Towards Net Zero: Implications for Australia of Energy Policies in East Asia

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Abstract

China, Japan and South Korea have all set targets to achieve net-zero carbon emissions by around the middle of this century. These three countries account for around two-thirds of Australia's fossil fuel exports. Based on emission scenarios consistent with these commitments, we find that Australia's coal exports could decline significantly by 2050, with a more modest effect likely for liquefied natural gas exports; both may be offset to some degree by increases in green energy exports. The effect on overall Australian GDP is expected to be relatively small and gradual. Significant uncertainty surrounds the speed and manner in which countries will work to achieve net-zero emissions, as well as the technological developments that could change the efficiency and carbon intensity of fossil fuels.

International energy production and emissions

Global carbon emissions have risen sharply over the past 150 years. The major driver of this increase has been the rise in global energy use. Over the past 50 years, the world's energy supply has more than doubled, and in recent years the share generated by fossil fuels – the major source of carbon emissions – has accounted for around 80 per cent (Graph 1).

As parties to the Paris Agreement on climate change, the governments of China, Japan and South Korea have each announced targets to substantially reduce carbon emissions over the coming decades. These economies are Australia's top three goods export partners, and are destinations for around two-thirds of Australia's fossil fuel exports. As a result, their efforts to reduce carbon emissions will be a significant determining factor in the outlook for Australia's exports.

China, Japan and South Korea are jointly responsible for around a quarter of global fossil fuel consumption. Fossil fuels (including oil, coal and

natural gas) dominate these countries' energy mix, providing more than 85 per cent of energy supplied in these countries in 2018, far higher than in the remainder of the world (Graph 2). China is the most significant emitter of carbon of the three countries, due to its large population and energy mix. Coal accounted for around 60 per cent of China's energy use in 2018, far greater than in Japan and South Korea (where oil is the main fossil fuel) and the rest of the world (where the main fossil fuel is natural gas). China is a heavy user of coal given the country's abundant coal reserves, while Japan and Korea, with minimal domestic energy reserves, have relied more on oil. In general, coal use produces substantially more carbon emissions than either oil or natural gas for the energy it generates. This means that China's energy mix in particular is highly carbon intensive; the ratio of carbon dioxide emitted to energy supplied in China was around a quarter higher than the global average in 2018 (International Energy Agency 2021a).

China is also the world's largest energy-consuming country, responsible for around one-fifth of the world's total consumption (International Energy Agency 2021b). This is primarily a function of China's population, which is also the world's largest. Adjusted for population size, China's per capita energy use is broadly comparable to that of other east Asian economies, including South Korea, when they were at a similar level of GDP per capita (Graph 3).

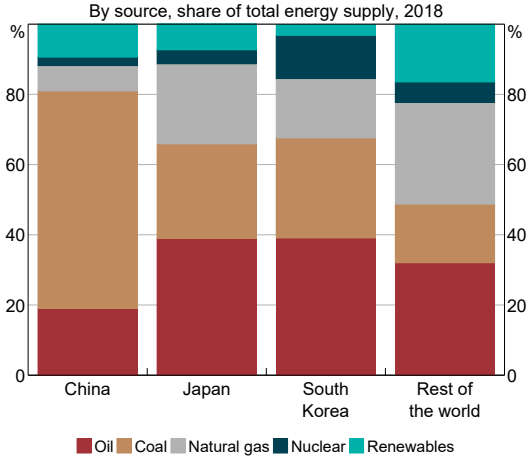
Emissions targets in China, Japan and South Korea and corresponding policies

Japan and South Korea have committed to achieving net-zero emissions of greenhouse gases by 2050, while China has committed to net-zero emissions of carbon dioxide by 2060. Carbon dioxide is by far the most significant greenhouse gas emitted by all three countries. In the interim, Japan and South Korea are targeting 46 per cent and 24 per cent reductions in greenhouse gas emissions from recent levels (2013 and 2017, respectively) by 2030 (Tsukimori 2022; Republic of Korea 2020).[1] China is similarly targeting a peak in carbon emissions by 2030 and a 65 per cent drop in the carbon intensity of output from 2005 levels at that time.[2] These targets are summarised in Graph 4. Emissions have been rising more quickly in

Graph 2

Energy Mix

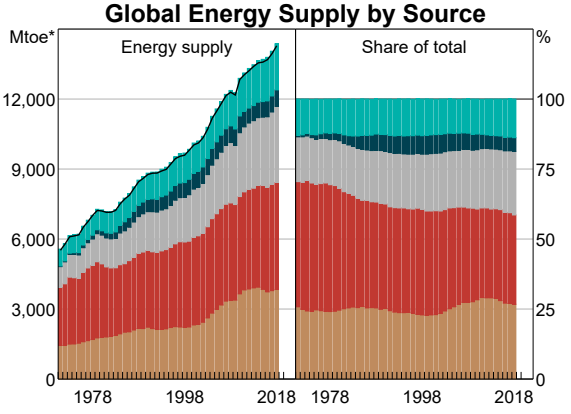
By source, share of total energy supply, 2018



Sources: International Energy Agency; RBA

Graph 1

Global Energy Supply by Source



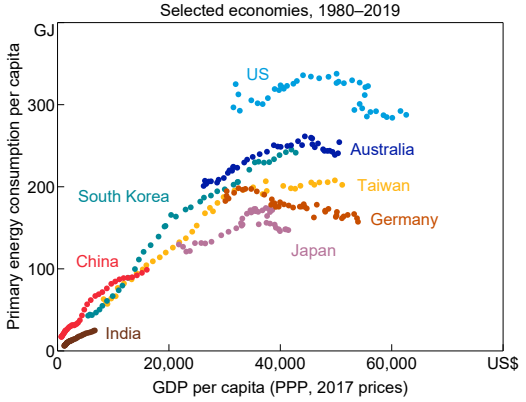
* Million tonnes of oil equivalent
** Crude oil, NGLs and feedstock

Sources: International Energy Agency; RBA

Graph 3

Energy Consumption per Capita

Selected economies, 1980–2019



Sources: BP; IMF; RBA

China than in Japan or South Korea in recent years, and the planned peak in emissions is much later. The absolute decline in emissions required to achieve net-zero emissions is highest for China, but on a per capita basis it is roughly similar across the three countries (Graph 5).

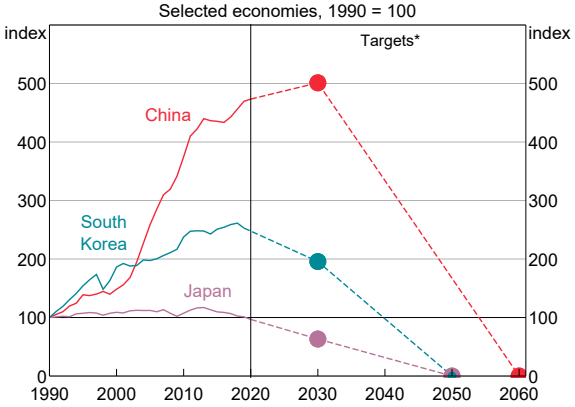
These emissions targets have been set with reference to broader global initiatives. Countries may put forward other or strengthened targets at the 26th UN Climate Change Conference of the Parties (COP26) in October and November 2021. Under the Paris Agreement, parties are required to submit updated plans ('nationally determined contributions' or NDCs) at least every five years (United Nations 2015).

A range of policies have been announced by China, Japan and South Korea to achieve these objectives, although full details are not yet available. In the near term, governments see reducing the use of fossil fuels in their energy mixes as key; reducing emissions from the rest of the economy will follow. Emerging technologies and innovations will also play an important role.

Graph 4

Carbon Dioxide Emissions

Selected economies, 1990 = 100



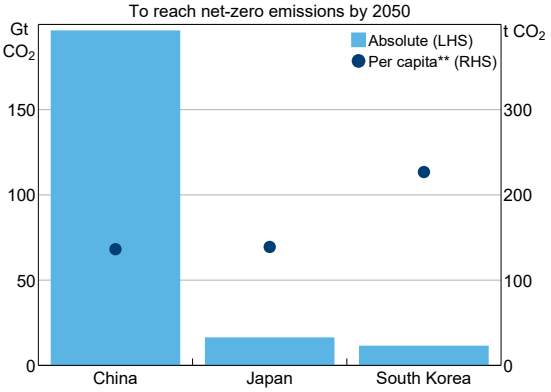
* Bubbles show targets; dashed lines show indicative paths to achieve them; Japan and South Korea's greenhouse gas targets are shown in terms of carbon dioxide; China's 2030 target is authors' estimate based on carbon intensity target for 2030 and authorities' desire for GDP growth to 2035

Sources: CEIC Data; International Energy Agency; RBA

Graph 5

Cumulative CO_2 Emissions Abatement*

To reach net-zero emissions by 2050



* The cumulative difference between 'current policies' and net-zero emissions scenarios by 2050

** Absolute emissions abatement per person to 2050, calculated using average population from 2020 to 2050 from UN population projections (constant fertility scenarios)

Sources: NGFS; RBA; UN

Moving away from carbon-intensive energy

China, Japan and South Korea have pledged to undertake a range of measures to assist in the shift from carbon-intensive energy use, including: investing in and further developing renewable sources; ensuring a pipeline of clean energy projects; and establishing a higher renewables share of energy supply. China is seeking to raise the non-fossil fuel share of primary energy consumption (including renewables and nuclear) to around 25 per cent by 2030 (Xinhua 2020b). Japan is looking to roughly double the renewables share of its electricity power generation to 36–38 per cent by 2030, while South Korea is seeking a six-fold increase to 42 per cent by 2034 (Kim 2020; Yamaguchi 2021). China and Japan's plans include a greater role for nuclear power, while South Korea is seeking to phase it out altogether (Kumagai and Yep 2021; MIT Energy Initiative 2018).

All three countries are seeking to reduce the use of coal through a combination of phasing out and decommissioning coal-fired power generation plants, improving plant efficiency and restricting capacity growth.[3] China and South Korea have also sought to put a price on carbon emissions through national emissions trading schemes (ETS), with China's now the largest in the world.[4]

The role of liquefied natural gas (LNG) in the transition to net-zero emissions is more mixed. LNG can be used as a cleaner near-term alternative to coal and a 'bridge fuel' until renewables are scaled up. However, while it produces lower carbon dioxide emissions than coal at the point of use, it still generates large methane emissions when it is produced – a greenhouse gas that is more potent

than carbon dioxide. China has increasingly used LNG as a cleaner alternative to coal power generation and has targets to increase domestic gas production. In contrast, Japan recently announced that it is seeking to almost halve LNG's share of its energy mix by 2030. South Korea is currently deciding between three potential policy roadmaps to achieve net zero, which see varying roles for LNG.

While these three countries appear committed to switching to other energy sources from fossil fuels, there may be challenging trade-offs to navigate. China is the world's largest renewable energy producer and has made significant domestic and foreign investments in renewable energy in the past decade (Global Commission on the Geopolitics of Energy Transformation 2019); however, in 2020 construction permits for new coal projects increased, and China's ETS does not impose an absolute limit on emissions. Japan and South Korea have also made significant progress expanding the renewables share of energy, but high population density, scarce land, the high costs of building and running renewable projects, and difficult terrain make it comparatively difficult to progress further (Graph 6). Accordingly, these two countries are seeking to build wind farms offshore.[5] Whether China and Japan will be able to scale-up nuclear energy to help offset declining fossil fuel use, as they are seeking to do, is unclear; for instance, much of Japan's nuclear fleet remains offline after the Fukushima disaster (Graph 6). Whether South Korea can sufficiently scale-up renewables to offset the role of nuclear in its energy system also remains to be seen.

Other policies

Green hydrogen, as well as carbon capture, use and storage (CCUS) and carbon dioxide removal (CDR) technologies, have the potential to play an important role in economy-wide decarbonisation.[6] Japan, China and South Korea are ambitious in their efforts to develop these technologies through combinations of regulatory and R&D support and subsidies. However, they still require large-scale investment and face numerous technical challenges before they can be deployed at scale and be commercially viable.

The three countries have also pointed to a range of other policies to work towards net-zero emissions, including electrification and efficiency-enhancing measures in transport, buildings and appliances.[7] Efforts to make industry less emissions intensive will also take place, although these are expected to be challenging in the near term.[8] Most notably, China, Japan and South Korea are all seeking to reduce emissions that arise from using coking coal in steelmaking. Chinese authorities are encouraging a shift in steel production towards low-carbon methods, and are targeting a 20 per cent reduction in steel sector emissions by 2025. Several Japanese and South Korean steelmakers have also pledged to substantially cut emissions by 2050, and are investigating ways to produce 'green steel' using hydrogen.

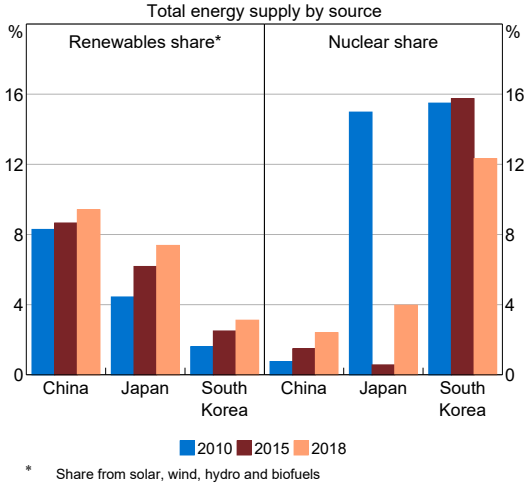
Australia's fossil fuel exports to East Asia

Fossil fuels account for around a quarter of Australia's total exports, of which around two-thirds is exported to Japan, China and South Korea (Graph 7). By value, Australia's fossil fuel exports mainly comprise thermal coal (4 per cent of total exports), coking coal (7 per cent) and LNG (10 per cent).[9] Oil accounts for a relatively small share of total exports, at just 2 per cent. Coking and thermal coal are estimated to account for around 80 per cent of carbon dioxide emissions made by Australia's fossil fuel exports, while LNG accounts for most of the remainder (Graph 8).

Graph 6

Energy Mix – Non-fossil Fuel Sources

Total energy supply by source



* Share from solar, wind, hydro and biofuels

Sources: International Energy Agency; RBA

Scenarios for energy demand and CO_2 emissions in Asia

The impact of net-zero emission targets in China, Japan and South Korea on Australia's fossil fuel exports is uncertain. The policies to achieve them are yet to be fully articulated, and technological advancements and carbon abatement costs are unclear. However, scenario analysis is one way of understanding how emission reduction policies might affect Australia's economy.

Several international bodies have explored how the global and regional energy mix might evolve under various policies aimed at achieving net-zero emissions by 2050. We focus here on climate scenarios designed by the Network for Greening the Financial System (NFGS), a consortium of central banks dedicated to improving climate risk management (NGFS 2021).[10] These scenarios were designed to provide a foundation and common reference point for analysis of climate change and its economic impacts, allowing for consistency and comparability of results across institutions around the globe.

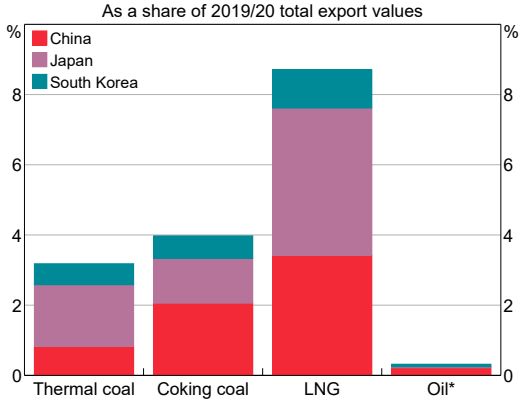
Importantly, the NGFS provides country-level energy demand profiles by fuel type, which outlines possible energy transition paths for China, Japan, South Korea and the rest of the world under different climate scenarios. Overall, the NGFS outlines the following transition paths required for countries to achieve net zero: an increasing role for renewable energy generation; a secular decline in the share of coal in energy production; and an eventual decline in the share of gas (Graph 9). These are in line with current plans signalled by China, Japan and South Korea. That said, there are many paths to net-zero emissions, and transition scenarios will depend crucially on the assumptions underpinning them.

Each NGFS scenario includes different assumptions about the availability of technologies and government policies. These can be summarised by the future paths for carbon emissions and carbon prices; carbon prices are used as a proxy for overall government policy intensity, but governments could use other tools. These assumptions are mapped to the consequences for the climate, such

Graph 7

Australian Fossil Fuel Exports

As a share of 2019/20 total export values



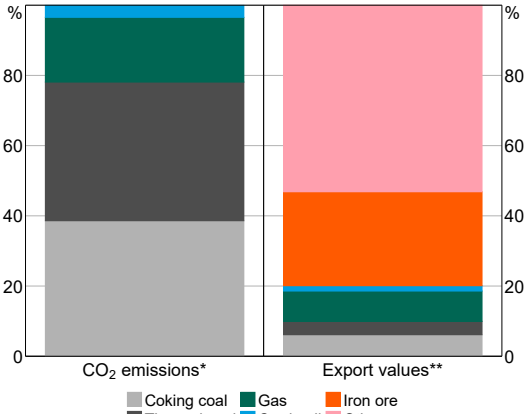
* Refined and unrefined petroleum

Sources: DFAT; DISER; RBA

Graph 8

Australian Exports

2020



* Estimated share of total exported emissions from coal, LNG, LPG and crude oil exports; emissions content of non-fossil fuels is negligible

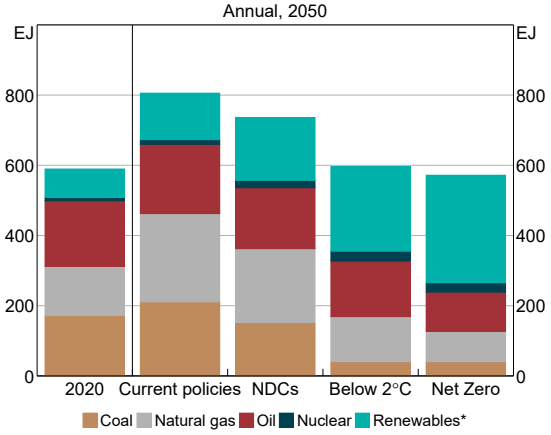
** Share of total export values (goods and services)

Sources: ABS; DISER; RBA

Graph 9

Global Primary Energy Consumption

Annual, 2050



* Includes solar, hydro, wind, geothermal and biomass

Sources: NGFS; RBA

as mean temperature changes, using scientific models. Key scenarios include:

- **Net Zero 2050 (Net Zero):** assumes ambitious policy responses, consistent with limiting global warming to 1.5°C. Global CO_2 emissions from energy use peak in 2020 and decline to around zero by 2050. Average carbon prices rise from around zero in 2020 to US$560 per tonne in 2050, with higher prices in developed economies. The scenario is based on existing and developing (but known) technologies, like CDR discussed above, but assumes they become cheaper to deploy and more widely accepted.
- **Below 2°C**: assumes policy and behavioural responses are more modest than in the Net Zero emissions scenario, such that global CO_2 emissions reach net zero by 2070. This is consistent with a 67 per cent chance of limiting global warming to below 2°C.
- **Nationally Determined Contributions (NDC):** assumes all NDCs pledged up to December 2020 are implemented fully, and that all countries reach their 2025 and 2030 targets on emissions and energy. While China, Japan and South Korea have not yet aligned their NDCs with a net-zero target, the scenario extrapolates their policy ambition levels implied by the NDCs beyond their 2030 targets.
- **Current policies (baseline):** incorporates only currently implemented government policies. In this scenario, limited progress in reducing emissions is achieved; global CO_2 emissions from energy use peak in the mid 2030s and are slightly higher than 2020 levels by 2050.

We use the NGFS country-level energy demand profiles under the various scenarios to estimate the effect of these developments on Australia's exports and provide some information on the contributions of China, Japan and South Korea. To do this, we assume that Australia's share of fossil fuel energy consumption in each country is unchanged.[11] This may overstate the impact because Australian fuel tends to be higher quality (and therefore produces fewer emissions per unit of energy) and is produced at lower cost than many competing producers.[12]

Coal

Under the baseline, coal exports increase gradually to be 17 per cent higher in 2050. By contrast, the volume of Australian coal exports falls under all other scenarios, with the sharpest falls seen under the Net Zero and Below 2°C scenarios (Graph 10). Coal exports under these scenarios fall by 80 per cent by mid-century, with declining demand from China, Japan and South Korea accounting for around two-thirds of the fall. Coal exports under NDC remain little changed over the current decade, before falling rapidly over the 2030s to reach 65 per cent of 2020 levels in 2050; falling demand from China, Japan and South Korea (while less sharp than implied by the Net Zero scenario) contribute over 90 per cent of the decline.

The NDC scenario suggests countries are unlikely to materially alter their energy mix in the near term, and that demand for coal will likely remain robust this decade. However, as global appetite for coal tapers off from 2030 onwards under all scenarios except for the baseline, Australian coal-related investments are at risk of becoming 'stranded assets' as lower export volumes and prices weigh on firm profitability. The risk is somewhat lower for Australian coking coal producers because of their lower cost of supply relative to other producers and strong global demand for high-quality coking coal in steelmaking until greener alternatives become more widespread. Nevertheless, current coal reserves at operating Australian mines notably exceed projected export demand to 2050 under the Net Zero and Below 2°C scenarios; this suggests there is potential for 'stranding' even if there is no investment into new mines.[13]

LNG

The outlook for LNG exports is more resilient to a range of scenarios, as developing countries in particular substitute from coal to gas to reduce emissions, cushioning the fall in demand from advanced economies switching to renewable energy. Under the baseline and NDC scenarios, LNG exports increase by around 80 per cent and 60 per cent from 2020 levels (Graph 11).[14] By contrast, LNG exports are projected to fall to around half of their current levels by mid-century under Net

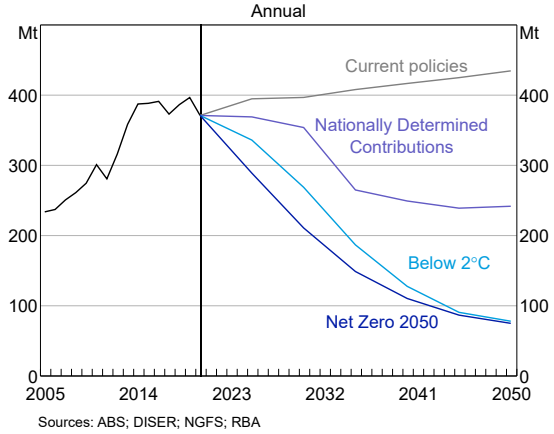
Zero, led by sharp declines in Japanese and South Korean demand (which account for almost 40 percentage points of the fall). LNG exports under Below 2°C also increase in the near to medium term, reflecting the interim global transition from coal to gas, but decline from 2040 onwards to be around 2020 levels by 2050.

Renewable and other energy sources

With the global momentum towards reducing carbon emissions, Australia is well-placed to participate in the nascent renewable energy export market. NGFS expects global demand for renewables to become the largest source of energy by 2050 under the Net Zero and Below 2°C, and reach around one-seventh of energy consumption under the baseline (Graph 9).

Graph 10

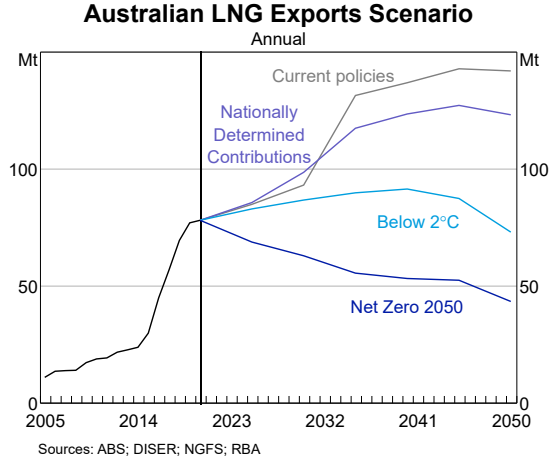
Australian Coal Exports Scenario



Sources: ABS; DISER; NGFS; RBA

Graph 11

Australian LNG Exports Scenario



Sources: ABS; DISER; NGFS; RBA

A number of export projects of green hydrogen have been proposed by industry – including the Western Green Energy Hub, a $100 billion project for the world's largest renewable energy hub in Western Australia. Japan has signalled plans to boost hydrogen and ammonia use under its decarbonisation plans, with a joint Australia–Japan partnership under way to establish the world's first international hydrogen trade route.[15] Several Japanese corporations have also increased investment into foreign green hydrogen projects, including in Australia. Green hydrogen also has the potential to be used in the domestic production of 'green steel', which can then be exported.[16]

Growing global demand for electric vehicles and batteries also provides opportunities for Australia to increase its exports of lithium, nickel, cobalt and other rare earth minerals. Australia also has the world's largest deposits of uranium; nuclear energy generation is projected to increase in some markets in the coming decades.

GDP impact

The overall impact of reduced fossil fuel exports on GDP is expected to be relatively small and gradual. The direct contribution of fossil fuel exports to annual GDP growth would be on average 0.1 percentage points lower in the Net Zero scenario relative to the baseline.[17] There would also be flow-on impacts to associated activity; however, these impacts are likely to be partly offset, over time, by opportunities in other sectors. One example is the renewable energy market, where investment has begun to support activity and employment, particularly in regional areas where large-scale renewable generators tend to be located (de Atholia, Flannigan and Lai 2020). However, the renewables export market is still at an early stage and the outlook is uncertain. More broadly, it is difficult to estimate the extent to which activity in other sectors could eventually offset a decline in activity related to fossil fuel production. Whatever happens, the impact of a decline in fossil fuel exports would be significant for certain communities and regions, especially those in which mining accounts for a large share of employment.

Uncertainties

The NGFS scenarios illustrate one of many possible paths for global emissions and fossil fuel consumption, but there is a large degree of uncertainty around how the global economy can transition to a lower-emissions world. Alternative plausible scenarios would result in a more (or less) favourable outlook for Australia's fossil fuel exports.

- A key uncertainty is the speed and manner in which countries make progress towards net-zero emissions. Achieving this will require far-reaching changes in government policy globally and rapid shifts in the behaviours of households and businesses. The appetite for such changes is uncertain. A slower transition than required to meet net-zero emissions targets – for example, because new renewable technologies are not widely accepted, the cost of renewable energy is high, energy security concerns are heightened or popular opinion opposes certain policies – would suggest a more moderate decline in Australia's fossil fuel exports than embodied in the net-zero emissions scenario above. Likewise, faster shifts in policy and behaviour would indicate additional downside risk to Australia's exports.
- Technology also remains an important uncertainty. Advances in renewable technology beyond those considered in the NGFS scenarios could lower the cost of alternative energy sources and speed up the transition away from fossil fuels. On the other hand, negative emissions technology or advances that lower the carbon intensity of fossil fuel energy could enable countries to continue to use fossil fuels, even while producing net-zero emissions.

Conclusion

The commitments by China, Japan and South Korea to achieve net-zero emissions by mid-century and the broader global shift towards carbon emission reduction puts downward pressure on the outlook for Australia's fossil fuel exports. Coal exports are projected to decline significantly, while the expected impact on LNG exports is more modest. Overall, the effect of net-zero emissions policies in these three economies on Australia's GDP is expected to be small and gradual, although it could be significant for directly affected sectors. However, significant uncertainty remains, including the speed and manner in which countries attempt to achieve net-zero emissions and technological developments that could change the efficiency and carbon intensity of fossil fuels.

Footnotes

[*] The authors are from Economic Analysis Department. They thank Zan Fairweather for work that laid the foundation for the international analysis in this article.

[1] South Korea's 24.4 per cent reduction by 2030 entails a 37 per cent reduction from a 'business as usual' path.

[2] 'Carbon intensity of output' is the ratio of carbon emissions to real GDP. The Chinese Government does not have a 2030 target for real GDP that would allow for calculating an implied carbon emissions target. However, Chinese President Xi Jinping has suggested that authorities are aiming to double 2020 GDP by 2035 (Xinhua 2020a). Assuming underlying GDP growth moderates only gradually, that suggests that real GDP will be around two-thirds larger in 2030 than 2020. The carbon-intensity target would then suggest a 2030 target for carbon emissions around 6 per cent higher than the 2020 level. This estimate is used in Graph 4.

[3] Korea has pledged to permanently close 30 aging coal-fired power plants by 2034 (or convert to LNG), half of its current capacity, which will reduce coal-fired power generation capacity to 29 GW from 38.3 GW in 2022 (Kumagai and Yep 2021). Japan's largest power generator will seek to shut down all inefficient older coal-fired power plants by 2030, or around 13 per cent of existing capacity. In China's latest Five Year Plan, authorities have noted they will control the development of coal-fired capacity, continuing the trend of seeking to restrict new coal plant capacity from 2016 (Boulter 2018).

[4] South Korea's scheme covers heavy polluters in the industrial and power sectors and has been in operation since 2015, while China's launched in mid 2021 after a number of years in development and various regional pilot programs. China's scheme has low initial coverage, low opening prices and a lack of an absolute cap on emissions, but coverage and prices are expected to increase in the coming years. Already the scheme covers around 40 per cent of China's emissions.

[5] Japan is seeking to ramp up its offshore wind capacity to 10 GW by 2030 and 30–45 GW offshore wind capacity by 2040, from around 65 MW currently (Ministry of Economic, Trade and Industry (Japan) 2020). This would make it the third-largest offshore wind generator in the world. South Korea recently announced plans to construct the world's largest offshore floating wind farm by 2030 (to generate up to 8.2 GW), a flagship project in South Korea's Green New Deal (Moon 2021).

[6] Green hydrogen is a source of clean fuel produced using renewable energy, and 'blue hydrogen' produced from natural gas or coal, with the resulting carbon emissions captured and stored. Conventional methods of creating hydrogen are emissions intensive.

[7] In China, the government has mandated that electric vehicles make up 40 per cent of all sales by 2030. The industry has significant momentum after years of government subsidies, tax waivers and support for charging infrastructure. Japan is pioneering hydrogen fuel cell vehicles and buses, and has pledged to stop the sale of new gasoline-only cars by 2035.

[8] The International Energy Association suggests this is due to: the need for high-temperature heat; emissions that naturally result from conventional industrial processes; narrow profit margins that leave little room for firms to absorb the costs associated with adopting more expensive production options; and the fact that heavy industries use capital-intensive equipment with long lives (30–40 years), slowing the uptake of innovative low-emission technologies (International Energy Association 2021).

[9] See Cunningham, Van Uffelen and Chambers (2019) for more information on Australia's coal exports.

[10] The NGFS is a group of over 90 central banks and supervisors including the RBA whose purpose is to share best practices, contribute to the development of climate and environment-related risk management in the financial sector and mobilise mainstream finance to support the transition towards a sustainable economy. The NGFS published its first set of climate scenarios in June 2020, which delivered a consistent set of transition pathways based on global policy responses, the energy network and the climate. The second vintage of the NGFS Climate Scenarios was published in June 2021, and included updated commitments by countries to reach net-zero emissions and greater region-level granularity. Three different 'integrated assessment models' were used for each scenario to provide an estimated range. We rely on the Global Change Assessment Model (GCAM) model as it provides the greatest country-level granularity for primary energy consumption.

[11] Fossil fuel exports to China, Japan and South Korea are individually calibrated based on their domestic fossil fuel demand profiles. Exports to the rest of the world are calibrated to change at the same rate as global aggregate fossil fuel demand (excluding China, Japan and South Korea) in the NGFS scenarios.

[12] For example, demand for Australian coal may decline by less in response to lower global coal consumption, particularly if tightening environmental standards support demand for higher-grade coal.

[13] Geoscience Australia estimates there to be 19,458 Mt of black coal Ore Reserves as of December 2019, 60 per cent of which are associated with operating mines. Ore Reserves are defined as an economically mineable part of a mineral resource, taking into consideration a range of factors including governmental and environmental regulations; this does not include a significant amount of mineral resources that can be converted into reserves (Geoscience Australia 2021).

[14] This would require investment into large expansions of Australia's current LNG export capacity.

[15] Under the Hydrogen Energy Supply Chain pilot, hydrogen produced from brown coal in Victoria's Latrobe Valley will be exported to Japan via a special vessel, with first shipments of liquefied hydrogen expected in October and March 2022 following COVID-19-related delays (Department of Industry, Science, Energy and Resources 2021).

[16] For example, Fortescue Metals Group is aiming to build Australia's first green steel project in the Pilbara, powered entirely by green hydrogen from local wind and solar in the next few years (Forrest 2021).

[17] The cumulative fall in fossil fuel exports subtracts around 3 per cent off the level of GDP in 2050 relative to the baseline. Assumes real GDP to grow in line with RBA forecasts to 2023 (RBA 2021), then at the OECD's growth forecast to 2050 (OECD 2018).

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