

THE ROLE OF RENEWABLES IN ELECTRIC POWER SYSTEMS IN ACHIEVING CARBON NEUTRALITY IN APEC

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Overview

The Asia-Pacific Economic Cooperation (APEC) member economies, which include the world's largest energy producers and consumers, are pushing to increase the share of renewable energy in their economies. The 2014 APEC Summit and the 2015 APEC Energy Ministers' Meeting set goals to double the share of renewable energy in the total energy mix by 2030 from 2010 levels to achieve sustainable and resilient energy development in the Asia-Pacific region.

In recent years, most of the largest energy consumers, and consequently the largest emitters of CO₂, have stated their plans to achieve carbon neutrality in 2050-2060. In the 8th edition of APEC Energy Demand and Supply Outlook, one of two scenarios is the Carbon Neutrality (CN) scenario. This is a hypothetical scenario, that includes plans and measures each economy could take to reduce emissions and capture opportunities to further reduce carbon intensity.

The power sector, which accounted for 46% of APEC's CO₂ emissions in 2018 (EGEDA, 2021), should play a key role in decarbonisation. In the CN scenario, the share of electricity in emissions reduction can reach 50%, which can be achieved by reducing the production of electricity generated by fossil fuels by 40%. In CN, electricity produced from wind and solar in 2050 exceeds the level of electricity produced by all thermal power plants in 2018.

Methods

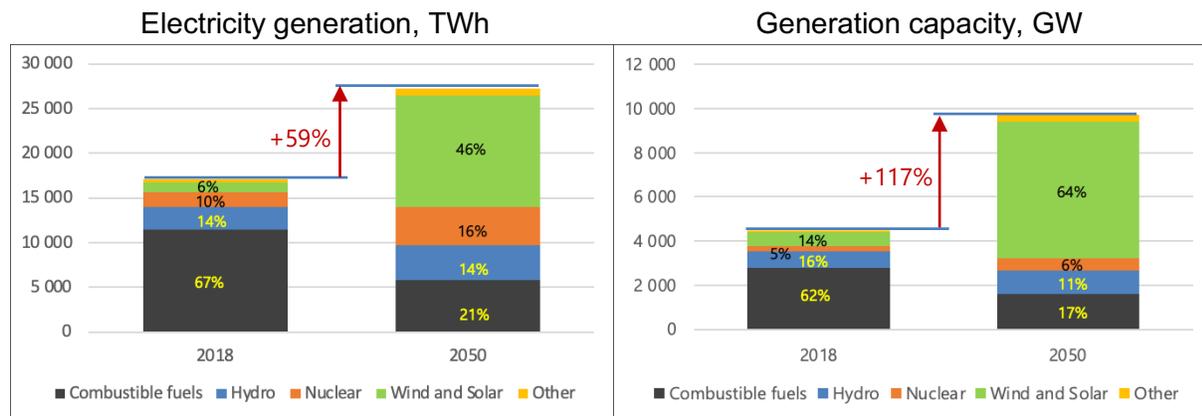
The results presented in this paper are based on the Carbon Neutrality scenario of the APEC Energy Demand and Supply Outlook 8th Edition. The 8th Outlook modelling involves decomposing the APEC energy system into multiple subcomponents spanning demand sectors (such as industry, transport, and buildings), 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, the least cost model is deployed. However, cost-based decisions are assumptions that are overridden if there is political backing for certain technologies or fuels that enhance their relative economic viability. There is a frequent iteration of results, with extensive review and input from economy and energy experts to arrive at final energy demand, transformation, and supply results.

Results

In the CN scenario, electricity production in the APEC economies in 2050 is 60% higher than at 2018 levels. On the one hand, this growth is due to projected economic growth and, on the other hand, to accelerated electrification in all end-use sectors. Electrification is one of the primary measures to achieve the CO₂ emission reduction goals. These goals are achieved mainly using renewable primary energy from wind and solar on the power generation side.

In the Carbon Neutrality scenario, electricity production from renewable energy increases more than 10-fold by 2050. At the same time, the share of such electricity will increase from 8% to 47%, and the share of electricity generated by fossil fuels will decrease from 67% in 2018 to 21% in 2050. To provide such an increase in electricity generation from renewables, a corresponding 10-fold increase in renewable generating capacity is required. The share of renewables generating capacity will increase from 14% to 64%. Thus, the shares of generating capacity of renewables and thermal power plants will become the opposite of the 2018 level.

This will require a significant transformation of the existing power systems to ensure a sustainable and reliable power supply to consumers.



Source. APEC Energy Demand and Supply Outlook 8th edition

Conclusions

There are two associated challenges in achieving carbon neutrality: decarbonising electricity generation and electrification in the end-use sectors. On the one hand, the reduction in electricity generated using fossil fuels will directly reduce CO₂ emissions in the power industry. On the other hand, deepening electrification will replace fossil fuels with electricity in end-use sectors, thus reducing emissions on the demand side.

The transformation of electric power systems to significantly reduce CO₂ emissions requires a predominance of low-carbon energy sources. Due to the lower capacity factor of renewables, significant growth in electricity consumption will require more than a doubling of generating capacity by 2050. Generation from renewable energy sources is not dispatchable. Therefore, the predominance of renewable generating capacity will require a significant transformation of existing power systems to ensure a sustainable and reliable power supply to consumers. In the Carbon Neutrality scenario, measures to keep the reliability of electricity supply include maintaining existing fossil fuel-fired generating capacity as a backup source and using storage facilities to balance electricity output from renewables. Overall, this will significantly increase the reliance on critical minerals used in the construction of both wind and solar power plants and storage batteries.

The implementation of the Carbon Neutrality scenario assumes significant technical breakthroughs in electricity storage and cost reductions comparable to those already seen in photovoltaic panels and wind turbines over the past decade. It should be noted that the trend to maximise the use of renewable energy to prevent climate change is not in doubt. However, implementing the Carbon Neutrality scenario will require a significant acceleration of change. Rather, accelerating the development of technologies seems to be a challenging task. In such a case, it will be necessary to implement the required changes faster than now.

Implementing such a transformation will require significant investment and effort from regulators and governments. In addition, energy conservation and changes in consumer behaviour regarding energy use will become even more important.

Thus, the implementation of the Carbon Neutrality scenario assumes significant progress in technologies and accelerated performance of changes, reducing costs in addition to unprecedented investments in the generation, storage and transmission segments of the power sector.

References

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