). According to the IEA, the CO_2 capture rate will increase to 99% or more in the future.

CCUS technology is recognised as a crucial technology to decarbonise hard-to-abate sectors, such as cement, iron and steel, and chemicals 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 (Carbon Brief, 2016).

There are currently nine coal CCUS projects in APEC, though only the Boundary Dam facility in Saskatchewan, Canada, is currently operational. Captured CO_2 from this facility is used for EOR, which involves injecting CO_2 into oil reservoirs to recover incremental oil from producing wells.

Petra Nova is another coal-fired CCUS facility that had been used for EOR in Texas, United States. However, operations were suspended in 2020 due to ongoing outage problems and unfavourable economics brought on by the COVID-19 pandemic. Petra Nova's management plans to resume the CCUS function if the oil market recovers sufficiently. The remaining seven projects are still in development stages, with five located in the United States, one in South Korea, and another in China. If all these facilities become operational, then the capture capacity of all APEC facilities would reach 26.8 Mt CO_2 per year (Figure 1.2) (Global CCS Institute, 2020).

Figure 1.2: CCUS capacities in the APEC region



Source: Global CCS Institute

CCUS cost

The limited deployment of CCUS technologies in coal-related sectors is mostly due to cost.[6] For a thermal or industrial power plant, CCUS requires additional capital expenditure and increased operating costs, relative to a similar plant without CCUS. Part of the additional operating costs involves a loss of efficiency (parasitic energy losses) or the need for additional energy from an external source. In jurisdictions that institute a carbon price or similar policy, CCUS deployment will become increasingly cost competitive.

Multiple technologically innovative pilot projects have the potential to lower the cost of CCUS facilities in the power sector. First, the NET Power demonstration project (United States) uses CO_2 as a working fluid in an oxyfuel, supercritical CO_2 power cycle, and began operating in 2018.

[6] There are also risks to economic viability when captured CO_2 falls short of projections. The Boundary Dam project was required to pay a penalty for not delivering an agreed amount of CO_2 (MIT, 2016). This has disincentivised additional projects.

If this demonstration project is successful, it could make zero-emissions coal-fired power generation economically competitive with existing power generation technologies. Second, Fuel Cell Energy introduces an entirely new system in which the flue gas stream in coal-fired power plants is fed into fuel cells to efficiently generate additional electricity (IEA, 2020a).

Finally, in December 2019, J-Power's Osaki CoolGen Capture demonstration project in Japan began testing CO_2 capture from a 166 MW integrated gasification combined cycle plant, enlarging the portfolio of capture technologies on coal-fired power plants in operation (IEA, 2020a).

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 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.

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 sectors such as cement and steel manufacturing 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.

Box 1: CCUS-equipped coal-fired power plant – Boundary Dam, Canada

General information

The Boundary Dam is an 824 MW coal-fired plant located in Estevan, Saskatchewan, Canada. The generation Unit 3, which opened on 2 October 2014, is the world's first commercial-scale CCS at a coal-fired power plant.

Unit 3 was originally scheduled for closure in 2013 after 45 years of service. A retrofit was undertaken to transform the unit into a reliable long-term producer of 110MW of clean baseload electricity and simultaneously supply CO_2 to an enhanced oil recovery (EOR) project in the province. Unit 3 is expected to have an increased life expectancy of 30 years and has the potential to capture one million tonnes of CO_2 a year (Sask Power).

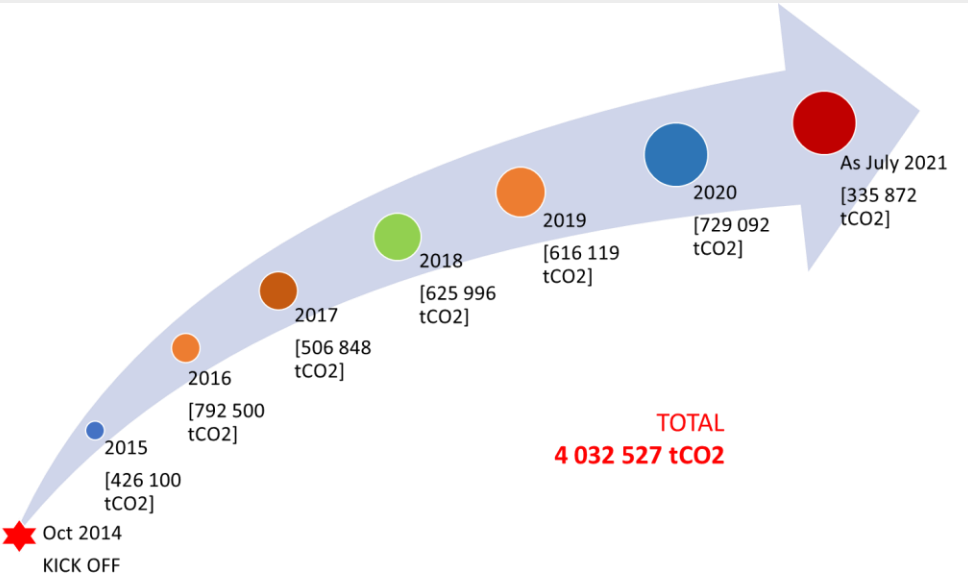
The Unit 3 retrofit included the replacement of the existing steam turbine generator with a new one that could be integrated with the CO_2 and SO_2 capture mechanism. The captured CO_2 is compressed and transported through a 66 km-long pipeline to an EOR project near Weyburn, which is part of an agreement signed with Cenovus Energy to purchase the full volume of one million tonnes of CO_2 a year.

Unused CO_2 is transported to an injection well and storage site belonging to an Aquistore research project that is managed by the Petroleum Technology Research Centre. The SO_2 provides feedstock to a 50 tonne per-day sulphuric acid plant, which will be built next to Unit 3. A flue gas desulphurisation (FGD) system was put in place to allow the installation of carbon capture equipment, which reduces CO_2 emissions by approximately 90%.

Results of carbon capture

As of July 2021, over 4.0 million tonnes of CO_2 has been captured from the Boundary Dam Unit 3 since it began operating, with the cumulative capture shown in Figure B.1 (Sask Power).

Figure B.1: Captured CO_2 at the Boundary Dam unit 3, 2015-2021



Source: SaskPower's Monthly Boundary Dam 3 Status Updates, APERC analysis.

Lessons for the world

Emerging economies will continue to demand more energy. Governments need to maintain the value of existing generating assets from diverse fuel sources, especially low-cost fuel, such as coal. The Boundary Dam unit 3 project paves the way for continuing to rely on coal while simultaneously striving to lower greenhouse gas (GHG) emissions. Coal with CCS can help coal become a sustainable, reliable, and clean energy source.

CCS is applicable beyond the power sector and can be applied to hard-to-abate sectors such as iron and steel, and cement. Analysts and governments have stated that some of the world's most carbon-intensive industries have no economic alternatives other than CCS for deep emissions reduction (International CCS Knowledge Center).

Next-generation of CCUS-equipped coal-fired power plant

Based upon the experience from Boundary Dam 3, a team of experts at the Knowledge Centre spearheaded a feasibility study to retrofit SaskPower's Shand Power Station, a 300MW, single unit, coal-fired power plant. Their studies show that next-generation CCS technology will be significantly cheaper, more efficient, and will be able to better integrate with renewable energy. The cost of CCS will continue to decline as more plants are built (International CCS Knowledge Center).

Coal-fired power efficiency

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, up to 42% for supercritical, up to 45% for ultra-supercritical technology and up to 50% for the newly commercialised advanced ultra-supercritical (Table 1.2).

Table 1.2: Technologies and thermal efficiency

Technology	Efficiency rate	Coal consumption (g/kWh)	Steam temperature (°C)	CO_2 intensity (gCO_2/kWh)
Advanced Ultra-supercritical	**45 to 50%**	230-320	≥700	670-740
Ultra-supercritical	**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: NextBig Future

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 controls 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.

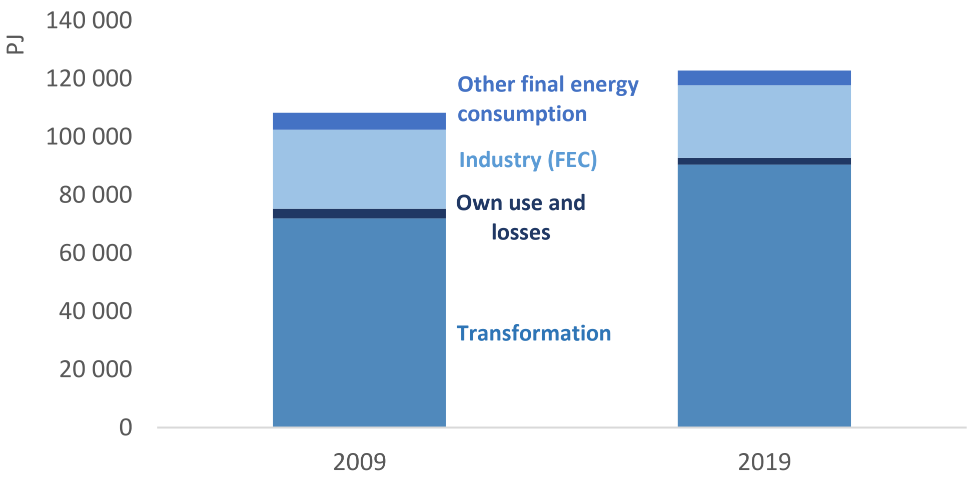
Japan is developing next-generation coal-fired power generation, using Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC) technology. The Nakoso IGFC plant in Japan's Fukushima prefecture began commercial operations on April 16, 2021 (Power, 2021). The IGCC technology has the potential to enhance thermal efficiency to 55% by 2025, and it is expected to be commercialised during the 2030s (METI Journal).

Coal use in energy sectors

Approximately 74% of coal consumed in APEC economies in 2019 was for transformation, dominated by power generation. The remaining 26% was consumed by industrial processes, own use and losses, and other final energy consumption applications (Figure 1.3). 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 very high demand for cement, the capacity of China's cement industry was significantly larger than 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 proportional share of APEC industry consumption of coal has fallen from 25% in 2009 to 20% in 2019, highlighting the magnitude of China's cement industry relative to all APEC coal consumption.

Figure 1.3: APEC coal usage by sectors, 2009 and 2019



Source: IEA (2021), APERC calculations

Coal's relatively low cost and consistent heating properties make it difficult to replace fuel for 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. This again emphasises the importance of CCS to decarbonise coal use in hard-to-abate industrial sectors.

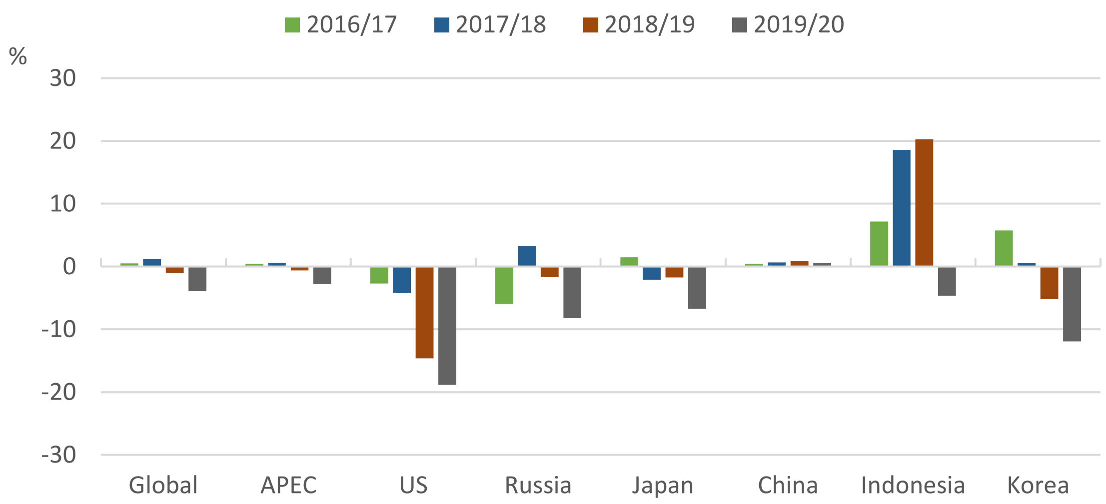
Chapter 2: Coal consumption

World and APEC coal consumption

Thermal coal and metallurgical coal continue to be consumed extensively throughout APEC and the world. For thermal coal, a competitive relative price in recent decades (relative to alternative power generation and heat providing technologies) has meant that thermal coal is the most prominent fuel in the APEC energy mix. Metallurgical coal is a similarly important fuel, though its importance is less to do with relative prices and more to do with the difficulty in replacing metallurgical coal as an input in steel production.

Global coal consumption fell by almost 4% in 2020 (Figure 2.1). Reduced demand for electricity and lower industrial output due to the COVID-19 pandemic explains much of this drop. However, China's rapid recovery from the pandemic meant it posted a small amount of growth in coal consumption in 2020. The global fall would have been far steeper if China's economy had been more impacted by the pandemic.[7]

Figure 2.1: Coal consumption growth rate of selected APEC economies, 2016-2020



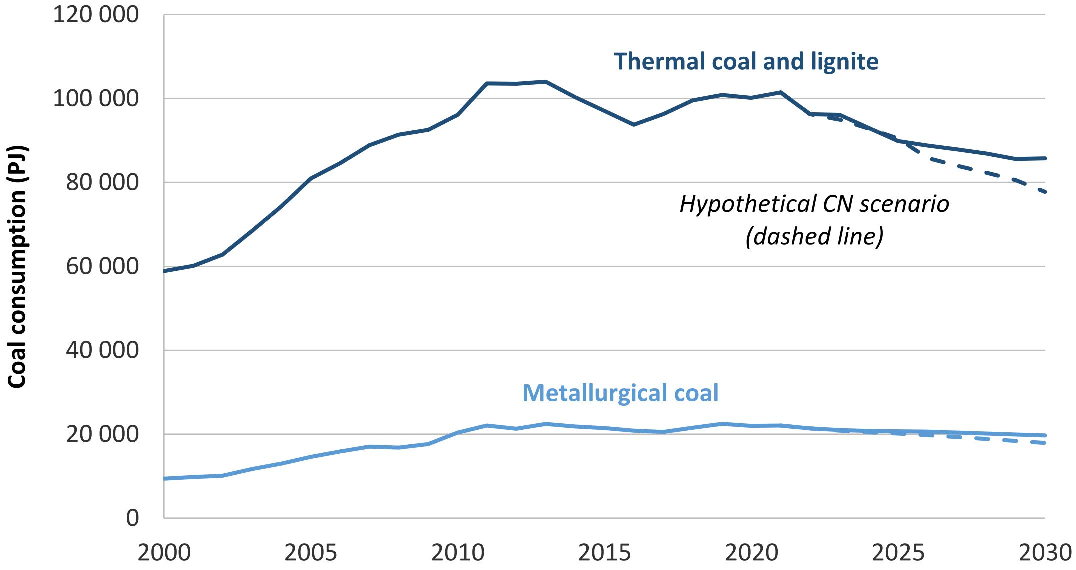
Source: BP (2021), APERC calculations

US coal consumption fell by 19% in 2020. While some of this fall was due to the pandemic, it represented a continuation of a declining trend of recent years, particularly in the power sector. Indonesia posted a decline in coal consumption in 2020 as well, though this represented a reversal of the previous two years of double-digit growth.

Focussing on the APEC economies only and looking at the split of thermal coal (and lignite) and metallurgical coal in Figure 2.2, it's notable that the fall in 2020 is barely distinguishable for both types of coal consumption, with much of this due to China's influence. China has accounted for an increasing share of APEC coal consumption, most recently accounting for 70% in 2019 (IEA).

[7] China accounted for 53.3% of global coal consumption in 2019 (IEA, 2021).

Figure 2.2: APEC coal consumption since 2000, with projections to 2030



Source: EGEDA (2021) and preliminary APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

Figure 2.2 shows that 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.

Thermal coal

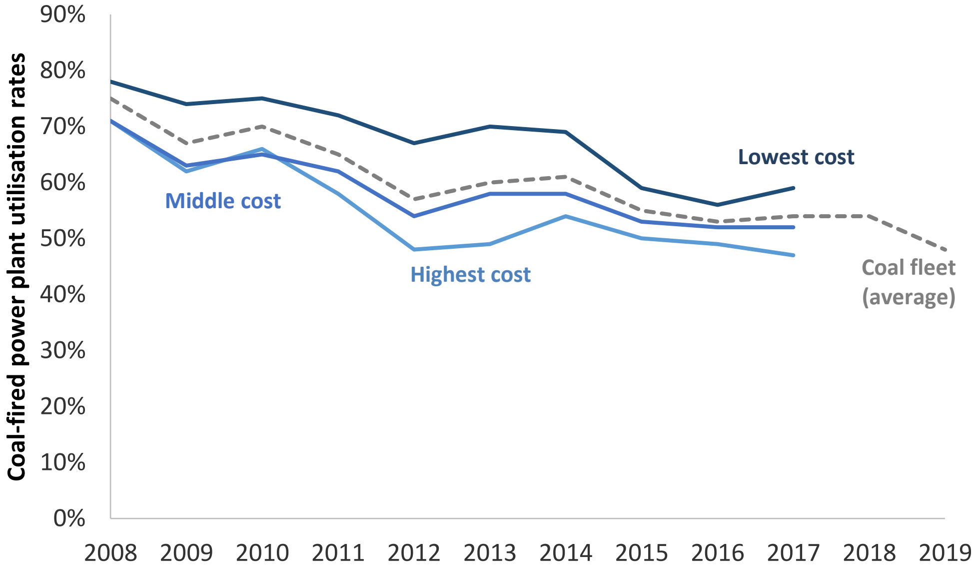
Coal-fired power utilisation trends

Consistently low natural gas prices in the US have made natural gas generating units more competitive and led to a general decline in the utilisation of coal-fired power plants, as shown in Figure 2.3. Even without very low gas prices, there is a global trend to lower utilisation rates of coal-fired power plants (IEEFA, 2021).

An analysis by RethinkX shows that the rates at which conventional power plants are utilised will continue to decrease as competitive pressure from near-zero marginal cost renewable generation continues to grow (RethinkX, 2021). Lower capacity utilisation leads to a reduction in revenues, which translates into lower operating margins and less ability to cover costs.

Some coal plants in the US are evaluating plans to operate on a seasonal basis, during periods of highest electricity demand. From 2020, two plants in Minnesota have switched to operating in the summer and winter only, while an additional plant in Arizona, and another in Louisiana, plan to only operate during summer (EIA, 2020). The effectiveness of seasonal operation in improving the economics for coal-fired power plants remains to be seen.

Figure 2.3: US coal-fired plant utilisation rate trends, by operational cost



Source: (EIA and Sargent & Lundy, 2019), APERC calculations

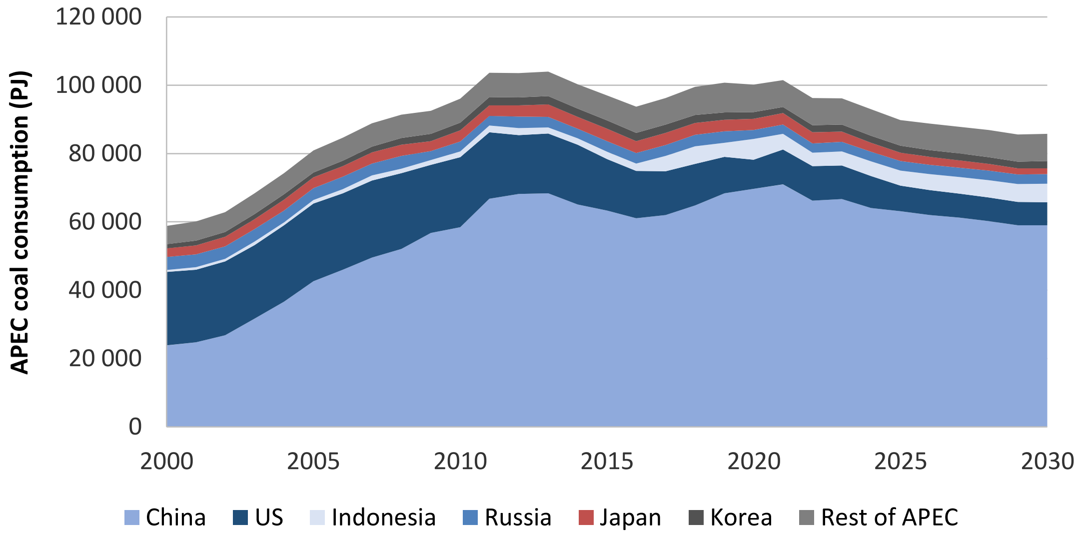
Measures to contain coal overcapacity in China were enacted in the 13th Five Year Plan (FYP) (2016 to 2020). The most notable imposition was that coal-fired power capacity was capped at 1100 GW, which led to the cancellation or postponement of multiple new coal-fired power plants. However, coal-fired capacity is expected to increase, following the easing of planning restrictions on new coal-fired power plants from 2022 onwards (Gardiner, 2020).

The recently released 14th FYP (2021 to 2025) is promoting the 'clean and efficient use of coal', and no longer places a cap on coal-fired capacity or consumption (OIES, 2021). The net impact will be that utilisation rates of coal-fired power plants continue to trend down, especially with the planned large increase in renewable generation capacity. Large power generation utility companies in China can only emit 550 grams of CO_2 per kWh, on average, across all their plants in 2020. This directive will mean that less efficient coal-fired power plants will be used less than more efficient coal-fired power plants.

APEC thermal coal and lignite demand

China remains the largest consumer of thermal coal (including lignite), accounting for 70% of APEC consumption in 2019, as shown in Figure 2.4. 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. Coal-fired heating has been replaced extensively by natural gas in recent years, particularly in Northern China cities. This will contribute to lower levels of thermal coal demand growth moving forward. In contrast to the large growth in China, US thermal coal consumption 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.

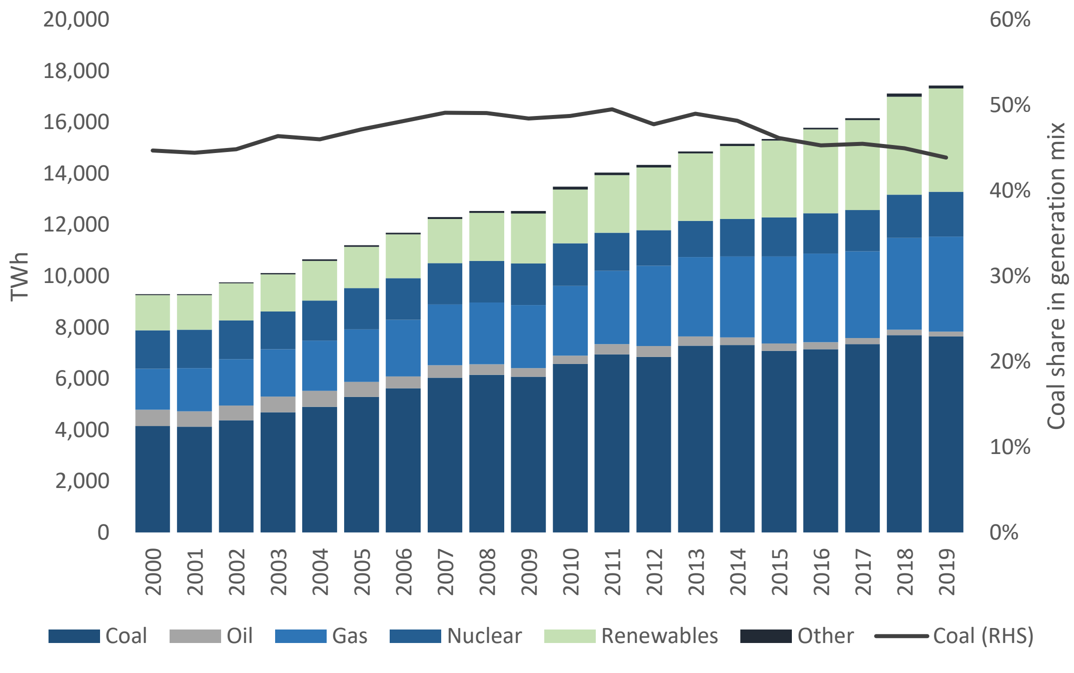
Figure 2.4: APEC thermal coal (including lignite) consumption since 2000, with projections to 2030



Source: EGEDA (2021) and preliminary APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

In the context of all generation fuels, coal is still the largest contributor to APEC-wide power generation, as shown in Figure 2.5. However, the share of total generation has been declining since 2013, most recently accounting for 43.9% of total power generation in 2019.

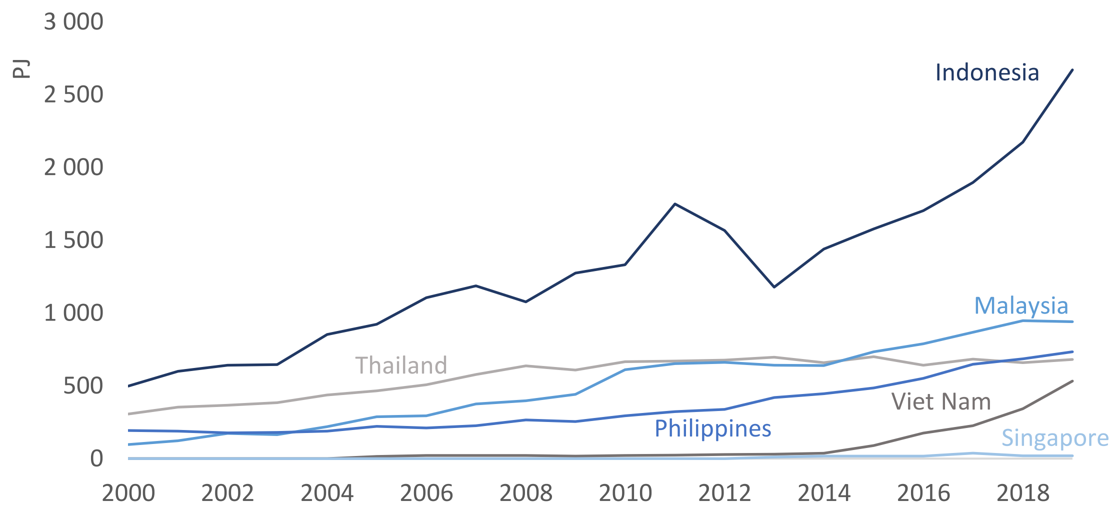
Figure 2.5: APEC power generation by fuel and coal's share of the APEC power mix, 2000-2019



Source: EGEDA (2021), APERC calculations

APEC thermal coal consumption is projected to decline through the 2020s in preliminary results from the reference (REF) scenario that has been modelled for the forthcoming *APEC Energy Demand and Supply Outlook*. 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, as shown in Figure 2.6. These economies are likely to continue to rely on coal for at least the next decade to meet their growing demand for electricity. The IEA notes that almost one-third of global coal-fired power capacity is less than ten years old, with most of that capacity in Asia (IEA, 2019). For these relatively young plants to continue to operate for their entire planned lifetime is not compatible with Paris climate commitments, absent abatement measures.

Figure 2.6: Southeast Asia thermal coal (including lignite) consumption, 2000-2019



Source: IEA (2021), APERC calculations

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 September 2021 draft of the Power Development Master Plan 8 (PDP8) shows an increase in coal-fired capacity, when compared with a February 2021 draft, mostly at the expense of wind generation (IEEFA, 2021).

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. However, the reality of these announcements is still yet to fully flow through to all impacted economies and their respective power plans.

In June 2019, Chile announced its aim to reach carbon neutrality by 2050. The Chilean Government and the Ministry of Energy have relied on carbon policy instruments to decarbonise the power sector, with one initiative being the establishment of a working group to develop voluntary and binding agreements to retire coal generation facilities (Inodu, 2019).

Almost 3.63 GW of coal-fired power plants will shut down before 2025 in Chile, which is equivalent to 65% of the total coal generation capacity. The operation of coal power plants will completely cease by 2040 at the latest (MEN, 2021). Decommissioning all coal-fired power plants by 2040 will result in a reduction of 7.5 $MtCO_2$ by 2050, with a positive abatement cost of USD 8 per tonne of CO_2.

In Canada, Alberta utilities continue to accelerate coal-to-gas conversions, and as a result, coal should be phased out of its electricity mix by 2023, well ahead of the 2030 deadline (Pembina, 2020).

Metallurgical coal

China remains the dominant consumer of metallurgical coal in APEC, owing to its global leadership in the production of steel. 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).

The large increase in China's steel production was partly driven by anticipation for global stimulus that would demand significant quantities of steel. Robust demand for steel has eventuated in 2020 and 2021, leading to large price increases for all steel products, given that the increase in China's steel production has not been sufficient to make-up for the diminished supply from other economies (IHS Markit, 2021).

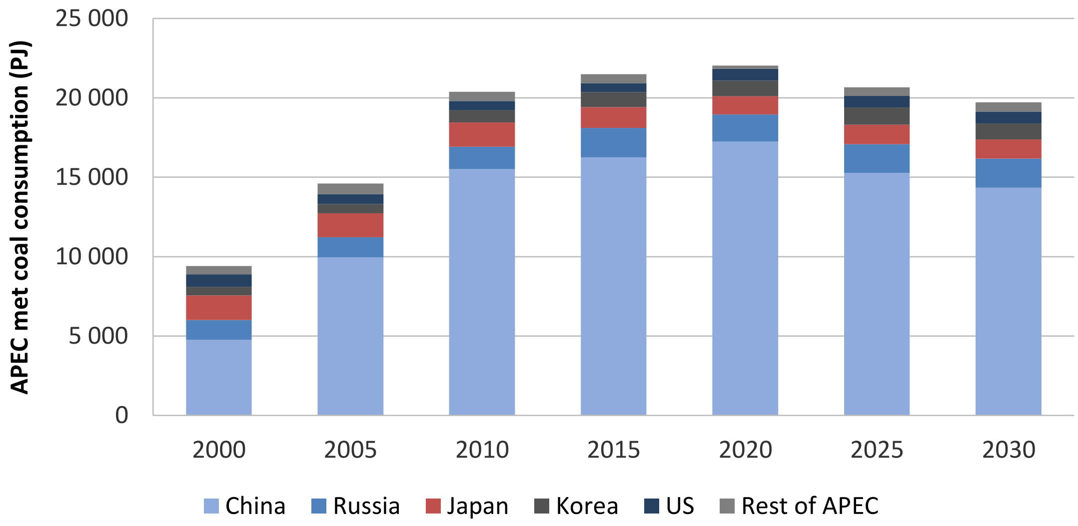
At time of publication, steel prices remain elevated. As inventories are replenished, and consumer demand switches more from goods to services, demand and prices are expected to moderate. Alongside moderating global demand for steel, the Chinese property and construction sector is experiencing a major contraction due to overleverage. The extent of any state-backed stimulus or bailout, if any, will have large implications for steel demand. A transition away from reliance on real estate led growth in China will mean steel production and consumption of metallurgical coal could potentially fall significantly in the coming years (FT, 2021).

China had committed to limit 2021 steel production to 2020 levels to curb industrial pollution. This commitment has been tested with an elevated pace of production from many of China's major steel producers in the first half of 2021. China's government has recently issued directives to many steel producers and other industrial enterprises to curb production in the face of large rises in natural gas and coal prices. Metallurgical coal consumption is expected to moderate in the latter half of 2021 due to these directives (MacroBusiness, 2021).

China's metallurgical coal consumption has increased from 15 500 PJ in 2010 to over 17 000 PJ in 2020, which represents 78% of APEC metallurgical coal consumption (Figure 2.7). 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 consumption of metallurgical coal. 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 US (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).

Figure 2.7: APEC metallurgical coal consumption since 2000, with projections to 2030



Source: EGEDA (2021) and preliminary APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

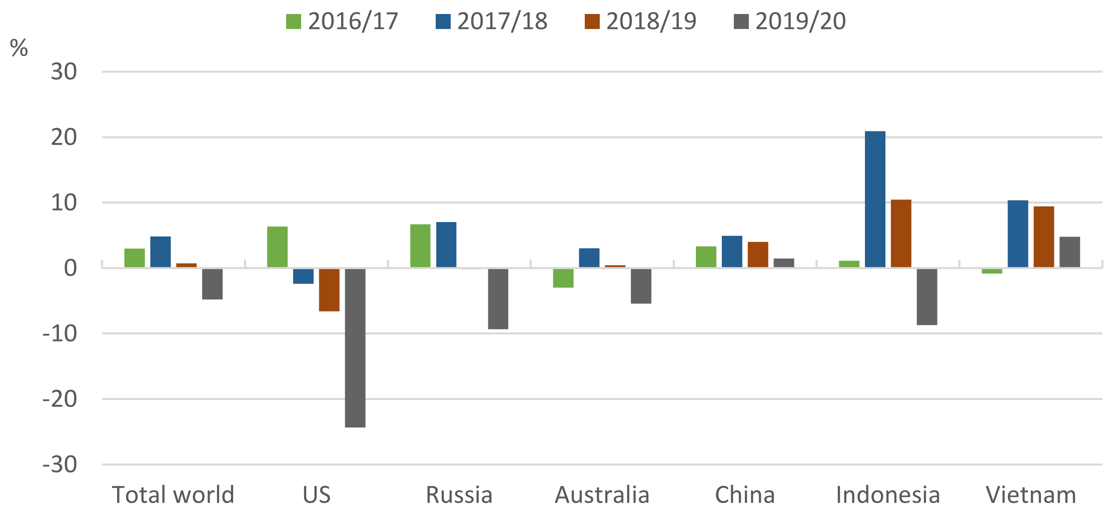
Chapter 3: Coal production

World and APEC coal production

Global coal production declined by 4.9% to approximately 160 EJ in 2020, after three years of growth (Figure 3.1). The pandemic and pressure of CO_2 emissions reduction explain most of this large decline. South and Central America recorded the highest reduction (-36%), followed by North America (-25%) and Europe (-16%) (BP, 2021).

In the APEC region, annual coal production fell by 4.2% (-5.7 EJ) in 2020, though the declining trend was not uniform across all economies. Coal production declined in most coal exporting economies, led by the United States (-25%), Russia (-9.3%), Indonesia (-8.7%), and Australia (-6.0%). Whereas coal production in Viet Nam and China rose by 4.8% and 1.4% (Figure 3.1).

Figure 3.1: Coal production growth rate of selected APEC economies, 2016-2020



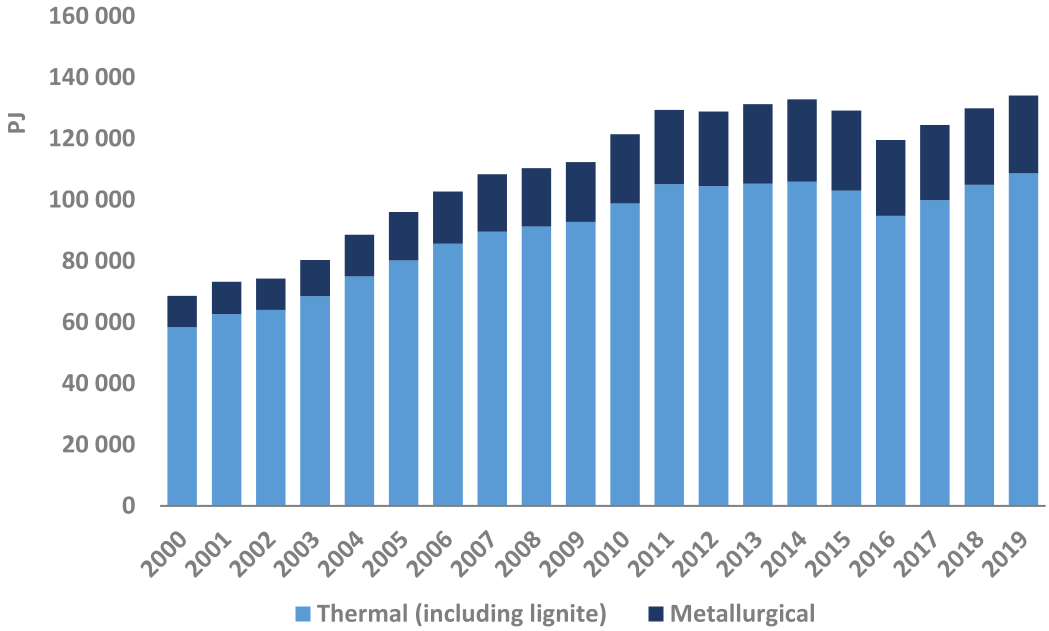
Source: (BP, 2021), APERC calculations

The split of thermal coal (including lignite) to metallurgical coal production in APEC was 81% to 19% in 2019 (IEA, 2021). Metallurgical coal's share of total coal production has increased from 15% in 2000 to 19% in 2019 (Figure 3.2).

Preliminary results from the forthcoming *APEC Energy Demand and Supply Outlook*, provide model results for a REF scenario and a hypothetical CN scenario for the APEC energy system out to 2030.

The coal production outlook from this modelling exercise is responsive to projected coal demand. In both REF and CN scenarios, there are projected declines. However, the decline in coal production is not quite as large as the decline in coal demand. This is due to non-APEC economies continuing to demand coal from APEC producers.

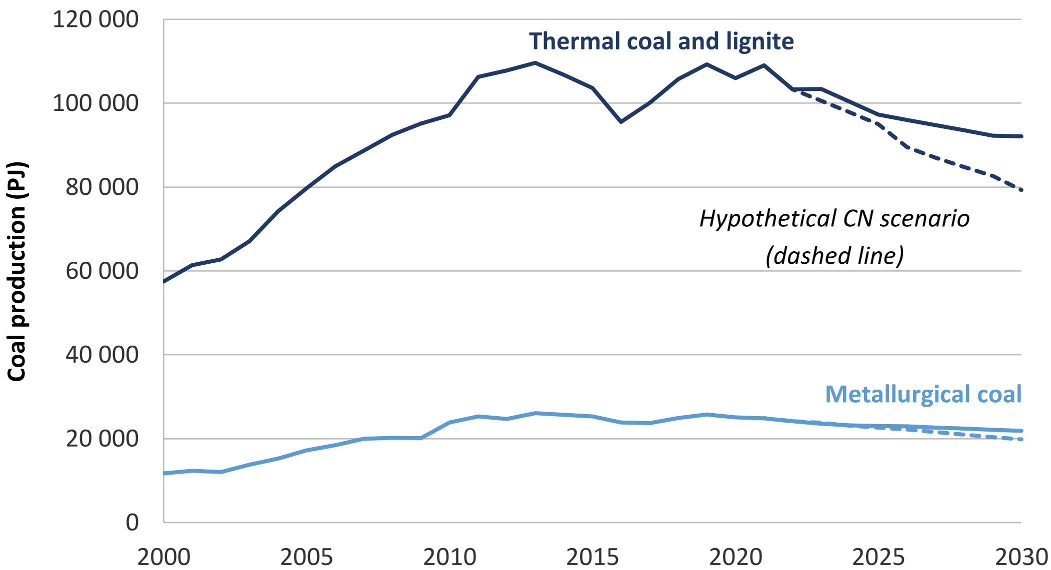
Figure 3.2: APEC thermal and metallurgical coal production, 2000–2019



Source: IEA (2021), APERC calculations

APEC-wide coal production is projected to fall by 13% in 2030, relative to 2018 (Figure 3.3). 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. This type of fuel switching is not viable for metallurgical coal consumption. Coal exports are also projected to decline, which is driving some of the declines in production out to 2030 for both thermal coal and metallurgical coal.

Figure 3.3: APEC coal production since 2000 with forecasts to 2030



Source: EGEDA (2021) and preliminary APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

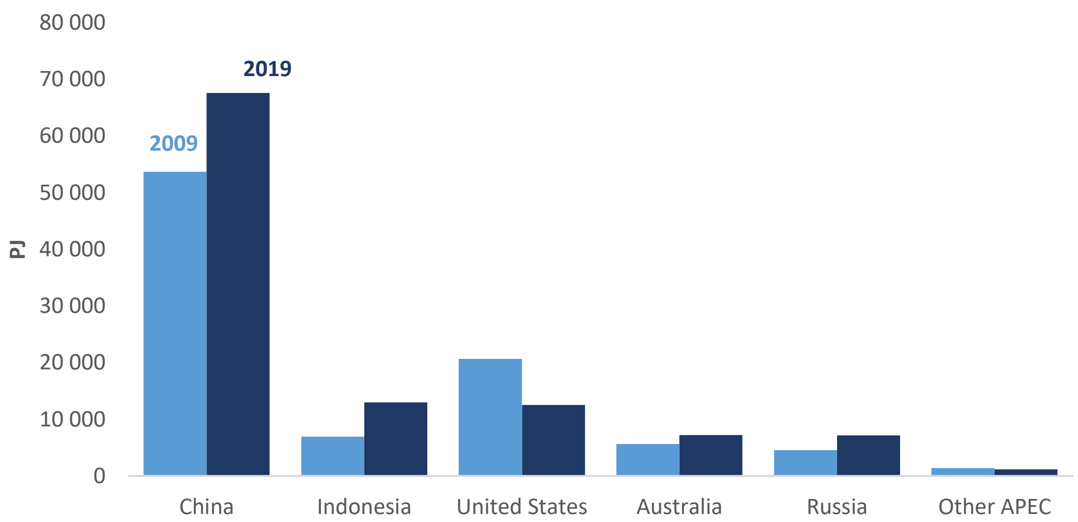
In the CN scenario, APEC coal production falls by 24% for the 2018-2030 period (Figure 3.3). Assumptions about coal phase-out policies, renewables, fuel switching, and low CO_2 emission coal combustion technologies are more aggressive in the CN scenario for most APEC economies. This is especially true for economies such as Canada, Chile, Hong Kong, Japan, South Korea, New Zealand, Papua New Guinea, the United States and China, which have committed to net-zero emissions goals. As a result, thermal coal production falls faster in the CN scenario. Metallurgical coal production remains robust in the medium term due to robust 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

In 2019, APEC thermal coal production was approximately 109 EJ, which was 9.0 EJ higher than APEC thermal coal consumption.[8] APEC has been a net exporter of thermal coal to the rest of the world for multiple decades due to the influence of large global exporting economies.

China is the largest producer of thermal coal in the world. In 2019, China produced 62 EJ, which accounts for 59% of total thermal coal production in the APEC region. China's thermal coal production grew by approximately 26% in 2019 relative to 2009 (Figure 3.4).

Figure 3.4: Thermal coal (including lignite) production for APEC economies, 2009 and 2019



Source: IEA (2021), APERC calculations

Indonesia was the second-largest APEC thermal coal producer, with production of 13.0 EJ in 2019. Most of Indonesia's coal production was destined for export markets (64%). US thermal coal production was slightly behind Indonesia's at 12.5 EJ in 2019. Unlike Indonesia, which has grown thermal coal production by 88% in the decade to 2019, US thermal coal production declined 39% for the same decade.

Thermal coal is mostly produced in Wyoming and West Virginia, with coal production recently ceasing in Kansas in 2017 and Arkansas in 2018. Arizona also stopped producing coal in the fall

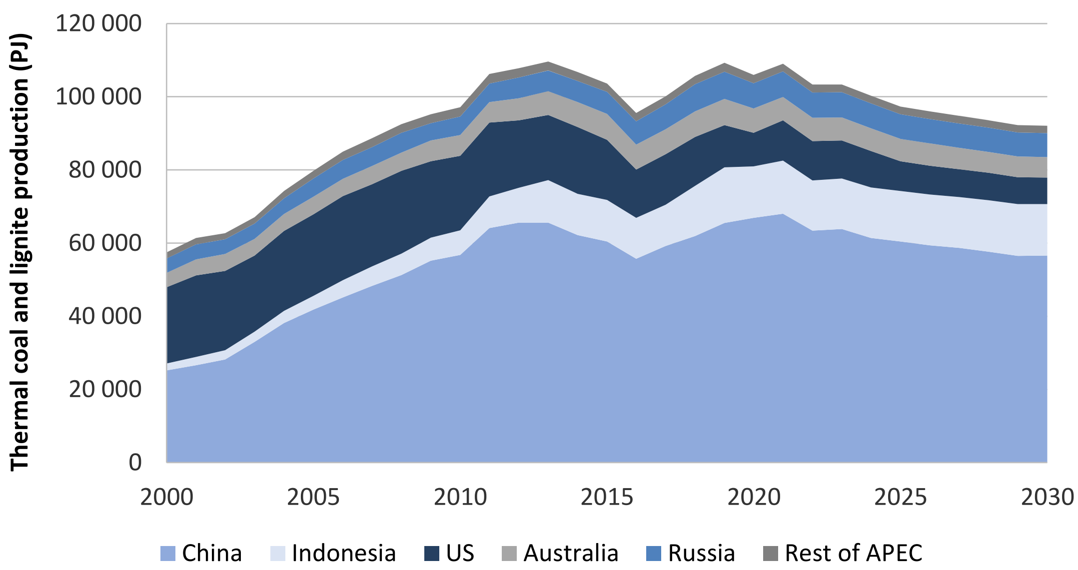
[8] Thermal coal includes anthracite, bituminous, sub-bituminous and lignite

of 2019 when the coal-fired Navajo Generating Station and adjacent Kayenta coal mine that supplied it both closed (EIA, 2019).

Australia and Russia were the next largest thermal coal producers, producing just over 7000 PJ in 2019. This represents increases of 28% and 58% for each economy over the decade to 2019, respectively.

APEC thermal coal production is forecast 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 then China. In contrast, thermal coal production in Indonesia is forecast to grow (Figure 3.5).

Figure 3.5: APEC thermal coal and lignite production since 2000 with forecasts to 2030



Source: EGEDA (2021) and APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

According to the EIA, demand for coal from the power sector will increase in 2021 due to high natural gas prices (EIA, 2021a). However, coal production is unlikely to match this increase in demand due to capacity constraints at coal mines and limited available transportation.

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 to 2030. China reduced the coal share in 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 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). 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 2: 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 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 then heavily 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 then flows to the surface via a large-scale ventilation system. Residual methane gas contained in the coal matrix (around 10%) continues to release 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 and then used as a fuel for industrial and utility purposes. CBM is often drained from coal seams prior to mining activities or in coal seams that are not appropriate for mining. 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). While 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

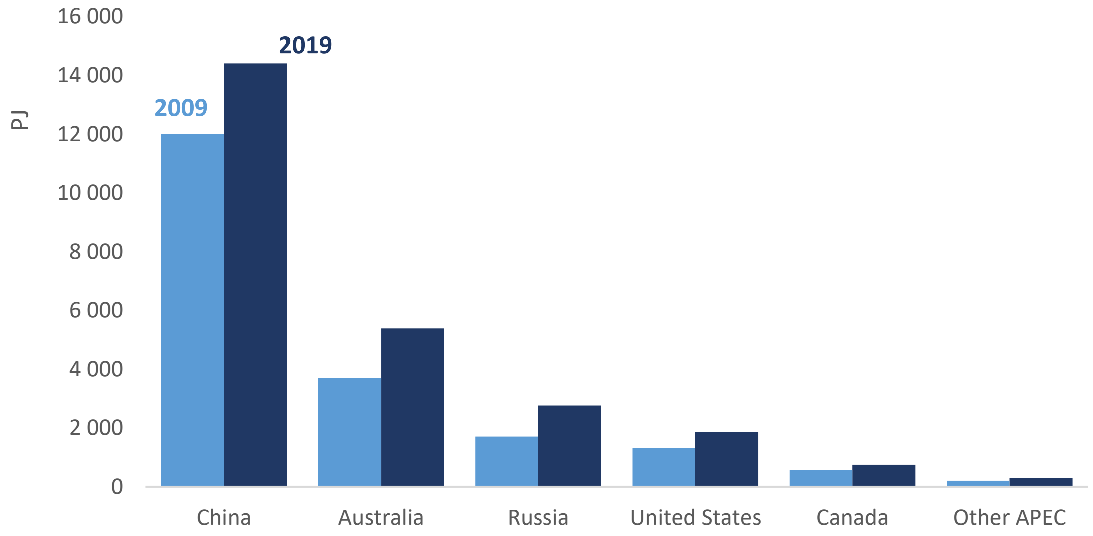
Metallurgical coal is primarily used for producing coke, which is one of the main inputs in blast furnaces used to make steel. Metallurgical coal production accounts for about one-fifth of total APEC coal production, though this proportion has been increasing over the last few decades. The share of metallurgical coal has grown due to metallurgical coal being less substitutable and less responsive to emissions and pollution policies than thermal coal.

China was the largest producer of metallurgical coal in 2019, producing 14.4 EJ (Figure 3.6). This production level was insufficient to meet its domestic demand, with China importing an additional 2 EJ of metallurgical coal in 2019.

Australia was the second-largest metallurgical coal producing economy, contributing 5.4 EJ of metallurgical coal in 2019, or 21% of total APEC metallurgical coal production. Almost all of Australia's metallurgical coal was exported, making Australia the world's largest exporter of metallurgical coal. The value of Australia's metallurgical coal exports fell from AUD 34 billion in 2019–20 to AUD 23 billion in 2020–21, due to a fall in prices and lower export volumes (Resources and Energy Quarterly, March 2021). The value of Australia's metallurgical coal exports is above the value of Australia's thermal coal exports, which was just short of AUD 15 billion in 2020–21, down from AUD 20 billion in 2019–20. Australian thermal coal exports fell due to lower prices brought on by the pandemic and reduced access to Chinese markets.

Russia, the US, and Canada were the next three most prominent metallurgical coal producers, with these three economies growing their production 62%, 42%, and 31%, respectively, for the decade to 2019. China's production increased by 20% for the same decade and Australia's increased by 46%.

Figure 3.6: Metallurgical coal production for APEC economies, 2009 and 2019



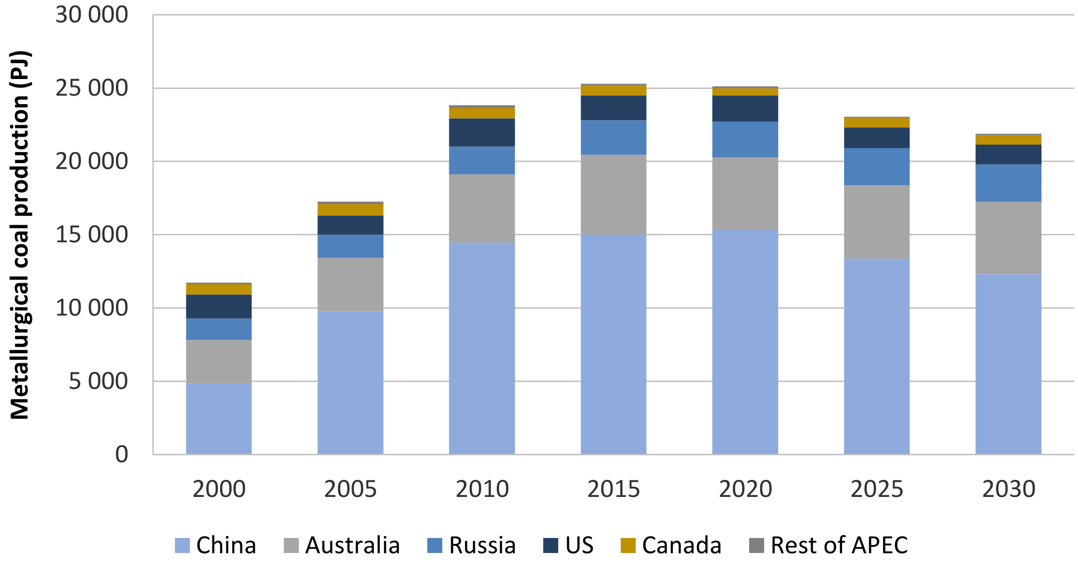
Source: IEA (2021), APERC calculations

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 US (-34%), Canada (-18%) and China (-13%). Australia and Russia are projected to post a small reduction in metallurgical coal production to 2030 (Figure 3.7).

According to the Institute for Energy Economics and Financial Analysis (IEEFA), there was a 35% decline in metallurgical coal output from mines in the Appalachian region of the U.S in 2020 (IEEFA, 2020). This pandemic impact has brought forward some of the declines that were anticipated to occur out to 2030.

Almost all of China's metallurgical coal production is used by its domestic steel industry. The projected decreasing trend out to 2030 is driven by a softening steel production outlook over the medium- to longer-term. For the immediate pandemic response, metallurgical coal production in Australia is estimated to rebound strongly in 2021, especially with the current supply bottle necks driving metallurgical coal spot prices to unprecedented levels of over USD 400 per tonne in October 2021. However, in the medium- to long-term, both Australian and Russian metallurgical coal production are expected to post small declines.

Figure 3.7: APEC metallurgical coal production since 2000 with forecasts to 2030



Source: EGEDA (2021) and preliminary APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

Box 3: 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.

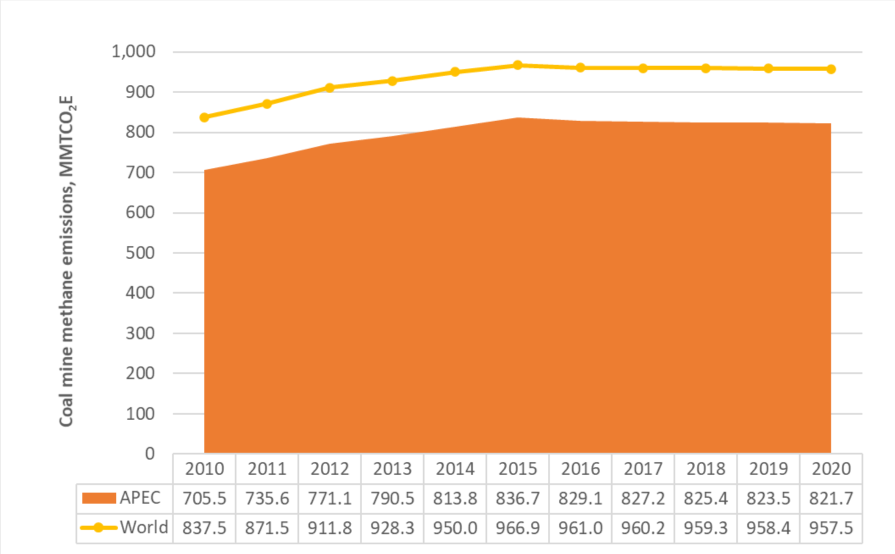
CMM from open-pit coal mines contribute 12% of total CMM emissions via direct exposure to the atmosphere. There is currently no method to recover CMM from open-pit coal mines (EPA, 2021a).

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.3.1: APEC-wide and global coal mine methane emissions, 2010-2020

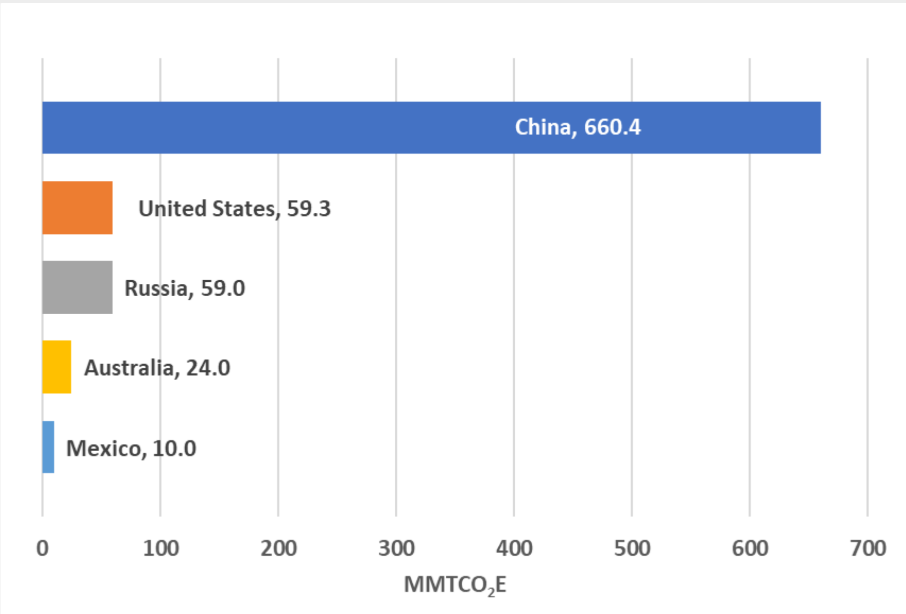


	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
APEC	705.5	735.6	771.1	790.5	813.8	836.7	829.1	827.2	825.4	823.5	821.7
World	837.5	871.5	911.8	928.3	950.0	966.9	961.0	960.2	959.3	958.4	957.5

Source: APERC analysis based on Global Methane Initiative data.

The top-five CMM emitters in APEC accounted for 99% of total APEC CMM emissions in 2020 (Figure B.3.2). 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.

Figure B.3.2: Methane emissions from coal mines in the top five APEC economies, 2020



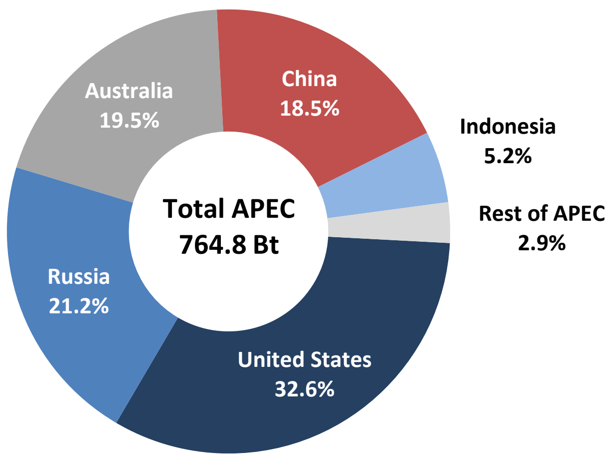
Source: APERC analysis based on Global Methane Initiative data.

APEC coal reserves

Coal reserves

APEC economies accounted for 72% of global coal reserves in 2019 (BP, 2020). The United States, Russia, Australia, China, and Indonesia, hold over three-quarters of proven coal reserves, which is 97% of APEC-wide reserves (Figure 3.8).

Figure 3.8: APEC coal reserves, 2019



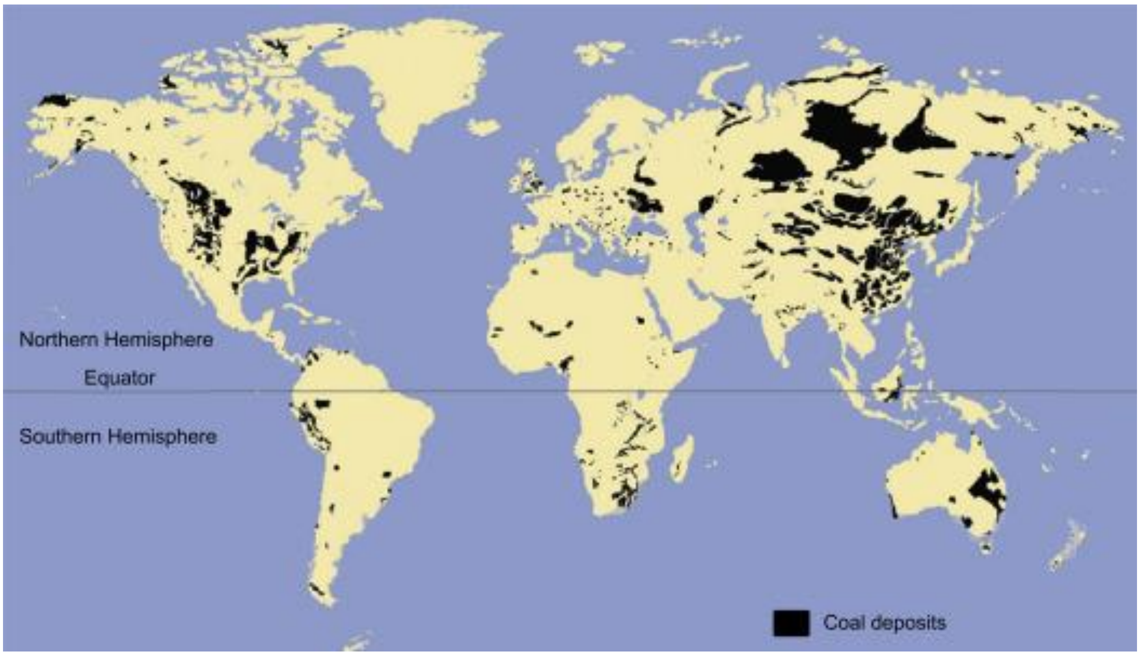
Source: APERC analysis based on BP (2020) and U.S. EIA (2021b)

The vast coal reserves in the Unites States are distributed among three main regions, namely, the Appalachian, the Interior, and the Western regions. The Appalachian coal region traverses Alabama, Eastern Kentucky, Maryland, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. The Interior coal region spans Arkansas, Illinois, Indiana, Kansas, Louisiana, Mississippi, Missouri, Oklahoma, Texas, and Western Kentucky. While the Western coal region covers Alaska, Arizona, Colorado, Montana, New Mexico, North Dakota, Utah, Washington, and Wyoming (EIA, 2021c). The North Antelope Rochelle coal mine operated by Peabody Energy in the Powder River Basin of Wyoming is the world's largest coal mine, in terms of reserves (Mining Technology).

Russia's 162 billion tonnes (Bt) of proven coal reserves are second, behind the US. 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. More than two-thirds of the coal produced in Russia is hard coal, with the Pechora and Kuznetsk basins accounting for most hard coal deposits. The Kansk-Achinsk Basin is known for huge deposits of sub-bituminous coal, while the Raspadskaya mine in the Kemerovo region is the largest coal mine in Russia (Mining Technology).

Australia holds 149 Bt of coal reserves, which is third on a global and APEC basis. 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).

Figure 3.9: Global coal reserves regions



Source: Suárez-Ruiz et al. (2019)

China's 142 Bt of proven coal reserves accounted for over 18% of total APEC coal reserves. Deposits of anthracite, bituminous, sub-bituminous and lignite, are mainly located in the north and north-west regions. China is the largest coal producer and consumer both in APEC and the world, which means that its reserves to production ratio is much lower than other APEC economies with large coal reserves.

Indonesia holds 40 Bt of APEC's total proven coal reserves, with deposits mostly located in South Sumatra, East Kalimantan, and South Kalimantan. The East Kalimantan province accounts for more than half of Indonesia's total coal production, East Kalimantan is the biggest coal mine in Indonesia (Mining Technology). Around 60% of Indonesia's total coal reserves is sub-bituminous (Indonesia Investments).

Coal reserves-to-production ratio

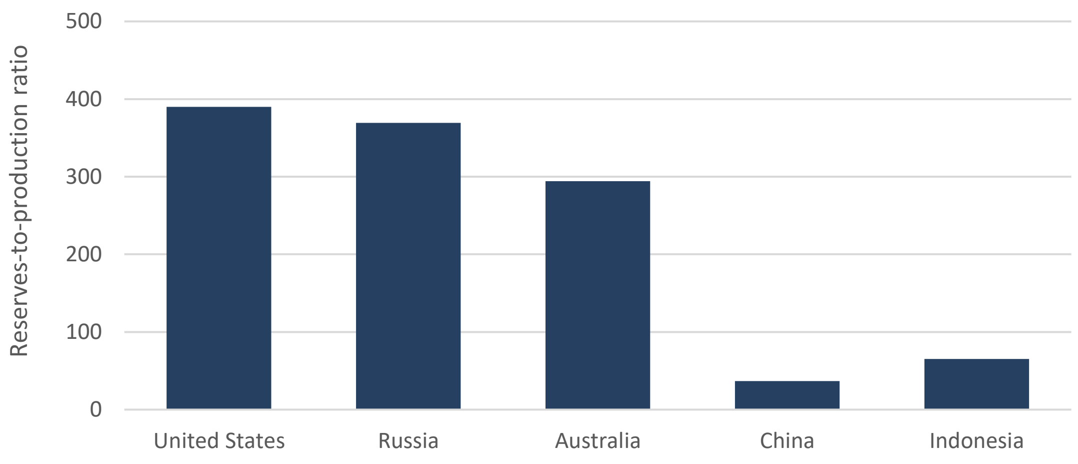
The reserves-to-production (R/P) ratio[9] is a method used to provide context for the size of coal reserves. The value represents the number of years that current reserves would last if the production remained constant.

Figure 3.10 shows that the United States, Russia, and Australia have reserves that are far larger than foreseeable levels of consumption (multiple hundreds of years of current production). China's very high current production levels, combined with lower reserves means the R/P is significantly lower. However, even at current very high production levels, China would be able to continue consuming coal from domestic sources until well past 2050.

[9] Reserves-to-production (R/P) ratio – if the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate.

Indonesia currently produces significant levels of thermal coal for domestic consumption and for export markets. But even with this high level of production, Indonesia could continue at the same rate for another 65 years.

Figure 3.10: R/P ratio of the top five APEC coal producers, 2019



Source: APERC analysis based on BP (2020).

Chapter 4: Coal trade

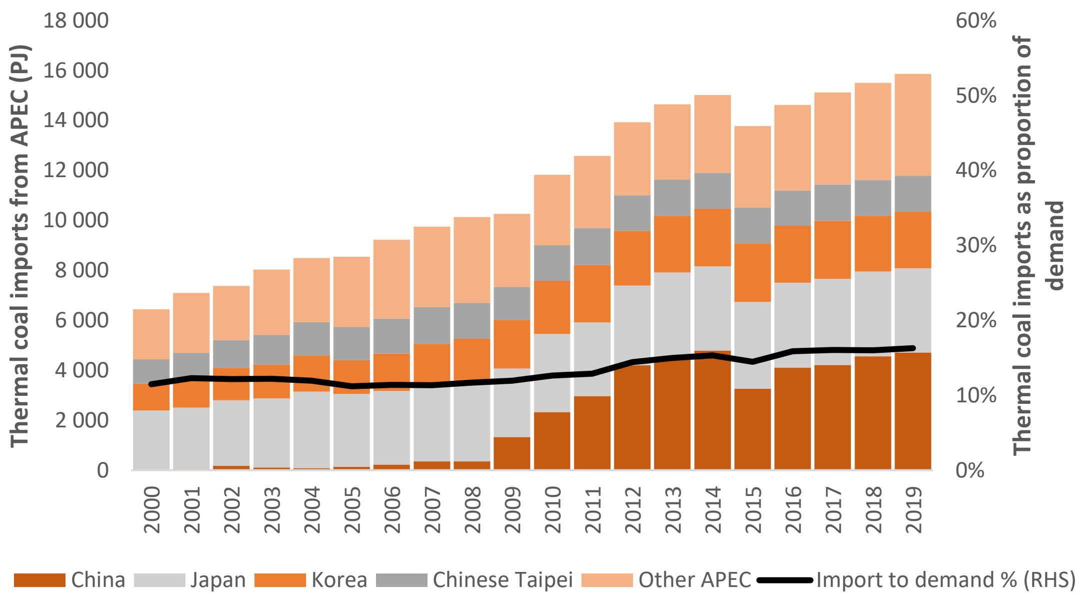
APEC thermal coal and metallurgical coal trade between APEC economies and the rest of the world has increased significantly over the past two decades. However, the COVID-19 pandemic caused a large drop in trade volumes in 2020, with total coal exports falling 4.7% to 26.1 EJ (BP, 2021).

APEC thermal coal trade

APEC economies imported increasing quantities of thermal coal from 2015 through 2019, before the impacts of the pandemic (Figure 4.1). China has significantly ramped its level of thermal coal imports since 2009, when it was no longer able to satisfy its demand from domestic production. 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 2019, steadily increasing from 11% in 2000. This shows that APEC thermal coal consuming economies have increasingly relied on overseas sources to meet their demand.

Figure 4.1: Thermal coal imports and proportion of thermal coal imports to thermal coal consumption, APEC economies, 2000–2019



Sources: IEA (2021), APERC calculations.

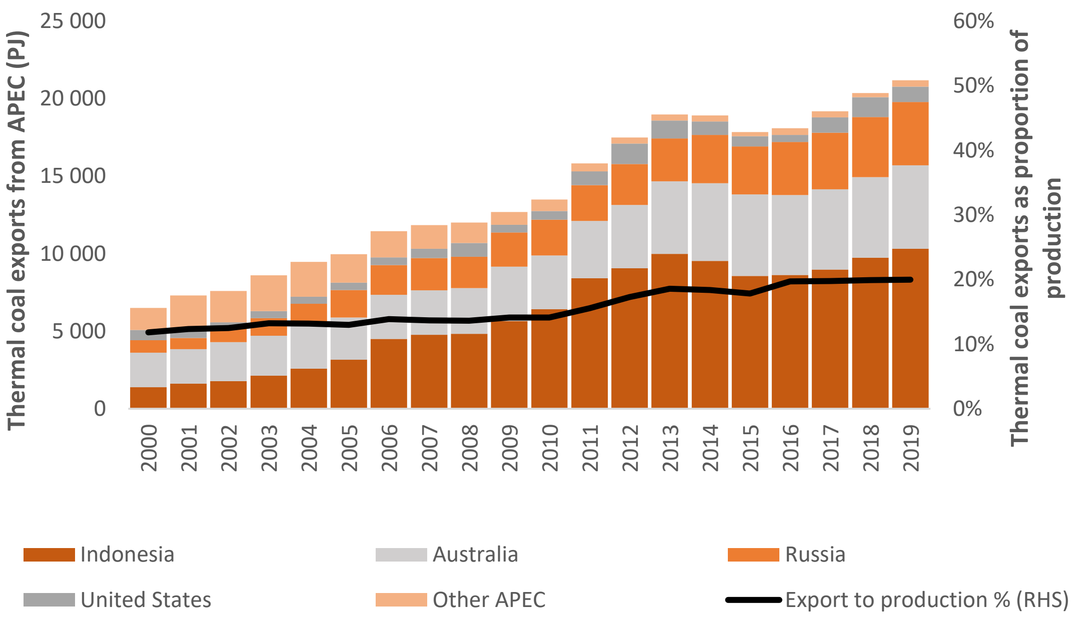
APEC thermal coal imports were 15.9 EJ in 2019, which is significantly lower than the 21.2 EJ of thermal coal exports from APEC thermal coal producers, as shown in Figure 4.2. Indonesia has ramped its thermal coal exports significantly over the last two decades, accounting for 49% of APEC thermal coal exports. Australia is the next most prominent thermal coal exporter, accounting for 25% of APEC thermal coal exports.

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 that proportion of thermal coal that would typically 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 is the case in the latter half of 2021, exacerbated by rapidly increasing demand. China has recently allowed multiple Australian shipments of thermal coal to clear customs in September 2021, in the face of the escalating energy crisis (FT, 2021).

In Canada, the federal government has developed policies to reduce thermal coal exports, including re-exports, by 2030 (Liberals, 2021). These policies are not law, though are likely to significantly reduce thermal coal exports in Canada this decade.

APEC thermal coal exports as a proportion of APEC thermal coal production maintained a level of 20% in 2019. This has increased from 12% in 2000, though shows that most APEC thermal coal production is consumed domestically (80%). This APEC wide statistic is mostly driven by China's pattern of overwhelming domestic consumption.

Figure 4.2: Thermal coal exports and proportion of thermal coal exports to thermal coal production, APEC economies, 2000–2019



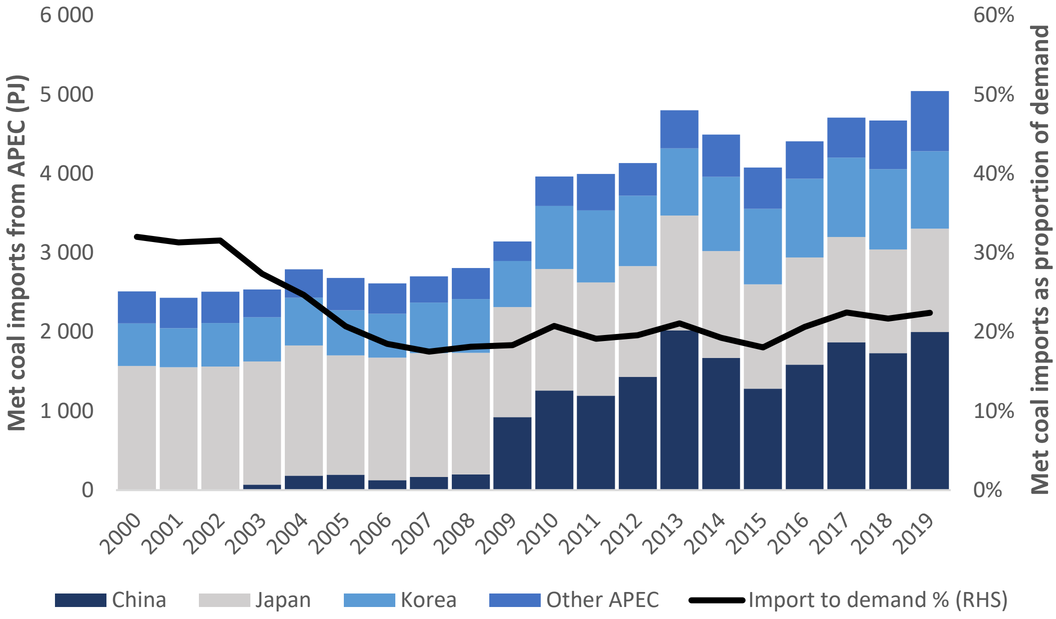
Sources: IEA (2021), APERC calculations.

APEC metallurgical coal trade

Metallurgical coal trade is significantly lower than 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 means that the value of metallurgical coal exports is more than suggested by traded quantities. Figure 4.3 shows that metallurgical coal imports reached 5.0 EJ in 2019, which represents a large annual increase of 8.0% from the year before. Again, China is the largest metallurgical coal importer, having had to significantly ramp-up its metallurgical coal imports from 2009, given that its domestic resources were insufficient to meet the needs of its rapidly growing steel industry.

Japan is still a major metallurgical coal importer, accounting for 26% 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 1.3 EJ in 2019 (Japan's metallurgical coal consumption was even larger before 2000).

Figure 4.3: Metallurgical coal imports and proportion of metallurgical coal imports to metallurgical coal demand, APEC economies, 2000–2019



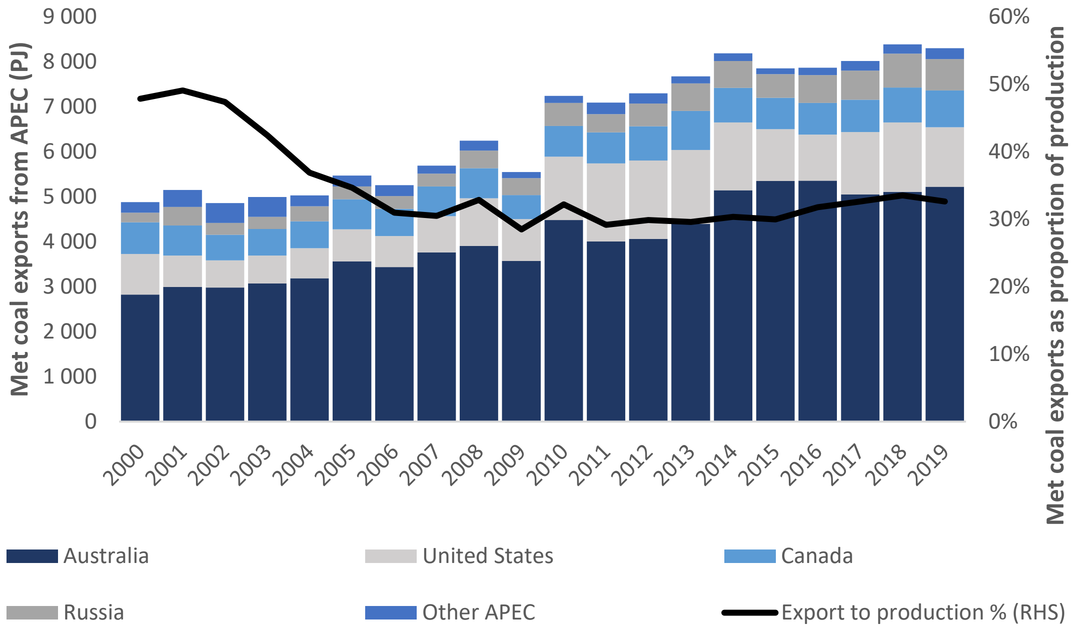
Sources: IEA (2021), APERC calculations.

Korea is the other major APEC metallurgical coal importer, with just under 1.0 EJ imported in 2019. APEC metallurgical coal imports as a proportion of APEC metallurgical coal consumption has fluctuated near 20% for over decade, having fallen from 32% at the beginning of the millennium.

APEC metallurgical coal exports moderated to 8.3 EJ in 2019, down from 8.4 EJ the year before, as shown in Figure 4.4. Australia is by far the largest metallurgical coal exporter, accounting for 63% of APEC metallurgical coal exports in 2019. The United States, Russia and Canada are the next most prominent metallurgical coal exporters, accounting for 16%, 10%, and 8% of APEC metallurgical coal exports in 2019, respectively.

One out of every three joules of APEC metallurgical coal production is exported by APEC metallurgical coal producers. This is down from a high of almost 50% of joules of production being destined for export near the beginning of the millennium.

Figure 4.4: Metallurgical coal exports and proportion of metallurgical coal exports to metallurgical coal production, APEC economies, 2000–2019



Sources: IEA (2021), APERC calculations.

APEC coal trade projections

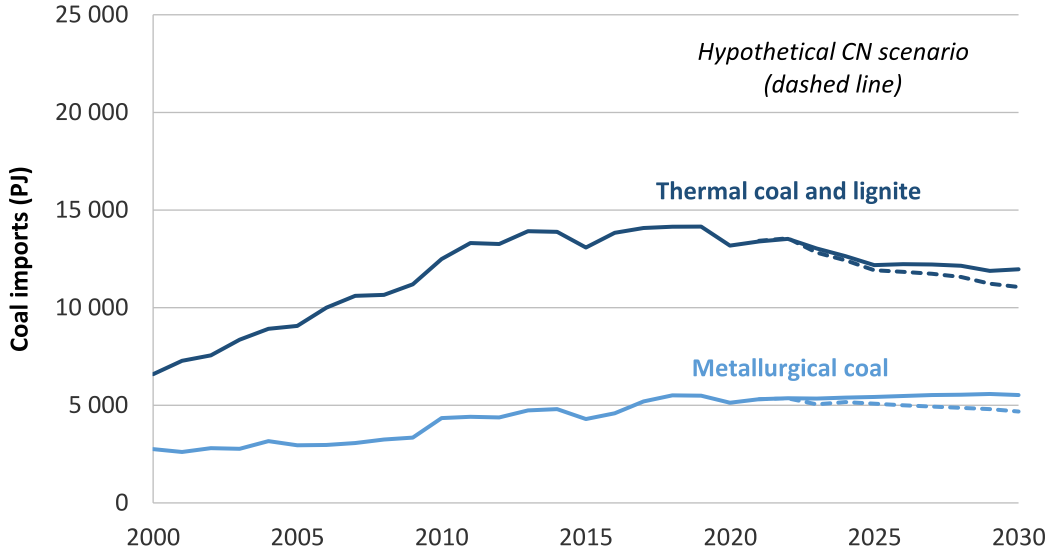
Coal import and export volumes were expected to rebound to pre-pandemic levels in 2021. However, the current large coal price spikes brought on by surging economic growth and supply disruptions mean that the magnitude of the rebound is uncertain.

Moving beyond the short-term volatility brought on by the pandemic, the forthcoming *APEC Energy Demand and Supply Outlook* estimates that thermal coal imports will decline slowly, while metallurgical coal imports will increase slowly, out to 2030, as shown in Figure 4.5. Assumed robust steel production explains metallurgical coal's resilience. The decline in thermal coal imports aligns with the planned movement 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 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 increases 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.

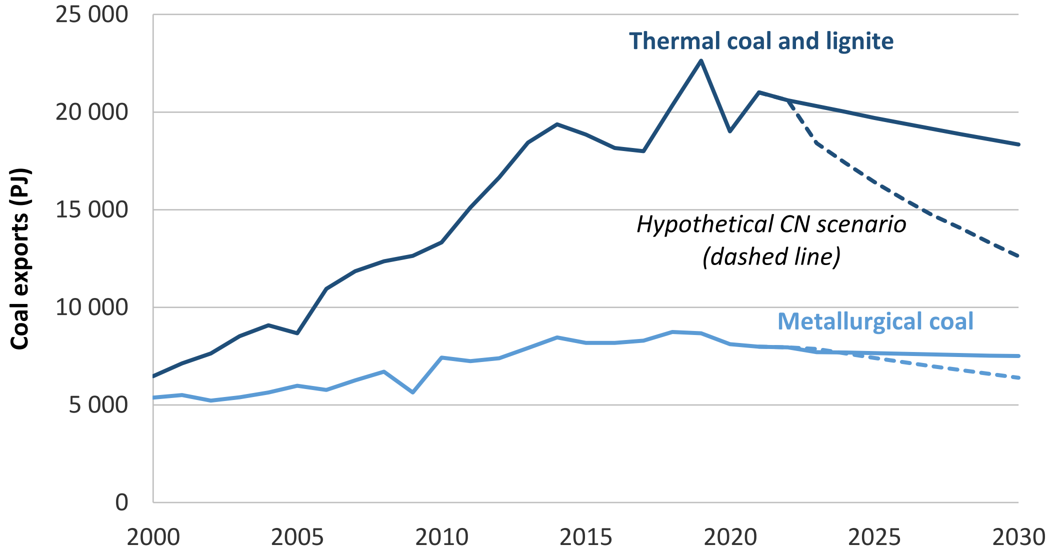
Figure 4.5: APEC coal imports from 2000, with projections to 2030



Source: EGEDA (2021) and APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

APEC coal exports are significantly larger than APEC coal imports. Figure 4.6 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 continue to meet supply requirements for large steel-producing economies.

Figure 4.6: APEC coal exports from 2000, with projections to 2030



Source: EGEDA (2021) and APERC forecasts from forthcoming APEC Energy Demand and Supply Outlook

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

The price of coal varies according to rank and quality and the costs associated with different mining methods and geographic regions. Coal rank and quality correspond to the carbon content and heat energy that different types of coal products. In terms of mining methods, opencast mines have lower production costs than underground coal mines. Whereas coal mines located far from export ports face additional transport costs. In some cases, transportation costs can account for 20% or more of total production costs.

Prices

Thermal coal and metallurgical coal are used for two different purposes. The power generation sector and industry (for example, cement and pulp and paper) use thermal coal as a source of heat, while the steel-producing sector uses metallurgical coal for the iron ore-smelting process.

Benchmark metallurgical coal prices have historically traded at a premium, and often significantly so. Certain market conditions have meant that metallurgical coal has traded at a price that is more than three times that of the thermal coal price (see Figure 1.1 earlier in the report).

Thermal coal

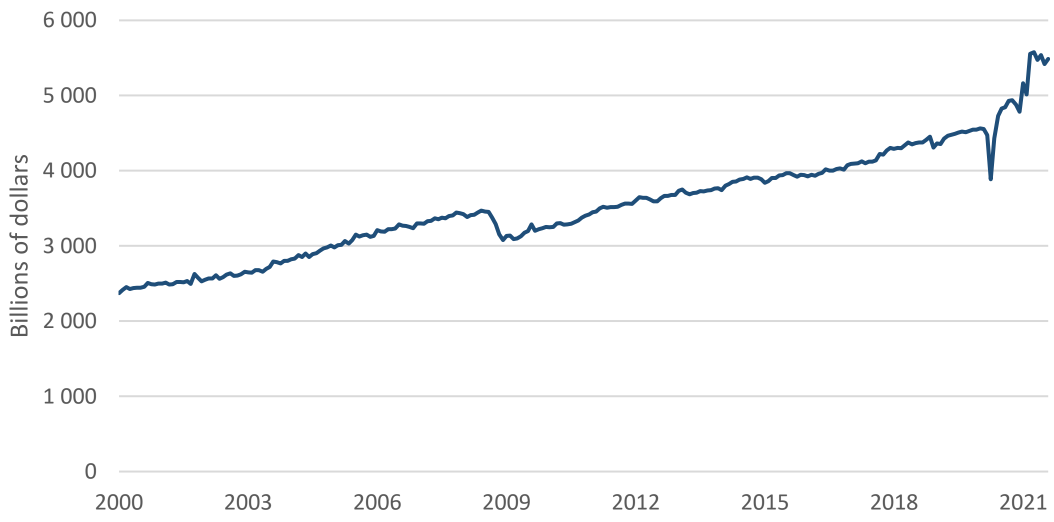
Figure 5.1 shows the Newcastle benchmark thermal coal spot price, which is a widely traded seaborne thermal coal price for the APEC region from September 2017 to September 2021. Following the initial COVID shock in early 2020, subsequent soft demand meant that prices dipped below USD 50 per tonne. Since this low in mid-2020, thermal coal prices have traced a meteoric rise, most recently reaching USD 218 per tonne at the end of September 2021.

Figure 5.1: Newcastle benchmark thermal coal spot prices, September 2017 to September 2021

Source: globalCOAL, Trading Economics.

The large rise in price has been due to both supply and demand issues. On the demand side, the COVID pandemic has 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 (see Figure 5.2 for US representation of this surge in goods demand). 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.

Figure 5.2: Monthly US personal consumption expenditure on goods, January 2000 to August 2021



Source: FRED (2021)

Preceding the very large increase in thermal coal demand, on the supply side, the initial shock of the pandemic led to large production declines in China. These declines in production were compounded by a mining safety campaign in late-2020 that was instituted in response to two catastrophic mining accidents in Chongqing (WSJ, 2021). The safety campaign significantly slowed China's coal production while electricity output posted tremendous growth. The result has been depleting thermal coal inventories through most of 2021.

To make matters worse, import bans on Australian coal remain in place, and Indonesian coal exports have slowed due to heavy rain and flooding. There have also been reduced imports from Mongolia, another major source of supply for China, due to COVID-induced falls in production (Nucleus, 2021). Natural gas supplies have also been difficult to secure with the unfolding turmoil in Europe, leading China to impose production restrictions on multiple industries, including steelmaking, aluminium smelting, cement manufacturing, and fertiliser production, to meet the challenge of a lack of power generation supply (BBC, 2021). Even with these industrial shutdowns, there has been a series of power blackouts in Guangdong in the south and Heilongjiang, Jilin, and Liaoning in the north-east, that have resulted from the ongoing energy crisis.

The coming 2021 winter and accompanying rising energy demand means that the energy crisis is yet to abate. China's largest coal producers have pledged to increase output to ensure that there is sufficient power generation and heating for the economy to return to prior levels of growth (Mining Technology, 2021). But even with an improvement in the energy situation, it is likely that APEC will be susceptible to tight energy markets for at least the remainder of 2021, as energy producers in China scramble to secure sufficient levels of fuel supplies. High prices will fall when more normal conditions return. But a particularly cold winter or additional supply shocks could see thermal coal prices remain elevated.

Ballooning thermal coal prices have implications beyond China. However, for economies that are not subject to rapidly rising electricity demand, long-term thermal coal contracts are often sufficient to meet short-term demand and avoid anomalous price spikes. For example, Japanese utilities typically negotiate prices up to a year in advance and these contractual arrangements are then used by other economies such as Thailand, Chinese Taipei, and Malaysia as a reference price to ensure surety of supply (SteelMint, 2020). Continued high prices will impact future negotiations, but it's less of a risk given that the current crisis should pass, assuming an absence of additional supply shocks.

Metallurgical coal

Figure 5.3 shows the Australian premium hard coking coal spot price between September 2017 and September 2021. The reduction in demand brought on by the COVID pandemic saw metallurgical coal prices soften to just above USD 100 per tonne, the lowest price level since 2016.

Figure 5.3: Australian premium hard coking coal spot price, September 2017 to September 2021

Source: Fastmarkets.

While many steel-producing economies had a reduced level of steel production in 2020, Chinese steel producers took advantage of reduced metallurgical coal prices and ramped production significantly, posting annual steel production growth of 5.2% (WSA, 2021). This increase in production was due to anticipation of large infrastructure stimulus spending, not only in China but throughout APEC.

The same mining safety measures that slowed thermal coal production in China have also slowed metallurgical coal production. Even with reduced metallurgical coal supply, Chinese steel manufacturers continued to produce steel at record high levels in the first half of 2021. This was at odds with government commitments to achieve emissions reduction goals (S&P Global, 2021).

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.a).

With the energy crisis coming to a head in China in September 2021, the government compelled multiple steel producers to temporarily limit production. 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, having spiked to over USD 400 per tonne at the beginning of October 2021; a quadrupling since the first half of the year. It will not take long for adequate supplies to arrive in the spot market and for there to be a significant fall in price.

Short-term projections

Inventory normalisation is still occurring for both thermal coal and metallurgical coal. China's power producers and steel producers remain the most influential players in both markets, with their activity driving much of the dramatic price rises through 2021 thus far. As supply issues improve, prices will fall and moderate. Futures prices for both thermal and metallurgical coal convey that market participants expect prices to return to prior lower levels relatively quickly (globalCOAL Newcastle Coal Futures, 2021).

The prices of for both major types of coal are volatile in the face of supply and demand shocks such as those that are currently occurring. However, on an inflation adjusted basis, the long-term average price for coal has been relatively stable for 140 years (Oxford, 2021). For the moment, the surge in industrial power demand brought on by heightened demands for goods, combined with multiple supply disruptions, are driving the unprecedented price levels.

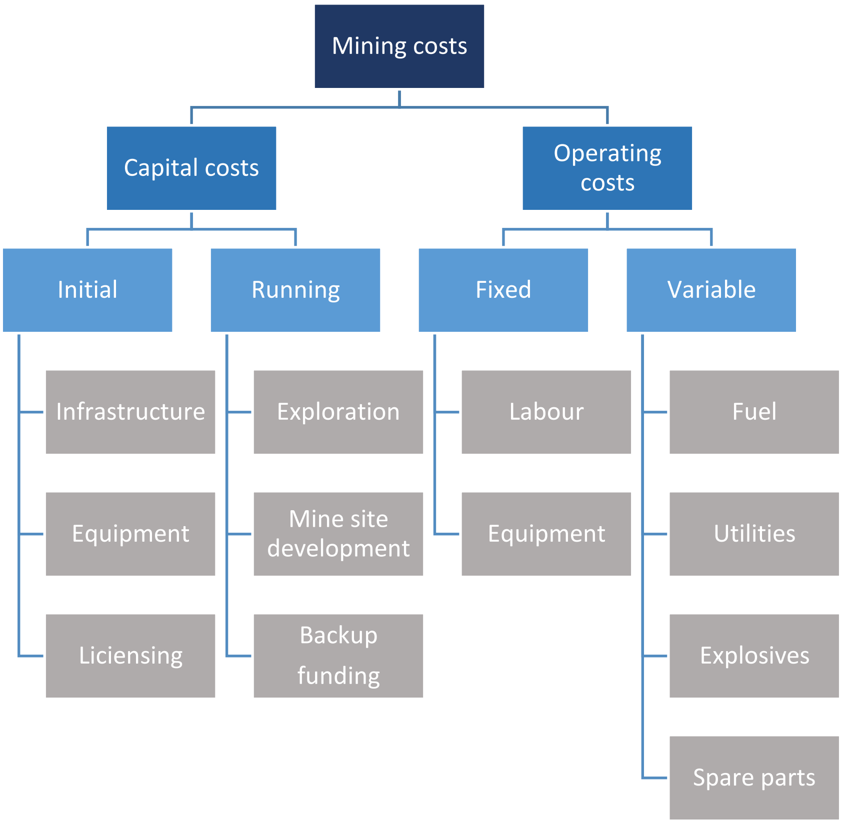
Coal supply costs

The cost of producing coal comprises two components: capital costs and operating costs (Figure 5.4). 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. Whereas 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.

Figure 5.4: Mining cost structure



Thermal coal

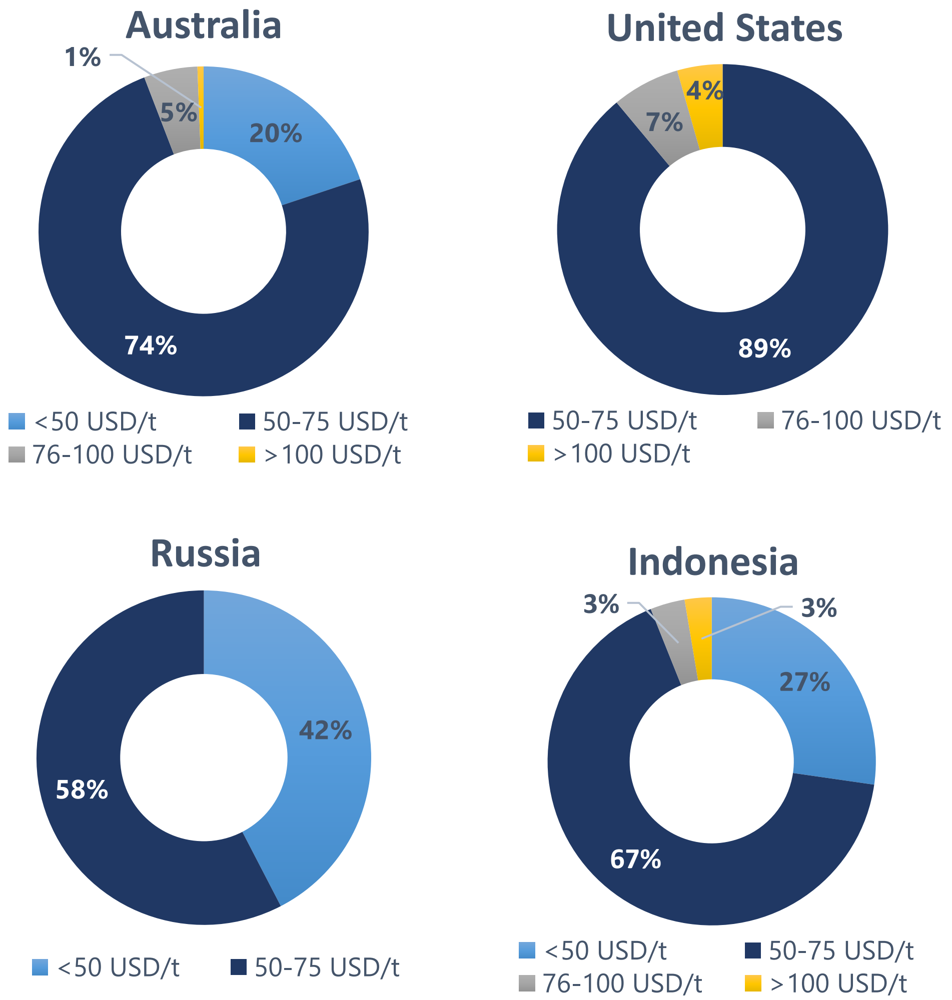
Calorific value (CV) is a measurement of coal quality or grade, with different grades associated not only with value, but also correlating with production costs. The analysis below is separated into thermal coal with high calorific value (greater than 5 700 kcal/kg) and low calorific value (less than 4 500 kcal/kg)[10].

Production costs for high CV thermal coal in 2019 ranged from USD 35.5 to USD 150 per tonne, depending on economy (Figure 5.5). 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%).

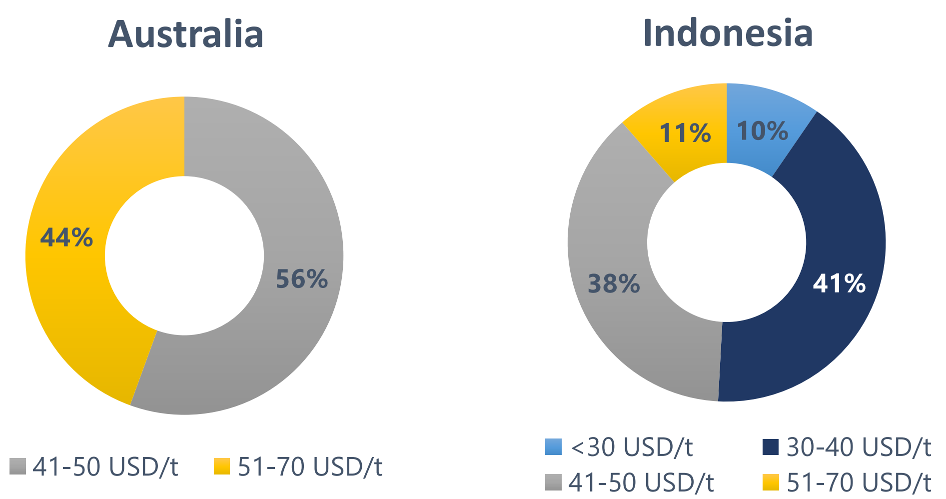
[10] Thermal coals with calorific values between 4500 kcal/kg and 5700 kcal/kg are excluded due to its lesser popularity in the Asia Pacific's coal market.

Figure 5.5: The share of high CV coal production by supply cost, 2019



Source: IEA (2020b), APERC calculations.

Figure 5.6: The share of low CV coal production by supply cost, 2019



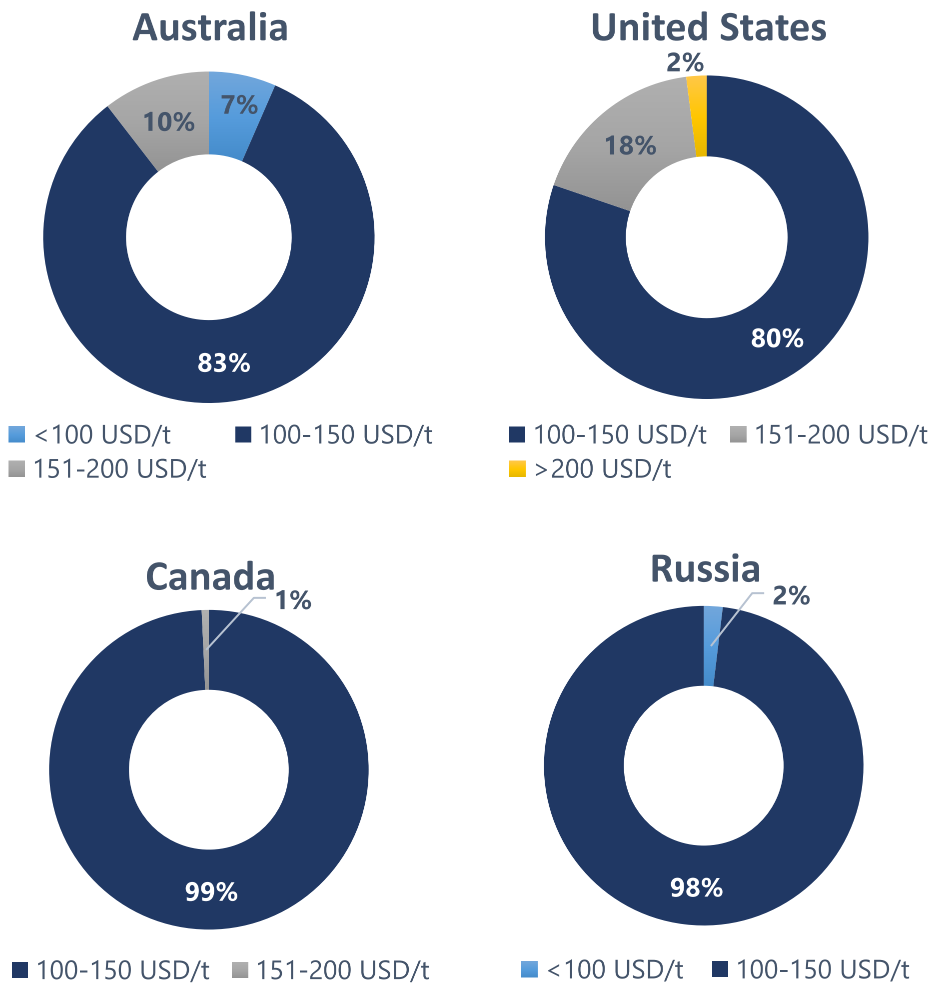
Source: IEA (2020b), APERC calculations.

For low CV thermal coal, production costs are typically lower. In Indonesia and Australia, costs ranged from USD 24 to USD 68 per tonne (Figure 5.6). Indonesia has the cost advantage over Australia, with 91% of its production achieved for less than USD 50 per tonne. In contrast, 44% of Australia's low CV thermal coal production had a cost of more than USD 50 per tonne.

Metallurgical coal

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. Then mining method (such as underground mining or opencast mining), location, and geological conditions, are also important cost determinants.

Figure 5.7: Supply costs in main APEC metallurgical coal producers, 2019



Source: IEA (2020b), APERC calculations.

Figure 5.7 shows 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.

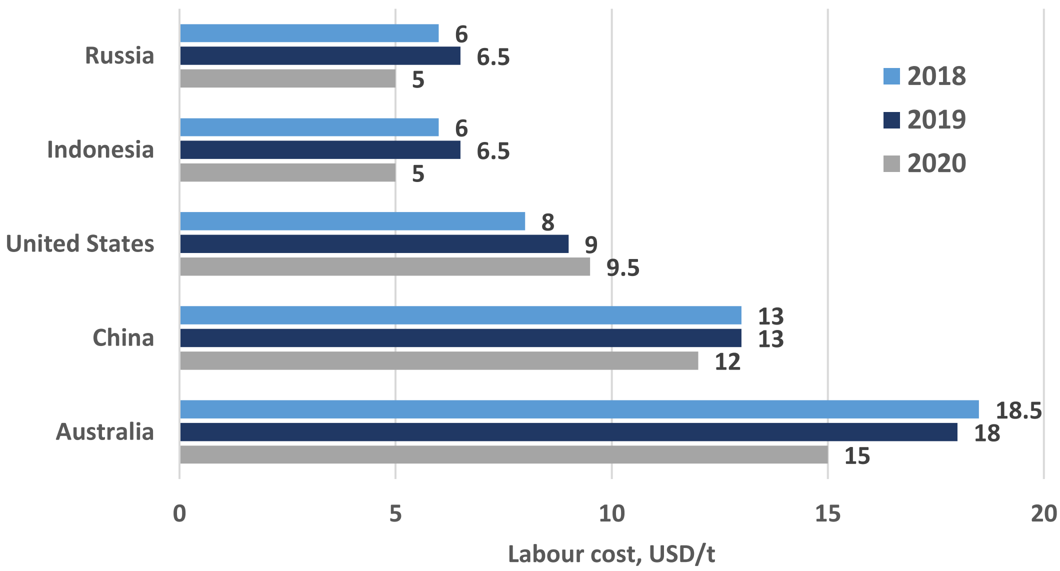
Input factors influence supply costs

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 US, Indonesia, and Russia (Figure 5.8). Labour costs were relatively stable in 2018 and 2019, though reduced substantially in all APEC economies in 2020, except for the US.

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 US has seen a continuation in rising labour costs in 2020 to USD 9.5 per tonne.

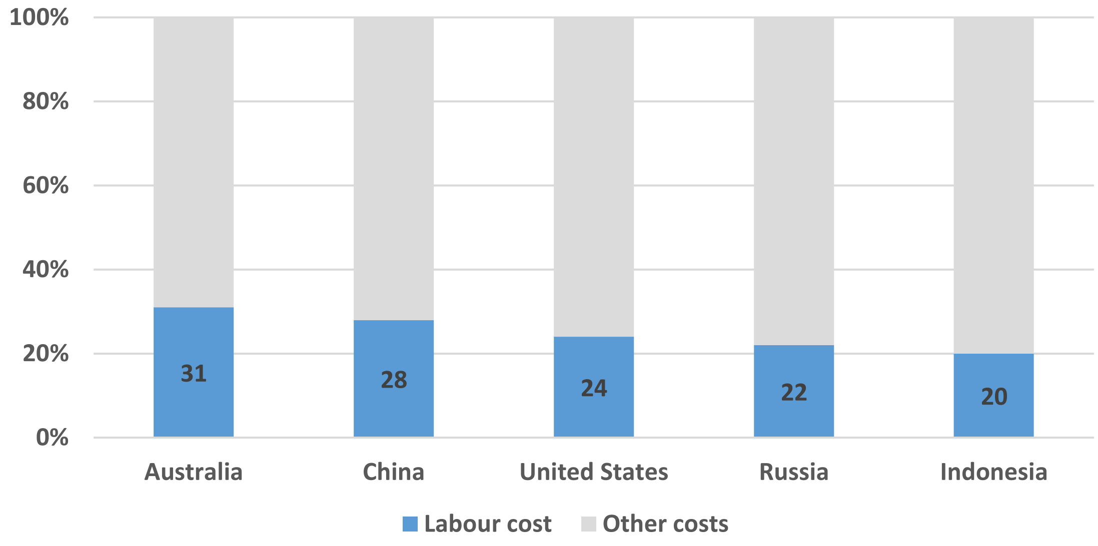
Figure 5.8: Average labour cost in main coal-producing economies in APEC region, 2018-2020



Source: IEA (2020b), APERC calculations.

Unsurprisingly, the economy with the highest labour cost proportion was Australia: labour accounted for 31% of total mining costs in 2019 (Figure 5.9). 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.

Figure 5.9: Share of labour cost in total coal mining costs in selected APEC economies, 2019



Source: IEA (2020b), APERC calculations.

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Appendices

Table A.1: Legal documents concerned with coal mining pollution in the APEC economies

Economy	Legal documents	Notes
Australia	Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).	Each state has its own legislation. E.g. Mineral Resources Act 1989 (QLD), Mining Act (WA, SA, NSW)
Brunei Darussalam	Environmental Protection and Management Order, 2016	
Canada	Mines and Minerals Act, and Environmental Protection, Enhancement Act in Alberta, Mines Act, Environmental Assessment Act, Sustainable Environment Fund Act, Waste Management Act (Placer Mining Waste Control Regulation, Sulphur Content of Fuel Regulation, Contaminated Sites Regulation), and Water Protection Act in the British Columbia.	Other provinces and territories in Canada have their own coal mine-related legislations.
Chile	The Law of Environmental Basis	
China	Mineral Resources Law	
Hong Kong, China		
Indonesia	Law No. 32 of 2009 on the Management and Protection of the Environment, Law on Mineral and Coal Mining 2010.	
Japan	Mining Act 1950	
Korea	Mining Industry Act, Air Environment Preservation Act (AEPA), Water Environment Preservation Act (WEPA), Noise and Vibration Control Act (NVCA), Waste Management Act (WMA), and Toxic Chemicals Control Act (TCCA).	
Malaysia	Mineral Development Act 525, and Environmental Quality Act	
Mexico	Federal Environmental Law	
New Zealand	Resource Management Act 1991, Climate Change Response Act 2002t, Health and Safety at Work Act 2015	
Papua New Guinea	Mining Act 1992	
Peru	General Mining Law	
Philippines	Philippine Mining Act, National Water & Air Pollution Control Act (R.A. 3931).	
Russia	The Federal law of Russian Federation, 1996	
Singapore	Environmental Protection and Management Act	

Chinese Taipei	Basic Environment Act 2002, Air Pollution Control Act	
Thailand	Mineral Act No. 5 B.E. 2545 (2002), the Enhancement and Conservation of Natural Environmental Quality Act B.	
USA	Clean Air Act, and the Clean Water Act	
Viet Nam	Environmental Protection Law, Law on Water Resources, and Law on Minerals.	

Table A.2: 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.

Sources: IEA (2019), Boom and Bust (2021).

Table A.3: 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)

Sources: Global Energy Monitor, as July 2021.

Table A.4: 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)

Sources: Global Energy Monitor, as July 2021.