

# ***APEC ELECTRICITY OUTLOOK: LONG-TERM SCENARIOS FOR A LOW-CARBON SOCIETY***

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## **Overview**

The Asia Pacific Energy Research Centre (APERC) is compiling the APEC Energy Demand and Supply Outlook 7th Edition to examine the implications of policy actions and regional cooperation within the framework of the Asia Pacific Economic Cooperation (APEC<sup>1</sup>) (APERC, forthcoming, 2019). This paper presents the preliminary results of electricity sector projections to 2050 in the Business as Usual scenario (BAU), which includes existing policies as of 2018, and the Two-Degree Scenario (2DS), which aims to identify a pathway that the APEC region could potentially follow to admire the global climate objective to stay below a 2°C rise in global temperatures.

APEC includes major electricity markets, representing 60% of global electricity generation in 2015. The electricity sector is one of the key sectors in the region from both an energy and environment perspective, as it consumed almost 40% of total primary energy and was responsible for 36% of energy-related CO<sub>2</sub> emissions in 2015. Despite efforts to reduce negative environmental impacts from the electricity sector over the last two decades, fossil fuels significantly increased in APEC generation to satisfy the rapidly-growing demand in developing economies. Both coal and gas generation more than doubled from 1990 to 2015 in absolute terms. Electricity demand is also expected to grow for the foreseeable future, driven predominately by economic growth in developing economies. Therefore, in order to support sustainable development, the APEC Energy Ministers agreed a collective goal in 2014, which aims to “double the share of renewables in APEC energy mix, including power generation, from 2010 to 2030” (APEC, 2014).

## **Methods**

APERC projects sectoral electricity demand employing a mixed top-down and bottom-up demand model, and electricity supply with an optimisation model. The demand model consists of buildings, industry, transport and other sector modules; each module projects sectoral electricity demand by economy based on macroeconomic indicators and sector-specific analyses, such as end-use activities in buildings, industrial productions, and vehicle stock. The long-term electricity model calculates the capacity and operation of power generation as well as storage facilities to satisfy the electricity demand projected by the demand model. This is a bottom-up model formulated as a linear programming problem. This model is designed to project electricity supply in each individual economy, through minimising the discounted total system cost over the projection period. As for temporal resolution of the model, one calendar year is divided into 72 time-slots (6 day types per year × 6 time slots per day × 2 weather patterns) to take into account seasonal and diurnal characteristics of electricity load and renewable power outputs. Economic and technical assumptions are obtained from IEA (2016), Komiyama, et al. (2015), and economy-specific assessments. The set of policies included under the BAU Scenario is to be published in APERC (forthcoming, 2019). Under the Two-Degree Scenario, annual CO<sub>2</sub> emissions from power generation are assumed to be reduced by almost 90% from 2013 to 2050.

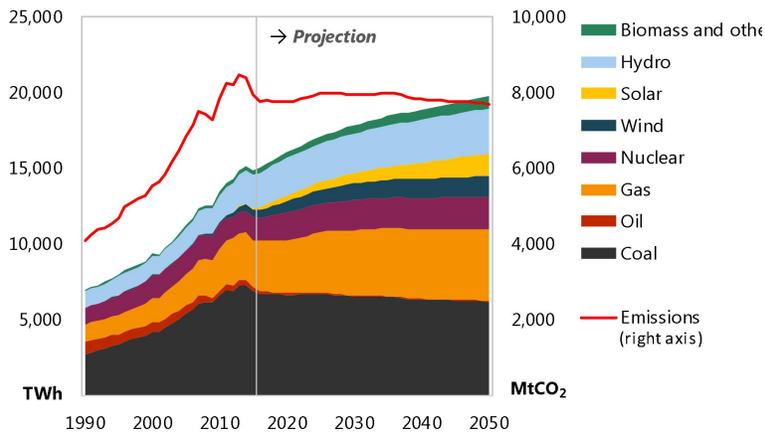
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<sup>1</sup> APEC consists of 21 member economies, including developed economies (like Australia, Japan, Russia, the United States) as well as developing economies (like China and Southeast Asian economies).

## Results

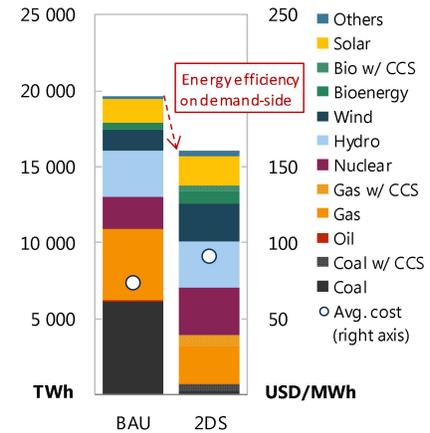
Electricity demand in the APEC region more than doubled from 1990 to 2015 and continues to grow by 36% over the projection period. China, USA and Southeast Asia are the key drivers, together contributing to almost 90% of the incremental demand from 2015 to 2050. Although China and the USA remain the two largest economies in terms of electricity demand, Southeast Asia grows the most rapidly; its share of APEC reaches 10% in 2050, compared with 6% in 2015. Economic development and rising per-capita income drive the growth in China and Southeast Asia, through accelerating a penetration of electric appliances in the residential sector. In China, shifts to electric-vehicles (EVs) in the transport sector also have a significant impact; the share of electricity demand for road transport reaches more than 10% by 2050. This level of penetration would have significant impacts on the electricity grid from an operations perspective, making it increasingly important to establish operational rules to coordinate EV charging activities.

Although non-fossil fuels show robust growth, coal and gas remain as the two largest sources for electricity under the BAU Scenario (Fig. 1). These two fossil fuels still hold the majority share, 55% (10 856 TWh), in 2050. Renewables grow backed by current promotion policies (like feed-in tariff), continuous cost reductions, as well as improving access to the transmission network; their share reaches one-third in 2050, from 21% in 2015. In relation to the APEC renewable energy goal, however, the projected share of renewables is 28% in 2030, four percentage-points lower than the doubling level in power generation. Although this goal is for the whole energy mix and not just power generation, the BAU implies that enhanced policies would be important to achieve the doubling level in the electricity sector. Growing shares of cleaner fuels improve CO<sub>2</sub> emissions intensity, contributing to a peak in absolute emissions from power generation around 2030. Yet, the BAU Scenario is not on track to meet global climate objectives. Cumulative carbon emissions from the electricity sector reach 270GtCO<sub>2</sub> in 2015-2050, which is almost 90% larger than the level for the Two-Degree Scenario.



**Figure 1: Generated electricity and CO<sub>2</sub> emissions from power generation under the BAU Scenario, APEC**

Under the Two-Degree Scenario, the APEC region meets the carbon constraint through combining energy efficiency measures on the demand side and low-carbon technologies, including renewables and carbon capture and storage (Fig.2). Demand-side measures across the consuming sectors, such as higher penetration of best available technologies, contribute to curbing electricity demand by 20%, and non-fossil fuels and CCS-equipped fossil-fired plants expand to 80% of generation by 2050. Cumulative captured CO<sub>2</sub> at power plants amounts to 14GtCO<sub>2</sub>, accounting for 10% of emissions reductions over the outlook period. By contrast, fossil fuels without CCS significantly shrink, implying stranded asset issues for these plants. Average generation costs, which are estimated by dividing total generation cost by generated electricity, increases by almost 25% in 2050 from the BAU to the Two-Degree Scenario. Capital payments for variable renewables and grid integration measures (including energy storage system in APEC by 2050), as well as CCS-equipped plants significantly push up the average cost.



**Figure 2: Generation mix and average generation cost in 2050, BAU and 2DS**

## **Conclusions**

Electricity demand in the APEC region continues to grow under the BAU Scenario, driven by China, USA and Southeast Asia. However, existing policy is not enough to support the APEC-wide doubling goal, nor to realise an environmentally sustainable society. APEC economies need to strengthen energy policies aiming at improving energy efficiency combined with accelerating low-carbon technologies, as illustrated in the Two-Degree Scenario. The alternative scenario implies economic challenges in terms of average generation cost. Continuous efforts for reducing mitigation costs would be important to realise the low-carbon pathway.

## **References**

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