Chapter 1

Introduction

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Chapter 1

Introduction

In recent years, global environmental problems have come to be regarded as important human problems more than ever before. According to a special report published by the Intergovernmental Panel on Climate Change in 2018, it is necessary to make the artificial carbon dioxide emissions of the entire world net zero by around 2050 or 2075 to restrict the temperature rise from pre-industrial levels to 1.5°C and 2°C. On the other hand, the Nationally Determined Contributions submitted by each country are insufficient for achieving a restriction to that level, and a more ambitious approach is essential.

In light of this situation, a movement aimed at decarbonising energy utilisation has been promoted amongst advanced countries. In Europe, the goal of carbon-neutrality by 2050 has been set. In the United States, since the inauguration of President Joe Biden in the United States, the decarbonisation movement is accelerating. In 2020, the Japanese Government expressed the target to achieve carbon neutrality by 2050. The Chinese Government has also declared its aim to be carbon neutral by 2060. Thus, reducing greenhouse gas emissions is not just a problem in advanced economies but also a problem faced by the entire world, including developing countries.

Introducing and expanding renewable energy are widely expected as a reduction measure, particularly variable renewable energies (VRE), namely wind and solar photovoltaic. The cost of these power sources, which conventionally have been expensive compared to conventional power sources, has been decreasing rapidly in recent years. The levelised costs of electricity of VRE are already lower than those of conventional power sources, depending on the area, and the costs are expected to fall further in the future. The introduction of VRE is already progressing amongst advanced countries, and its share in the power generation mix, which was 0.7% in European Organisation for Economic Co-operation and Development countries in 2000, already reached 16% in 2019 and 28% in Germany in 2019 (International Energy Agency, 2020). Given that the introduction and expansion of hydro and geothermal have been limited and that it may be difficult to expand the capacity of nuclear power generation rapidly enough because of its intrinsic problems, expectations are high for VRE to achieve the decarbonisation of power supplies. However, because VRE is intermittent, it is necessary to note that introducing a large amount of VRE involves specific risks. That is, when a large amount of VRE is installed, there is a risk of insufficient power supply, depending on the weather conditions. Equipment such as batteries will be necessary to reduce the risk, but this will increase the cost of the power system. In view of such a problem, assessing the optimal share of VRE is currently an important problem that many countries are facing when formulating energy policy.

In Association of Southeast Asian Nations (ASEAN) countries, future demand for decarbonisation is expected to increase in order to substantially reduce greenhouse gases at the global level. It should be noted, however, that the energy supply and demand in these countries are different from those of advanced countries, such as those in Europe. That is, in these countries, the energy demand is rapidly increasing along with economic development, and demand is expected to continue its rise. According to forecasts by ERIA (2020), in the business-as-usual scenario, the primary energy consumption of the 10 ASEAN countries is expected to increase from 662 million tonnes of oil equivalent (Mtoe) in 2017 to 1,373 Mtoe in 2040 and 1,823 Mtoe in 2050. In particular, the expected growth in power demand is remarkable, and the total amount of power generation by the 10 countries is expected to increase from 1,041 terawatt hours (TWh) in 2017 to 2,496 TWh in 2040 and 3,439 TWh in 2050. How to stably supply power demand that is rapidly expanding in this way has been a significant policy challenge and will continue to be important in the future.

In addition, because of the difference in energy resource distribution, the energy transition pathways in this region may be different from those in other areas. First, in the ASEAN region, the resource of wind power generation is generally poor. In addition, as hydro and geothermal resources are unevenly distributed, additional investment will be necessary to utilise them effectively. Second, countries in this region have been supplying power using coal-fired and natural gas-fired thermal power generation, which have been relatively cheaper than in other regions. Regarding natural gas, resource depletion and increasing demand have been casting a shadow over supply stability; however, coal is still a cheap and stable energy source for ASEAN members. This highlights the challenges for decarbonising energy utilisation whilst considering economic efficiency in the ASEAN region.

A powerful means for resolving the uneven distribution of energy resources is to construct international transmission interconnection lines. A construction plan for the ASEAN Power Grid has long been developed, and it is expected to contribute to increasing the efficiency of energy utilisation and decarbonisation in the region. In a previous ERIA study by Kutani and Li (2014), model calculations were performed for the 10 ASEAN countries and neighbouring areas to quantitatively evaluate the effect of the international transmission interconnection lines. The study demonstrated the role of grid interconnection for expanding the utilisation of hydroelectric power generation, which would replace mainly thermal power generation, at a time when fossil fuel prices were relatively expensive. However, as of 2021, international energy prices have decreased compared to that time, and the relative economic advantage of hydropower generation is deteriorating. On the other hand, if a large amount of VRE is introduced to ASEAN countries in the future, international transmission lines would be expected to reduce the risk of power-supply shortages due to the intermittency of VRE. From such a point of view, under new circumstances different from the 2014 study, it is important to identify the role of the international transmission interconnection system and to quantitatively evaluate its effect.

For this purpose, in this study, a new power-supply configuration model was constructed for part of the ASEAN region, and the effect of the international transmission interconnection system in the future power-source configuration was quantitatively evaluated. Here, by dividing 1 year into 8,760 time slices, modelling was performed to simulate the power supply and demand under high shares of VRE, taking into account the most recent data, such as primary energy prices and the power generation costs of VRE. By comparing the results obtained here with the previous study by Kutani and Li (2014), it is possible to evaluate whether the recent changes in energy supply and demand situations have altered the significance of the ASEAN transmission interconnection system. In addition, the evaluation in this study involves two types of risks: to what degree the risk of a shortage of fossil fuels, such as natural gas, and the risk of power shortages associated with the introduction of VRE are reduced by the transmission interconnection system; and to what extent VRE can be introduced within the scope of economic rationality, or to what extent cost measures will be necessary to realise the low-carbonisation of the power sector. Thus, this study provides information that contributes to policy formulation for sustainable development.

This report is constructed as follows: Chapter 2 explains the background of the study, the data used, and the assumptions for the calculations. Chapter 3 describes the models used and the case settings. Chapter 4 presents the results of the calculations for each case and contains a discussion on the interpretation of the results. The chapter also illustrates the power supply and demand of each of the target countries and areas to clarify the characteristics of each country/area. Finally, Chapter 5 summarises the calculation results and proposes policy implications.