FUTURE PERSPECTIVE OF NUCLEAR POWER DEVELOPMENT IN THE APEC REGION: A MODELLING STUDY

Hao Jia, Asia Pacific Energy Research Centre (APERC), +81 03 5144 8546, jia.hao@aperc.ieej.or.jp
Takashi Otsuki, APERC, +81 03 6863 9700, takashi.otsuki@aperc.ieej.or.jp
Kazutomo Irie, APERC, +81 03 5144 8539, kazutomo.irie@aperc.ieej.or.jp

Overview

Asia-Pacific Economic Cooperation (APEC) economies include the world's major electricity markets, together accounting for about 60% of global generation over the last two decades (IEA, 2016). The APEC region has also dominated the nuclear power generation in the world. Eight APEC economies, among twenty-one, utilize nuclear generation as of November 2016, with 265 reactors in operation and 39 under construction out of 449 and 61 globally, respectively. Several developing economies, such as South-East Asian economies, has considered nuclear power as a lower-carbon option to meet their growing demand. However, after the accident in Fukushima in 2011, nuclear power has been experiencing a setback, and large uncertainties exist regarding the degree of future nuclear generation in some economies. Based upon this background, this study aims to examine the long-term impacts of future nuclear scenarios on the APEC region.

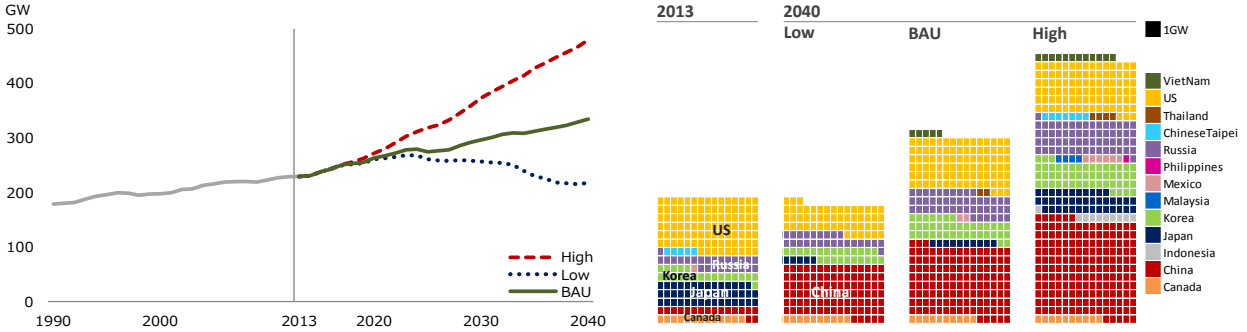
Methods

This study evaluates the economic and environmental impacts of future nuclear scenarios, employing a long-term electricity supply model developed by APERC (APERC, 2016). This is a linear programming model, which aims to minimise each economy's overall system cost over the outlook period, 2013-2040 in this study.

We develop three scenarios, Business-as-Usual (*BAU*), High-Nuclear (*High*) and Low-Nuclear (*Low*) Scenario, considering recent energy policies (Table 1). Nuclear capacity in the APEC region grows from about 224 GW in 2013 to 334 GW in the *BAU* and 479 GW in the *High* by 2040, while peaking out and declining to 218 GW under the *Low* (Fig. 1a). China drives the growth in any Scenario, increasing its presence (Fig. 1b). In our methodology, these nuclear scenarios are given as exogenous variables to the model. Renewables capacity in this study are also subject to government policies and any recent developments; therefore, what the model determines are the fossil fuel capacity and dispatch of power generation and storage technologies, taking into account representative yearly or daily load duration curves (see APERC (2016) for detailed model explanations). Projected electricity demand is obtained from APERC (2016), which projects a 70% growth by 2040 in the region.

Table 1 Scenario definition

Scenario	Definition
Business-as-Usual (*BAU*)	Current policies exist over the projection period. Recent nuclear construction and retirement trends are included, but proposed projects are not considered.
High-Nuclear (*High*)	Proposed projects are included on top of the *BAU*. License extensions are applied to most of the existing reactors.
Low-Nuclear (*Low*)	Slow down of nuclear developments as well as accelerated retirements of existing reactors are assumed. South-East Asian economies do not deploy any reactors.

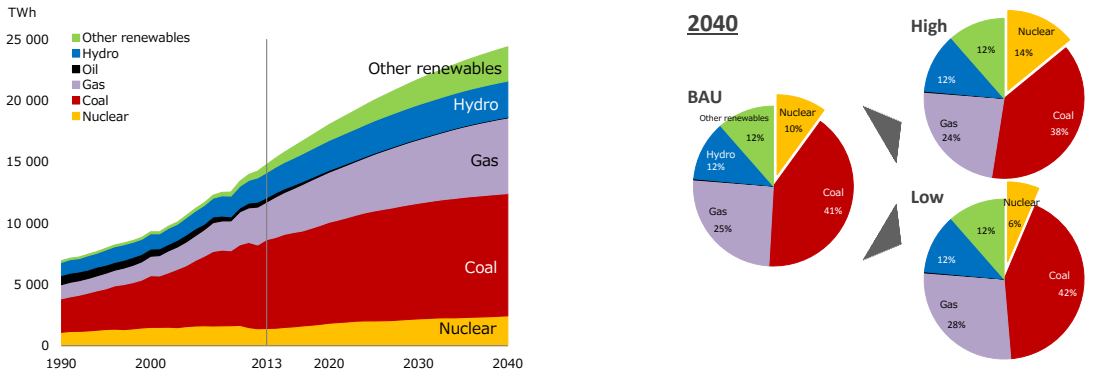


(a) Nuclear capacity, APEC region (b) Capacity by economy, 2013 and 2040

Figure 1 Future nuclear scenarios. Note: Nuclear capacity in each economy is rounded in Figure 1b. The number of block does not necessarily indicates the exact installed capacity

Results

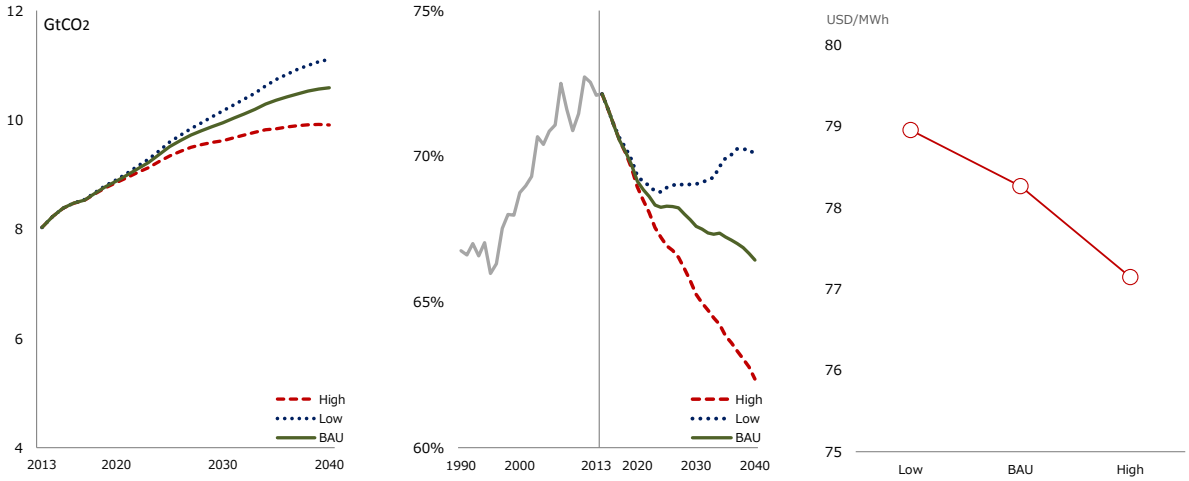
Low-carbon sources grow under the *BAU* Scenario; however, fossil fuels remain the main source for power generation to meet the rising demand (Fig. 2a). Nuclear capacity increases in the *BAU*, yet the share holds steady, around 10%. Fossils still dominate the APEC generation even in the *High* (Fig. 2b), altough accelerated nuclear developments contribute to reducing them. The incremental share of nuclear (4 percentage points thanks to additional 145 GW by 2040 from the *BAU* to *High*) mainly replace coal, resulting in the environmental benefits as discussed later in Fig. 3. The *Low* Scenario, on the other hand, shows a drop of nuclear's share to 6% in 2040. This is mainly due to accelerated retirements of existing reactors, especially in the US where we assume a 60-year lifetime.



(a) *BAU* Scenario (b) Generation share by Scenario, 2040

Figure 2 Power generation, APEC

From the "3E"—Environment, Energy security and Economic efficiency—perspectives, our analysis shows relatively large benefits in terms of Environment and Energy security (Fig. 3). For example, compared with the *BAU*, annual CO_2 emissions in 2040 decline by 10% in the *High* while increase by 5% in the *Low*. Dependencies on fossil fuels in generation, which have shown an increasing trend since 1990, would also be lowered to 62% by 2040 in the *High*. Whereas, our analysis implies a modest economi benefits—only a 1.4% reduction from the *BAU* to the *High*—due to high capital investments and costs for safety measures after the Fukushima accident in some economies. Also, low fossil prices since mid-2014 negatively impact on "relative" competitiveness of nuclear. Cost reduction efforts, while maintaining a high safety standard, would be important for nuclear to be a more economically attractive option.



(a) Cumulative CO_2 emissions (b) Fossil fuel dependencies (c) Average generation costs

Figure 3 Results related to the "3E" perspectives, APEC

Conclusions

Accelerated nuclear deployments would bring benefits from the "3E"—especially from Environment and Energy security—perspectives. Economic benefits are evaluated to be relatively modest due to higher investments and recent low fossil fuel prices, which negatively impact on the relative cost-competitiveness of nuclear.

References

APERC (2016): "APEC Energy Demand and Supply Outlook 6th Edition", APEC#216-RE-01.8.

IEA (2016): "World Energy Statistics and Balances".