A Study on Nuclear and Gas Scenarios of China using GCAM

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Overview

China is endowed with a lot of coal resources, holding an estimated 114.5 billion short tons of recoverable coal reserves, 14 percent of the world's total reserves, the third-largest in the world. But China is currently a net coal importer, starting from 2007 [4]. With its high economic growth, China would face a great challenge to meet its increasing energy demand. Energy mix in China heavily consists of coal: 78.95% in 2009 [5]. Thus, there is also a huge concern over the greenhouse gas emitted by those coal. China is currently, and would still be, the biggest CO2 emitter in the world. Development of cleaner energy such as nuclear would assist China on tackling those problems. Although China only has 11.27 GW of nuclear power capacity, it would have 284.46 GW in the future, overtaking USA as the biggest nuclear country [3]. Also, the current boom of gas production and consumption, which is partly driven by the unconventional gas reserve, would give China more alternative of relatively cleaner energy resource.

In this paper, we design several scenarios of nuclear and gas deployment in China. They are developed based on current and projected utilization of nuclear and gas in China. These scenarios would be analyzed using an Integrated Assessment Model (IAM), which allows us to see the interaction between energy, economics, and climate systems. Results from the modeling of those scenarios would provide insights for a wide range of aspects, including energy mix, electricity generation, greenhouse gas emission, and energy prices.

Methods

Global Change Analysis Model (GCAM) is a global integrated assessment model of interactions among the global economic, energy, agricultural and land use, climate, and technology systems. Formerly known as MiniCAM, it is a partial equilibrium model that balances supply and demand of energy commodities and agricultural products [1]. It divides the world into fourteen region, including USA, China, and South Korea. In detail, GCAM consists of four separate modules (Energy, Economics, Agriculture, and Climate) that interact between each other. Although it is not a predictive model, it can be used as research and analysis tools to aid understanding of the complexities and interactions [2].

Using GCAM, several scenarios of nuclear and gas utilization in China can be modeled. Early results of nuclear scenarios show that high utilization of nuclear would cut some shares from coal, although coal would still be dominant. Combination of both nuclear and gas scenarios would provide some insights of how nuclear and natural gas could help China reduce its dependency on coal and also mitigate the greenhouse gas emission.

Results

Based on developed scenarios, GCAM will be used to observe their effects on various energy variables, such as energy mix, electricity generation, price of energy, and CO_2 generation. Figure 1 shows an example of four scenarios of nuclear deployment in China. These scenarios are developed based on the reported capacity of currently operating, constructing, planned, and proposed nuclear power plant in China. Figure 2 then shows a set of result generated by GCAM, which is electricity generation by technology. It can be seen that strong nuclear development would reduce the dependency of coal-fired power generation.

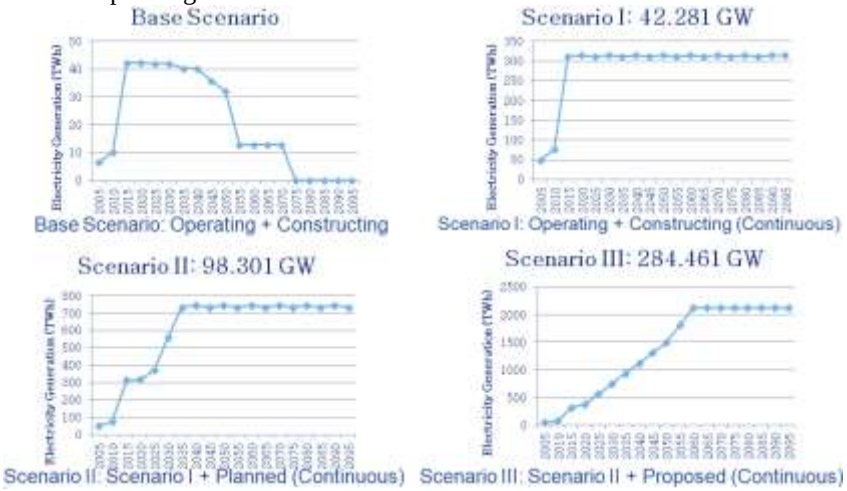

Figure 1 Four Scenarios of Nuclear Deployment in China

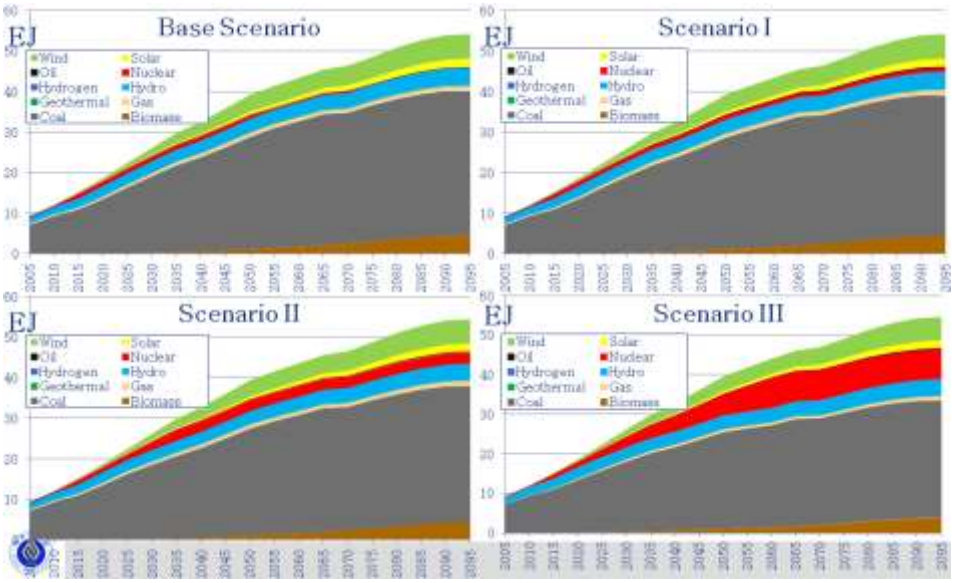

Figure 2 Electricity Generation by Technology based on Four Scenarios

Figure 3 then shows various scenarios of gas consumption in China based on three sources. It can be seen that the range of forecast is quite high, ranging from 302.7 billion m^3 to 550 billion m^3.

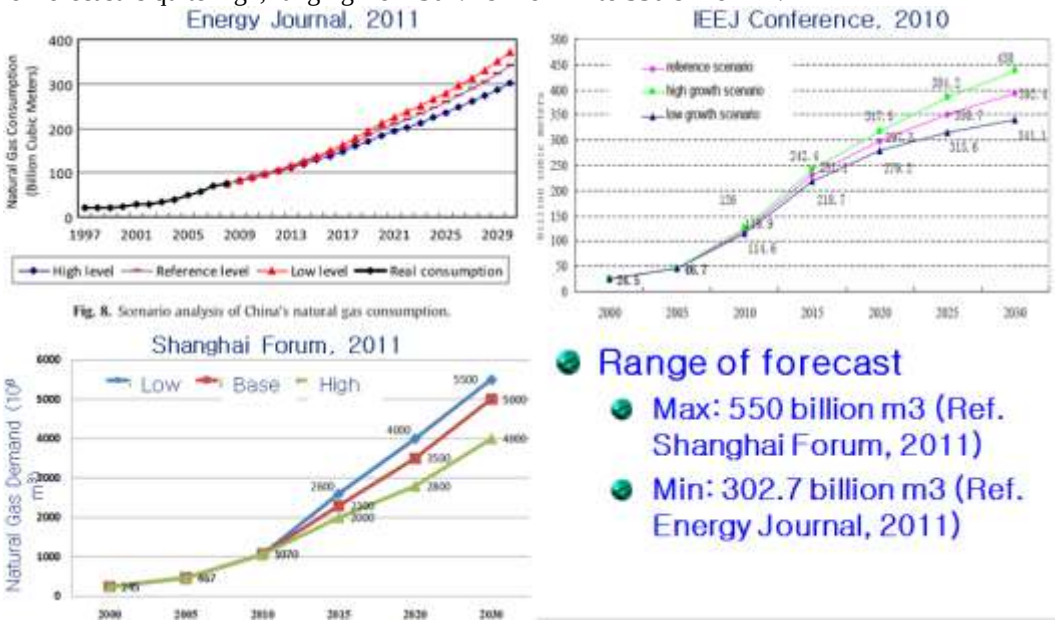

Figure 3 Scenario Comparison of Gas Consumption in China

Conclusions

The simulation of nuclear scenarios in GCAM have been done. Strong policy of nuclear utilization in China would result in reduction of coal use. Further, less utilization of coal in China would set free coal resources available in the world. The simulation result also shows that the CO_2 emissions from other regions than China would get higher. It can be attributable to more coal utilization there. Even so, the share of coal utilization in China is still high to still become the highest CO_2 emitter in the world. It is shown in figure 3 that the expected utilization of gas in China is quite high. Although its utilization share in electricity generation is quite small (currently 4%), it is expected to rise in the future.

References

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