The Role of Fossil Energy During the Energy Transition in APEC

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1 Overview

The 21 economies that comprise the Asia Pacific Economic Cooperation (APEC) forum are home to almost three billion people and account for 60% of global GDP. APEC is reliant on immense levels of energy supply, with a large trade component, required to enable continued strong economic growth in the region. The forum's purpose is to promote regional economic integration and trade. Understanding long-term energy market trends is fundamental to achieving this and has become increasingly important in the context of the global push toward decarbonisation.

For the 8th edition of the APEC Energy Demand and Supply Outlook, the Asia Pacific Energy Research Centre has constructed two potential energy futures out to 2050. The 8th edition contains two scenarios. The Reference scenario analyses recent trends in APEC energy consumption, production, and trade, to deliver one potential energy future. The Carbon Neutrality explores hypothetical pathways for each of the 21 APEC member economies to reach carbon neutral energy sectors. The Carbon Neutrality scenario (CN) explores additional energy sector transformations such as increased levels of energy efficiency, behavioural changes, fuel switching, and CCS deployment. The pathways are constructed based on the unique characteristics, policy objectives, and starting points of each economy. The CN scenario does not consider CO_2 emission sinks, such as land-use or technologies like direct air capture.

It is uncertain if the CN will come to fruition. While APEC members are courting stronger decarbonisation goals, the recent energy security crisis is shifting the focus of policymakers to ensuring the security of fossil fuel supply. However, there is value in understanding what the trajectory of fossil fuel demand and supply in the APEC region means in a world that is embracing carbon neutrality. Producers and consumers alike can use these results to help illuminate their risk to stranded assets if they invest in fossil fuel assets today and a carbon neutral world unfolds over the coming decades. Furthermore, the results highlight how fossil fuels can continue to play a role in the APEC energy system, provided that they are developed in a way that is in line with carbon neutrality.

2 Methods

The 8th Outlook modelling involves decomposing the APEC energy system into multiple subcomponents spanning demand sectors (such as industry, transport, and buildings), transformation (power, heat, and refining), and supply (production and trade). Demand sector modelling relies on estimates of output, energy efficiency, fuel switching rates, activity rates, technology diffusion, and multiple other variables. Calibration occurs via knowledge-based iteration, particularly with economy-level experts. When demand is finalised, the power, heat, refining and supply, sector models deliver the required energy based on assumptions about fuel cost trajectories, and policy/market intervention. In the case of the power sector, a least cost model is deployed. However, cost-based decisions and assumptions are overridden if there is political backing for certain technologies or fuels that enhances their relative economic viability.

There is frequent iteration of results, with extensive review and input from economy and energy experts to arrive at final energy demand, transformation, and supply results.

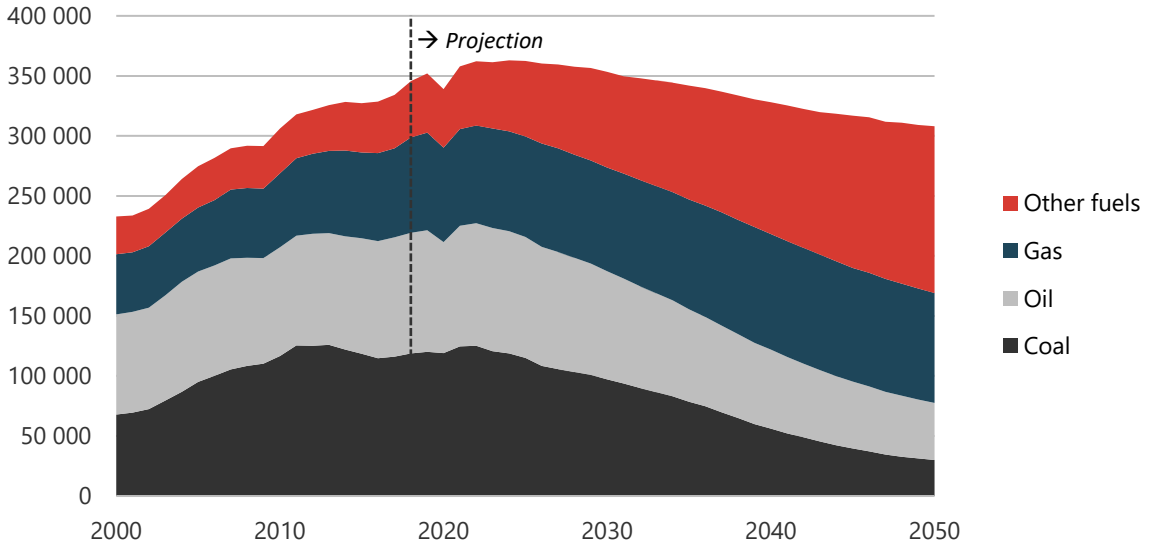
Characteristics that distinguish the Reference scenario results from the Carbon Neutrality scenario are energy efficiency rates that follow historic trends; gradual rates of fuel switching; and relatively slow diffusion of new technologies in demand and power sectors. Assumed macroeconomic activity is the same in both 8th Outlook scenarios.

3 Results

3 – 1 Introduction

Results from our modelling study in the CN scenario indicate that APEC continues to rely on fossil fuels to fuel its economic activities despite its transition towards carbon neutrality. However, the role of fossil fuels is significantly diminished over the projection period. Figure 1 shows the final energy supply through to 2050, in which total fossil fuels requirements fall by 43%, from almost 300 000 PJ in 2018 to just over 169 000 PJ by 2050. Fossil fuel consumption initially rises, as economic activity and mobility picks up as the world recovers from the COVID-19 pandemic. Thereafter, electrification and energy efficiencies in the end-use sectors,higher renewable deployment in the power sector, and stricter regulations to reduce CO_2 emissions combine to cause a significant decline in fossil fuel use from 2023 through to 2050. However, fossil fuels still account for a substantial proportion (55%) of the total primary energy supply (TPES) by 2050.

Figure 1: APEC fossil fuel supply by fuel in CN, 2000-2050 (PJ)

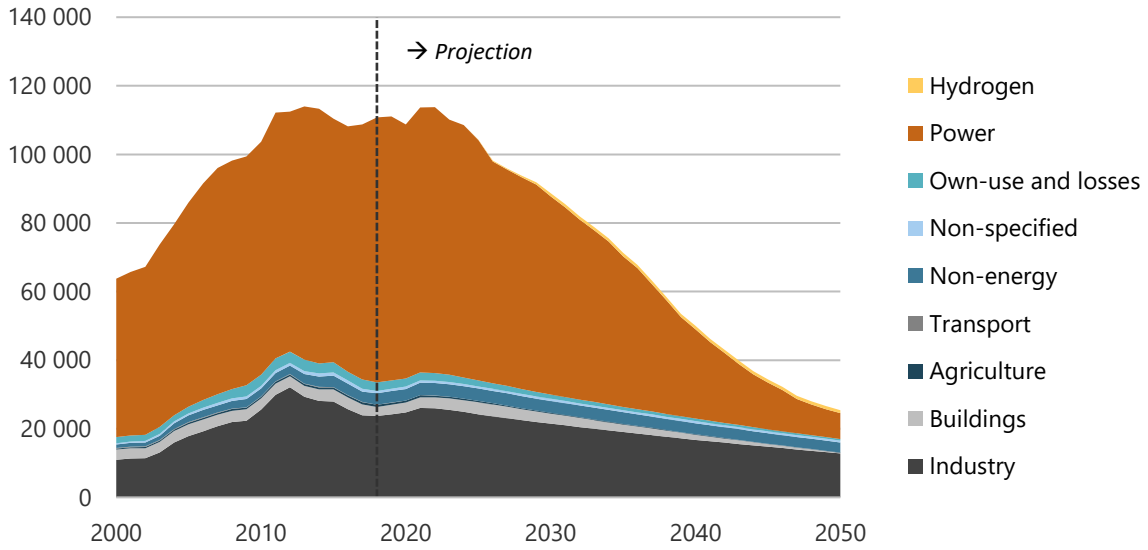


Source: EGEDA, APERC analysis.

3 – 2 Coal

Due to environmental and climate change pressures, coal consumption in the APEC region is expected to fall by almost 80% in CN, with a more than 90% fall in the power sector. Higher rates of fuel switching and more stringent coal phase-out policies contribute to this decline (Figure 2).

Figure 2: Coal consumption by sector in CN, 2000-2050 (PJ)



Source: EGEDA, APERC analysis.

At COP26, nine APEC economies signed the Global Coal to Clean Power Transition Statement, wherein they commit to not building any new coal-fired power plants from the 2030s or 2040s, depending on their economic situation. Assumptions in CN lead to an even lower level of consumption than these commitments imply. However, coal-fired power generation still increases in southeast Asia, albeit at a lower level than in REF.

Coal consumption in the industry sector declines by almost half in CN. Electrification and other fuel switching are the main drivers of this reduction. Greater prominence of electric arc furnaces and hydrogen-based technologies partly displace metallurgical coal in steel making towards the end of the projection period. However, approximately 13 000 PJ of coal consumption remains by 2050, underlining the challenge of eliminating coal from the industry.

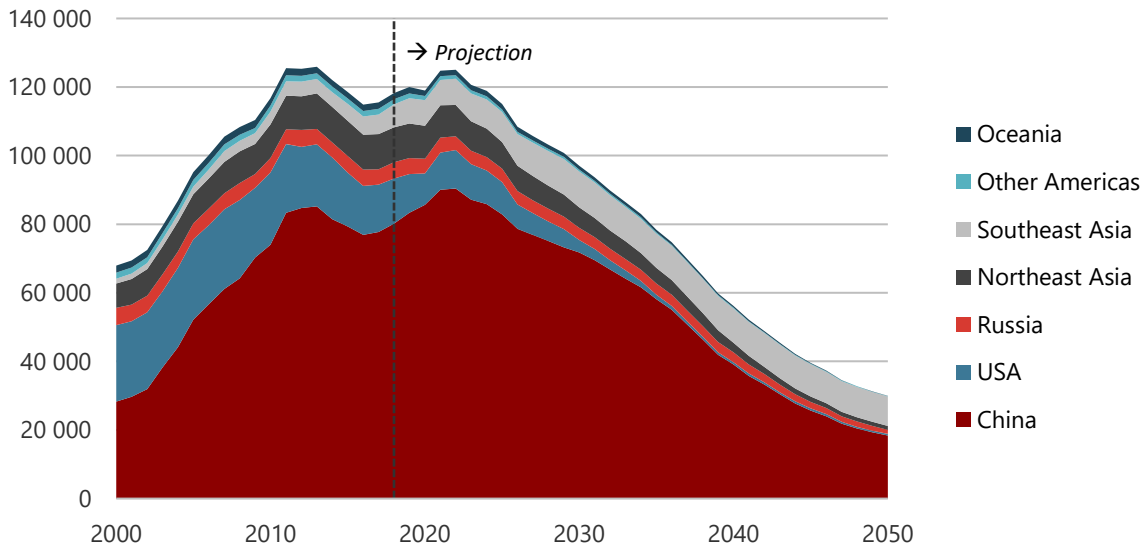
A rapidly increasing hydrogen market supports additional coal use to produce the nascent energy carrier. Howber, hydrogen use remains relatively low in the context of total APEC coal consumption, reaching peaking under 1 000 PJ. The occurs solely in China and Australia, the two pioneering economies in producing hydrogen from coal. This reflects their desire to leverage domestic resources to support the nascent hydrogen industry.

APEC coal supply falls shy of three-quarters in the CN, as nearly all APEC regions strive to significantly switch away from the high-emitting fuel enroute to carbon neutrality (Figure 3). Every

region reduces its coal supply by at least three-quarters, except for southeast Asia, where coal use increases to fuel the industrialisation of the region and some economies, including Indonesia and Viet Nam, opt to continue to burn coal but reduce its emissions with the utilisation of carbon capture and storage (CCS) technology. China and southeast Asia together make up over 90% of all coal use in APEC by 2050 in CN.

A further reduction of coal use by power plants, particularly in China and southeast Asia, and increased fuel switching by heavy industry, particularly in cement and iron and steel production, is required to reduce APEC coal supply further.

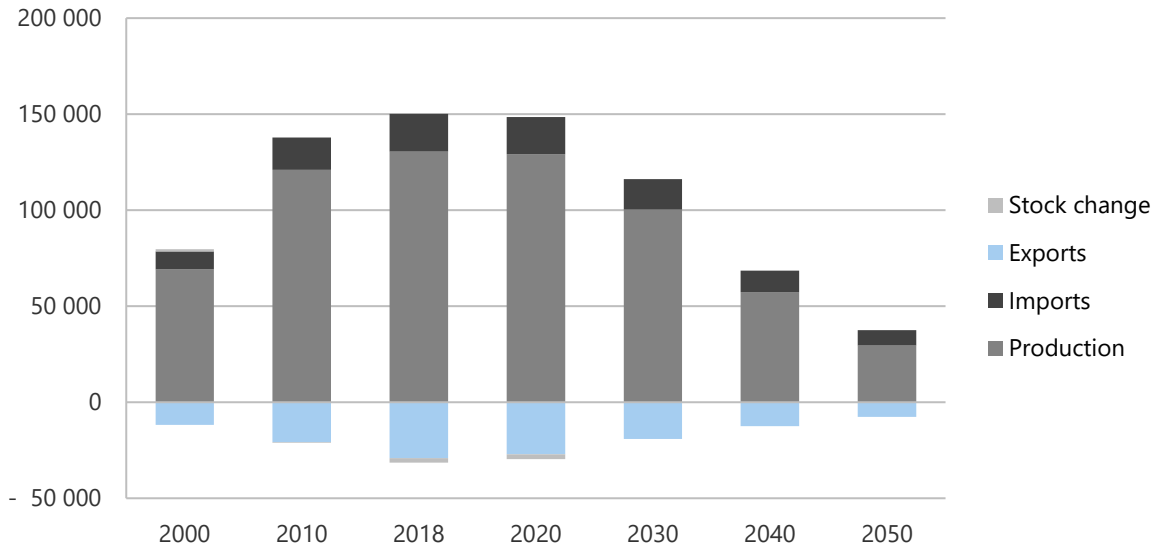
Figure 3: Coal supply by region in CN, 2000-2050 (PJ).



Source: EGEDA, APERC analysis.

Coal production falls by 77% from around 130 000 PJ in 2018 to about 30 000 PJ in 2050 (Figure 4). The reduction is due to declining coal demand in APEC and the world, which sees coal trade (imports and exports) fall by two-thirds through to 2050. The APEC region continues to remain an important source of coal supply in this scenario.

Figure 4: Coal production, imports, and exports in CN, 2000-2050 (PJ).



Source: EGEDA, APERC analysis.

3 – 3 Natural Gas

APEC natural gas consumption grows at a slower rate in CN, peaking in the early 2040s and falling 14% below current levels in 2050. The US, other Americas, northeast Asia, and Oceania all reduce gas consumption in this scenario. In contrast, China, southeast Asia, and Russia consume greater levels of natural gas, and China and Russia both surpass the US to become APEC's largest natural gas consumers in the 2040s.

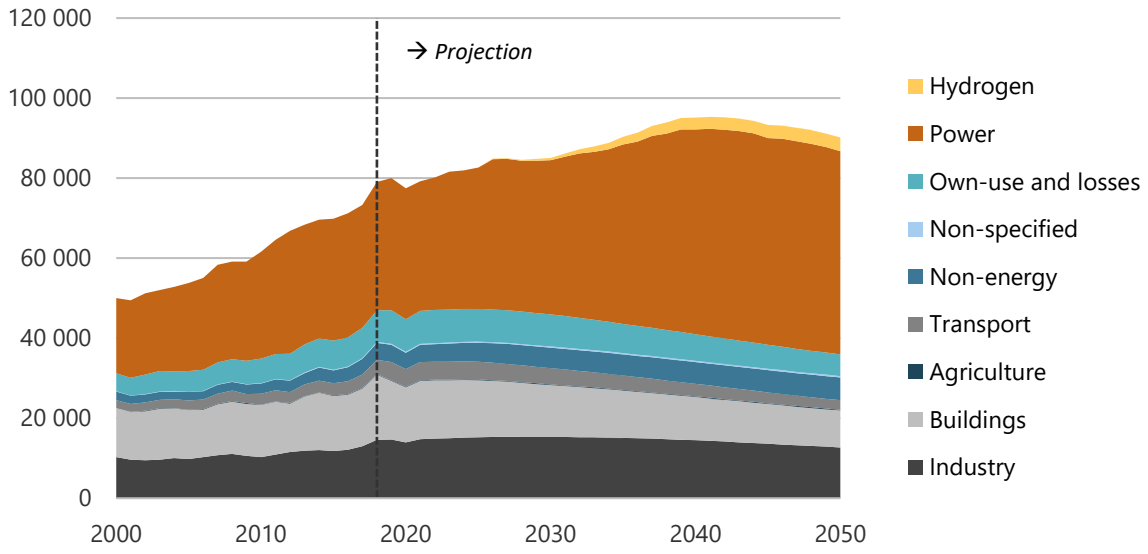
The power sector remains the largest natural gas consuming sector in CN but peaks by the early 2040s and is a tenth below REF levels by 2050. Natural gas remains important for providing peaking and ancillary services as coal phase-outs and renewable deployments accelerate. The penetration of storage technologies is uncertain, but its success would challenge the role of gas in the power sector.

In the early 2030s, all APEC economies, except Chile, New Zealand, Papua New Guinea, and Peru, begin to equip gas-fired power plants with CCS technology to reduce CO_2 emissions from the power sector. This trajectory is heavily dependent on the successful development and utilisation of gas-fired CCS technology at a commercial scale. Failing that, natural gas will likely be unable gain the social license as a transitional fuel as shown in this Outlook. The CCS industry will also need to develop scalable products streams for sequestered carbon, as well as a well-functioning carbon supply chain. Current utilisation of sequestered carbon is almost exclusively

for enhanced-oil recovery (EOR). It it is unlikely that large amounts of carbon supply EOR if the world produces fewer barrels as it strives for carbon neutrality.

Outside of power, hydrogen, and the non-energy sectors, natural gas consumption declines in CN as more stringent efficiency policies, improvements in technology, and electrification all lead to lower gas consumption.

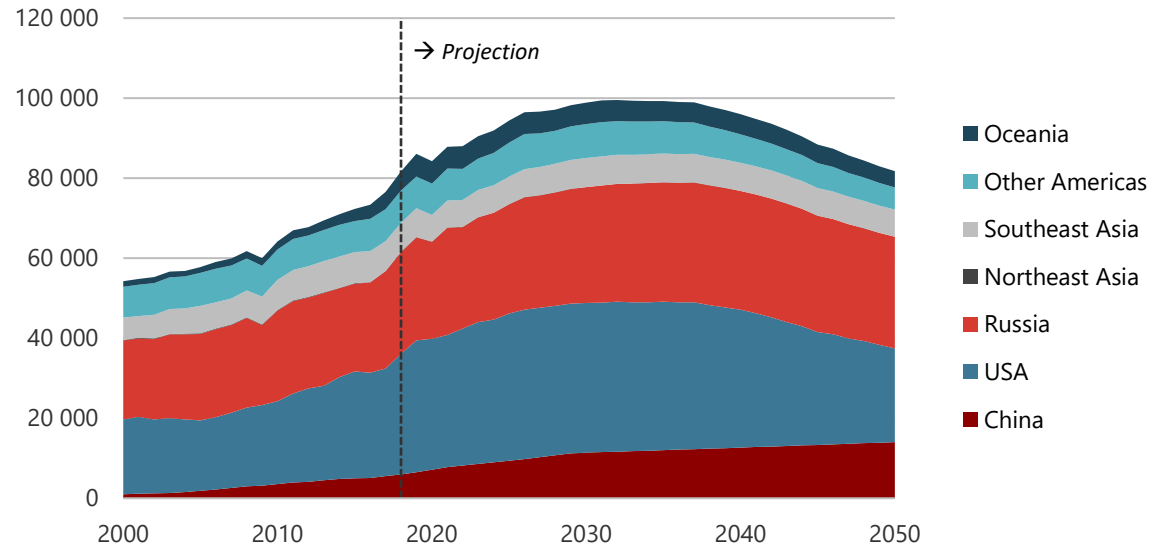
Figure 5: Natural gas consumption by sector in CN, 2000-2050 (PJ).



Source: EGEDA, APERC analysis.

APEC production follows a similar trajectory to consumption, declining during the last two decades of the projection after a peak in the 2030s. Production from large APEC natural gas exporting economies, including the US and Russia and members of other Americas and Oceania, declines in response to falling demand. China continues to experience growth in natural gas use, as its production predominantly serves domestic markets, and use rises in CN to meet industrial, building and power sector requirements.

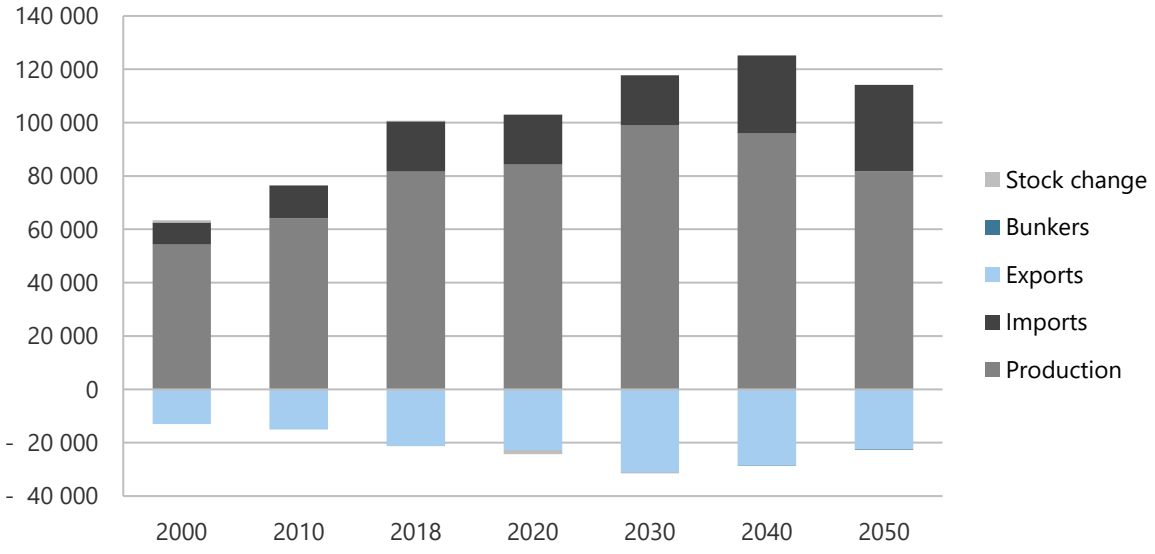
Figure 6: Natural gas production by region in CN, 2000-2050 (PJ).



Source: EGEDA, APERC analysis.

APEC natural gas trade volumes in 2050 are 25% lower in CN than REF, with exports declining from the early 2030s. In contrast to exports, APEC natural gas imports continue to grow, with volumes almost 75% larger than 2018 levels by 2050. APEC becomes a net natural gas importer in 2040, which is four years earlier than in REF.

Figure 7: Natural gas production, imports, and exports in CN, 2000-2050 (PJ).



Source: EGEDA, APERC analysis.

In CN, there is a similar level of reliance on LNG and pipeline infrastructure to REF, though trade levels are all lower in 2050 relative to REF due to lower APEC natural gas demand. This occurs because, despite the demand declines, the peaks in both scenarios are very similar.

LNG imports take off in the 2030s, as APEC members, particularly those in southeast Asia, embrace more gas in their power mix enroute to carbon neutrality. Imports grow to 23 658 PJ (483 Mtpa) by 2050, which is 15% below REF levels. Regasification capacity to service this reaches 949 Mtpa in 2050, 2% lower than REF. LNG exports grows out to the mid-2030s, peaking around 18 000 PJ (370 Mtpa), before falling close to 12 000 PJ (246 Mtpa) by 2050 as the world reduces its natural gas consumption. These LNG export volumes are about a quarter below REF levels, and the liquefaction capacity to satisfy the peak of these trade volumes is 447 Mtpa, 2% lower than REF.

Pipeline imports only grow by a small amount in CN. The completion of the southern leg of the Power of Siberia line from Russia to China supports higher trade from 2025, but declining utilisation in North America – due to declining gas demand – and in southeast Asia – as economies prioritise volumes for their domestic markets – weighs on pipeline trade for the rest of the Outlook period. By 2050, both pipeline imports and exports are about a third lower below REF levels.

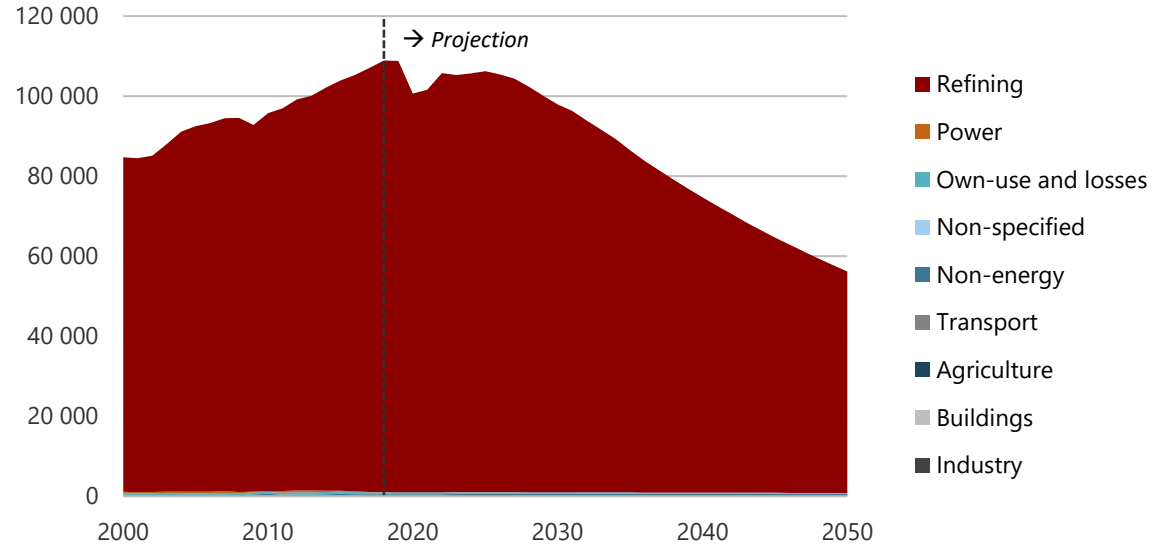
There is a growing push to quantify the emission footprint of the entire natural gas supply chain so that importers may elect to import gas from the least-emitting carbon pathway. While industry still needs to adopt consistent measurement, reporting and verification practices, it is reasonable to believe that this will be a higher priority if the world embraces carbon neutrality. The realisation of this CN trajectory will require APEC natural gas producer-exporters to continue improving the carbon-intensity of their entire supply chain. This includes eliminating flaring, restricting venting to emergency situations, deploying leak-detection technology across the value chain, and electrifying the production, transmission, and liquefaction processes.

3 – 4 Crude Oil and NGLs

Declining demand in CN sees crude oil consumption peak prior to the COVID-19 pandemic. A more-than-halving of global demand for refined products leads to a halving of crude oil and NGLs use through to 2050.

The risk of current refinery investments becoming stranded assets remains elevated in CN. While refinery runs never reach pre-pandemic highs, refinery consumption partially recovers to a lower high in 2025. Refinery capacity falls a third through the projection, as lower oil demand reduces utilisation rates, and in turn the profitability, of the existing refinery fleet. Even with greater retirements, the utilisation rates still fall under 64% by 2050, indicating that further decommissioning is possible.

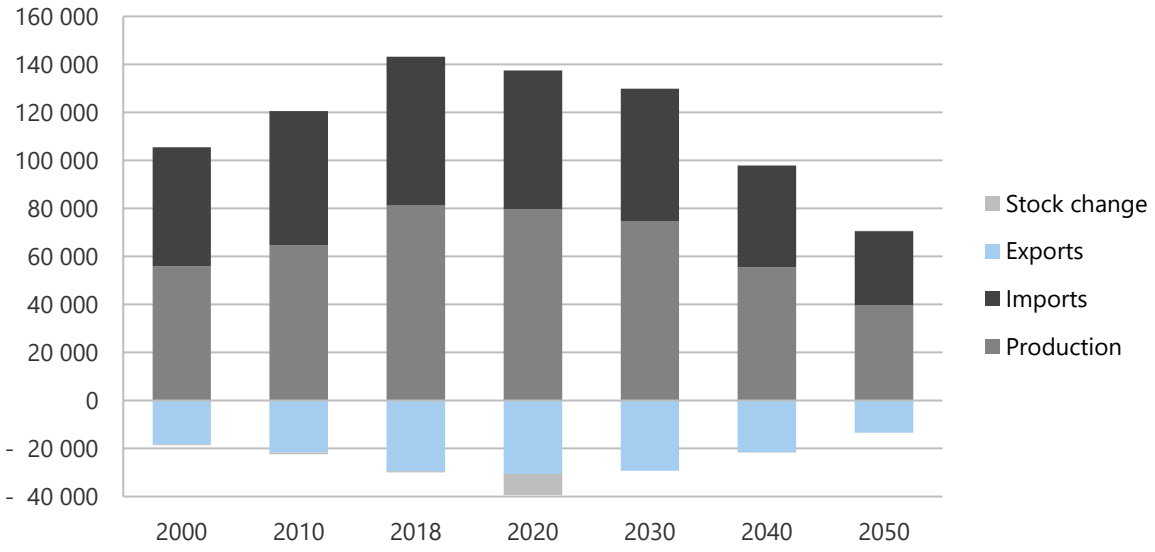
Figure 8: Crude oil and NGLs consumption by sector in CN, 2000-2050 (PJ).



Source: EGEDA, APERC analysis.

APEC oil production fails to reach its pre-pandemic peak, declining steadily after 2025 in line with a declining global market for crude and domestic demand reductions (Figure 8). By 2050, production is half of REF levels, exports are 58% below REF levels and imports 48% below REF levels.

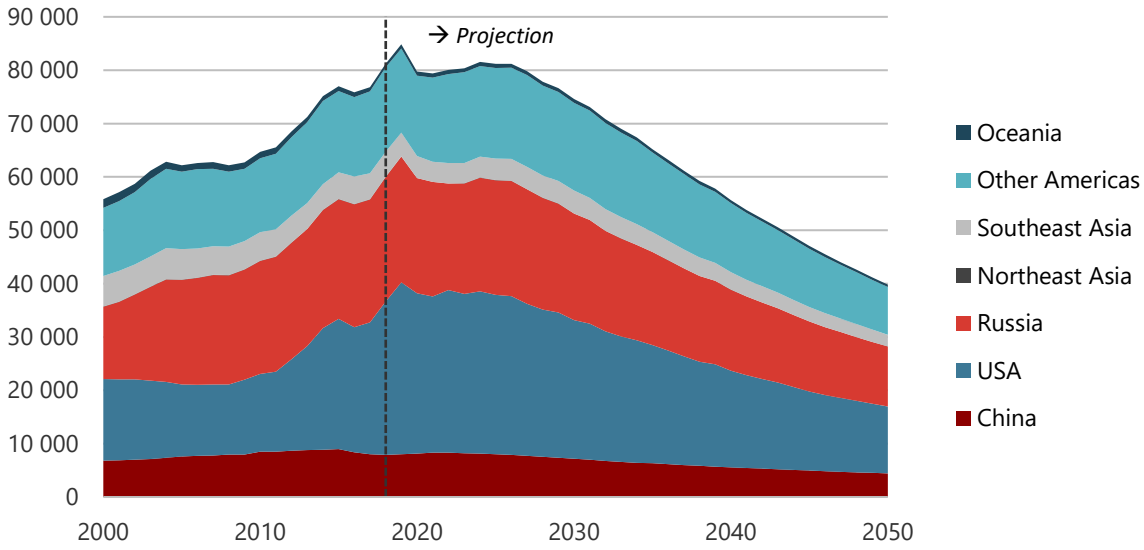
Figure 9: Crude oil and NGLs production, imports, and exports in CN, 2000-2050 (PJ).



Source: EGEDA, APERC analysis.

Figure 10 illustrates how production of crude oil and NGLs continues to be dominated by the US, Russia, and other Americas. While macroeconomic fundamentals are assumed to be constant in both scenarios, the declining revenues from a shrinking oil market could impact the economies of large-scale producer-exporters, such as Russia, Canada, Mexico, and Brunei Darussalam. APEC members should investigate what the economic implications of these trends are for GDP, employment, incomes, and equality.

Figure 10: Crude oil and NGLs production by region in CN, 2000-2050 (PJ)



Source: EGEDA, APERC analysis.

The CN oil trajectory highlights how investments in oil demand reduction are a longer-term strategy for alleviating the energy security concerns in the APEC region. Lower demand for crude oil will reduce the impact of potential oil supply disruptions over the Outlook period.

This projection highlights the increased risk of investments in oil infrastructure as a world embraces carbon neutrality. Current investments in pipelines, refineries, storage, shipping containers, and import and export terminals, which are meeting current demand requirements, all face elevated levels of stranded asset risk in CN.

3 – 5 Refined products

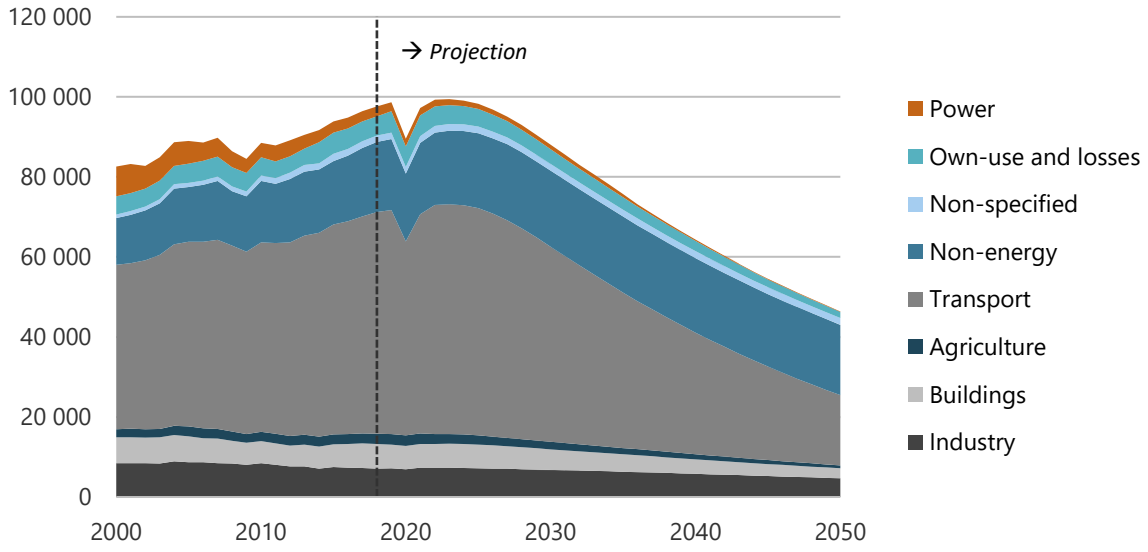
Consumption of refined products halves in CN. The main driver of this fall is the transport sector, which accounts for well over half of current consumption. Transport sector refined products use peaks in 2023 due to a rapid roll-out of low and zero-emission vehicles, efficiency improvements, and modal switching.

Fuel switching in other sectors also contributes to the projected decline. Consumption in the power sector falls 95%, industry a third, buildings more than half, agriculture three-quarters, and own-use two-thirds.

Non-energy consumption of refined products is more robust than other sectors, staying relatively constant through to 2050. This is buoyed by the continued strong growth for petrochemical products.

Reductions in refined product use across APEC regions generally reflects current consumption shares, with slightly higher reductions coming from the US, northeast Asia, other Americas, and Oceania, and slightly lower reductions from China, Russia, and southeast Asia.

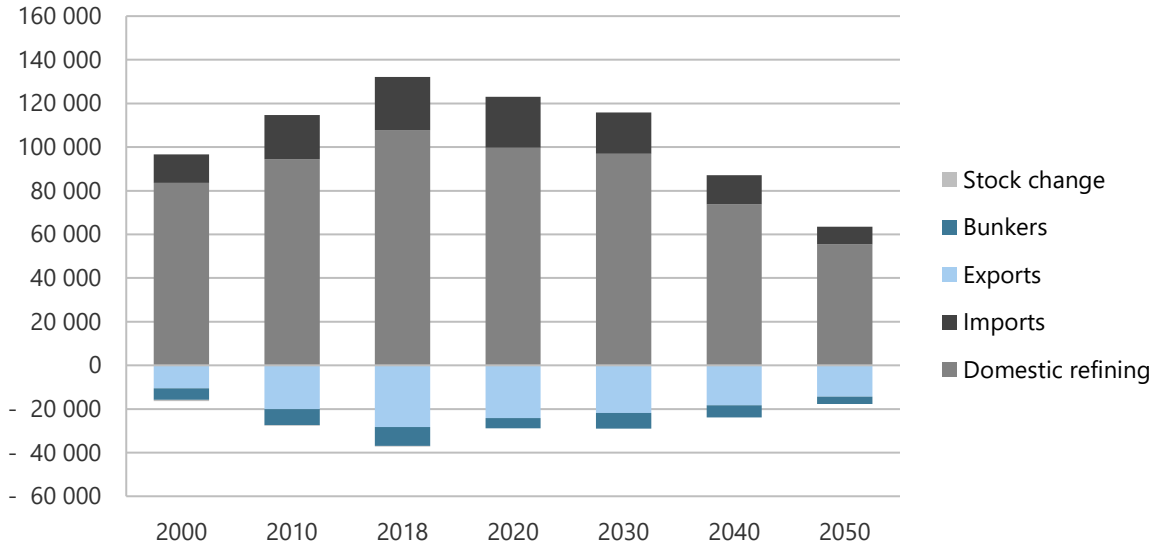
Figure 11: Refined products consumption by sector in CN, 2000-2050 (PJ)



Source: EGEDA, APERC analysis.

Refinery production halves in CN as lower domestic and global demand for refined products is met by a reduction in output from APEC refineries. Refined product trade falls almost three-fifths, with imports taking a larger hit than exports as member economies opt to protect domestic market share. Bunkers, too, fall three-fifths, as the international marine and international aviation sectors switch to lower-emitting fuels.

Figure 12: Refined products production, imports, and exports in CN, 2000-2050 (PJ)



Source: EGEDA, APERC analysis.

This projection highlights the elevated risk of investment in oil product infrastructure as the world strives to achieve carbon neutrality. Current investments in product pipelines, refinery hubs, storage, bunker services, and import and export terminals, which are meeting current demand requirements, all face a higher likelihood of becoming stranded assets in CN.

However, there are energy security risks associated with retiring fossil fuel infrastructure ahead of schedule. The demand shock during the onset of the COVID-19 pandemic led many refiners to retire capacity ahead of schedule. With demand reverting to and past pre-pandemic levels, refined product prices are hitting multi-decade, or even record, highs and shortages of diesel, gasoline and jet fuel are starting to emerge globally. Constraining parts of the oil supply chain ahead of demand could bring economic peril, and policymakers will need to carefully evaluate how to mitigate the impacts of petroleum product supply disruptions if the demand trajectory towards carbon neutrality is more volatile than shown here. Walking the tightrope between energy security and the energy transition could emerge to be a difficult one for refined product markets.

4 Conclusions

CN provides a touchstone for the level of fossil fuel energy required for APEC to pivot towards carbon neutrality by 2050. This scenario is one of many possible paths for APEC members to achieve this goal.

While there is a steady transition away from fossil fuels, they still account for half of APEC energy supply by 2050. The modelled pace of change for CN means that emissions are only slightly lower by 2030, are down two-thirds by 2050, and are not consistent with international climate commitments such as the Paris Accord or the net-zero goals of several APEC members. While

the decoupling of fossil fuel use from GDP accelerates in this scenario, achieving these targets may require more transformation change than this pathway illustrates. Emissions from fossil fuel sources remain by 2050, and achieving carbon neutrality will require removals, offsets, or further abatement via sequestration of these remaining emissions. Furthermore, the reality of a CN world is that all economies would need to adapt to faster rates of climate change, but less so than in REF. Such changes would have implications for socio-economic outcomes and projections.

Natural gas plays a key role as a transition fuel in CN. However, APEC needs to prove that it can mitigate methane emissions throughout the supply chain. Commitments by some members to join the Global Methane Pledge and separate ambitions to reduce further methane venting and fugitives are welcome initiatives.

Coal consumption in APEC is still significant in CN, especially in the power and industry sectors. It will continue to play a crucial role even during the transitional period in coal-reliant APEC economies, particularly in China and southeast Asia.

Oil also continues to play a substantial role in the transitional period, especially in the transport, non-energy, industry, and buildings sectors. While APERC assumes constant macroeconomic fundamentals in both Outlook scenarios, falling revenues from a declining oil market could impact the economies of large-scale producer-exporters such as Russia, Canada, Mexico, and Brunei Darussalam. APEC members should investigate the economic implications of these trends for their each respective economies.

The results presented here do not achieve the NDCs in the Paris Agreement but put the APEC region on a possible pathway to achieving carbon neutrality through offsets or further reductions in the second half of the century. Further reductions in fossil fuel use would be required to achieve these commitments, which would also help mitigate some of the aforementioned energy security concerns.

This projection highlights the risk of stranding recent investment in fossil fuel infrastructure as a world embraces carbon neutrality. Investment in pipelines, refineries, storage facilities, oil and LNG carriers, and import and export terminals, which are meeting current demand requirements, could all face stranded asset risk in CN.

5 References

Asia Pacific Energy Research Centre (2022), APEC Energy Demand and Supply Outlook 8th Edition [scheduled to be published in June 2022]