

CARBON NEUTRALITY SCENARIO IN THE 8TH APEC ENERGY DEMAND AND SUPPLY OUTLOOK

David Wogan, PhD, APERC, +81 3 5144-8545, david.wogan@aperc.or.jp

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 constructed two potential energy futures out to 2050. The Reference scenario is based on recent trends in APEC energy consumption, production, and trade, and assumes continuation of currently enacted policies. 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 CO₂ emission sinks, such as land-use or technologies like direct air capture.

Methods

The 8th edition 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 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. Assumed output and activity is close to the same in both 8th Outlook scenarios.

Results

The APEC region currently consumes almost a quarter-of-a-million petajoules of energy, which represents an increase of around 50% since the 2000s. China accounted for more than 80% of this increase, with the increase in energy consumption fundamental to its rapid economic growth.

In the Carbon Neutrality scenario, energy demand peaks in the mid-2020s due to a combination of more stringent energy efficiency policies and fuel switching. By 2050, energy demand is one-fifth lower than the Reference scenario. In CN, absolute levels of energy consumption decline in all regions except South-east Asia. The economies in South-east Asia¹ are expected to grow rapidly and more than double their relative share of end-use energy demand in the APEC region. China's, which experienced rapid industrial- and infrastructure-led growth in the past 20 years, is expected to transition increasingly to service-oriented growth.

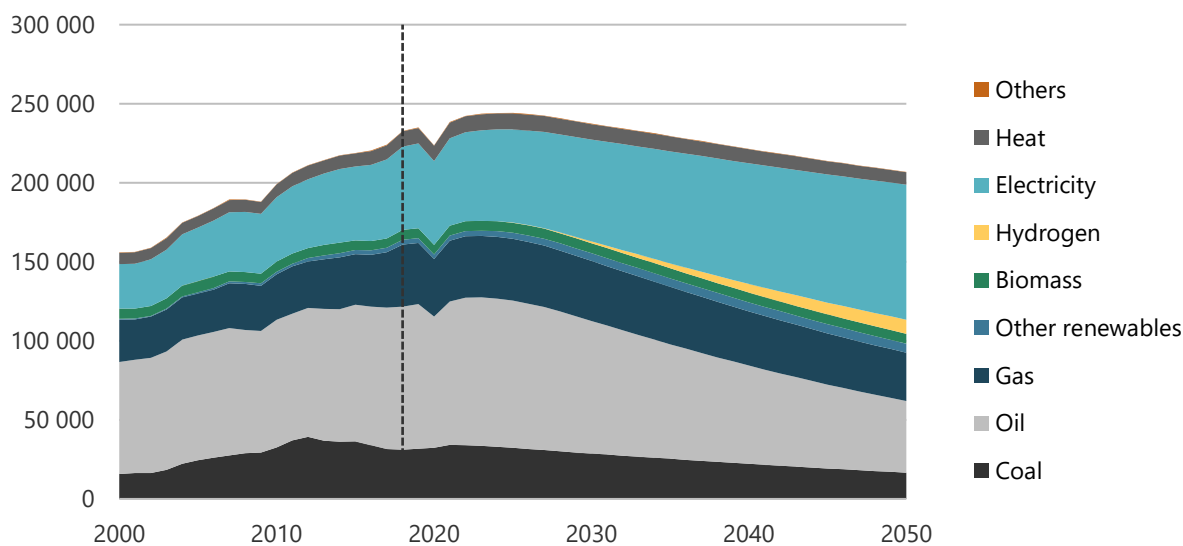
In the buildings sector, retrofit activates improve building envelope efficiency, while deployment of more energy efficient technologies enables lower energy consumption to satisfy the same service demand (e.g., lighting, cooling, heating). In the transport sector, fuel economy standards for new vehicles reduces consumption of diesel and gasoline for road vehicles.

At the same time, a shift away from fossil fuels to electricity and increases more substantially than in the Reference scenario. Oil demand in end-use sectors, mostly the transport sector, decreases by 50% over the projection period. Electrification of the transport sector has an added benefit of increasing energy efficiency because electric motors are more efficient than internal combustion engines. Natural gas declines from through the projection period

¹ Brunei Darussalam, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam

but remains an important component of the end-use energy mix due to its continued utilisation in buildings and industry.

Figure 1. Energy demand in end-use sectors in the Carbon Neutrality scenario, 2000-2050 (PJ).



While fossil fuel demand decreases, electricity demand increases over 60% during the same time period, reaching 40% of total energy demand in 2050. In some APEC economies, electrification goals are achieved adding to electricity demand. However, the largest source of electricity demand is in the transport sector as electric vehicles become cost competitive and policy support increases. Sales shares of electric vehicles accelerate rapidly through the 2030s.

The requirement for more electricity and lower CO₂ emissions results in a much different electricity system in 2050 compared to 2018. Over 75% of electricity is generated by wind, solar, and to a lesser extent nuclear, technologies. Natural gas plants equipped with CCS reduce unabated CO₂ emissions. In terms of capacity, nearly two-thirds of total installed capacity in 2050 is solar and wind, which reflects lower capacity factors. This substantial deployment of variable renewable electricity capacity will require market design and policies that ensure a stable and reliable electricity grid.

The supply of energy in APEC follows demand. Lower demand for fossil fuels in end-use sectors and the power sector leads to lower APEC production. Likewise, an assumed decline in non-APEC demand for fossil fuels dampens export opportunities. APEC is home to several producer-exporter economies that would be affected by declining demand for fossil fuels within and outside APEC. However, some APEC economies are expected to increase domestic consumption of natural gas and would increase reliance on imports from other APEC economies.

In aggregate, APEC CO₂ emissions decline by two-thirds between 2018 and 2050. Roughly 7 000 million tonnes of energy-related CO₂ emissions would remain unabated. The remaining CO₂ emissions would need to be removed through natural or technological means to reach full carbon neutrality. There is large uncertainty around technological capabilities, costs, and policies.

Conclusions

The APEC region represents nearly 60% of global energy demand and energy-related CO₂ emissions. The hypothetical carbon neutrality pathway analysed in this paper highlights the substantial transformation to the trajectory of APEC energy demand and CO₂ emissions. The practical assumptions for policy guidance and technology deployment show that reaching full carbon neutrality will be challenging and will likely require the support of CO₂ sinks. A carbon neutral pathway represents challenges and opportunities for APEC member economies to work towards a shared outcome. This issue has potential for future study.

References

Asia Pacific Energy Research Centre, APEC Energy Demand and Supply Outlook 8th Edition [scheduled for publication in June 2022]