Chapter 2

Research Issues and Literature Review

October 2016

This chapter should be cited as

ERIA (2016), 'Research Issues and Literature Review', in Li, Y. and S. Kimura (eds.), *Study on Power Grid Interconnection and Electricity Trading in Northeast Asia*. ERIA Research Project Report 2015-9, Jakarta: ERIA, pp.6-9.

Chapter 2

Research Issues and Literature Review

2.1 Research Questions

Power grid interconnection among the NEA countries has been raised as an alternative energy solution from many years. Several studies have been done for different plans of such an interconnection, and the following key benefits were identified:

(i) It diversifies energy supply while creating new markets for the untapped energy resources.

(ii) It avoids building expensive peak power generation capacities and using expensive fossil fuel, such as liquefied natural gas.

(iii) It makes use of the wide geographical spread of these countries, which in turn incurs differing peak hours.

(iv) It results in a higher capacity to absorb intermittent renewable energy.

(v) The diversification and geographical proximity enhance energy security of all participating countries.

However, little progress has yet taken place in terms of interconnection projects and exchange or trade of electricity among the NEA countries. In view of this background, ERIA proposes studies to address the following research questions:

- What is the supply potential of PV and wind power generation?
- How is clean coal technology applied for coal power generation using domestic coal?
- What are the costs and benefits of power grid interconnection and the corresponding trade of electricity in the region?
- What are the priority projects that are optimised and stand as economically and financially feasible?
- What are the remaining technical, economic, and institutional barriers?
- How could standards, grid codes, and regulations for both bilateral and multilateral interconnection and trade of electricity be harmonised?

ERIA has established rich experiences in economic, institutional, and political issues on cross-border power grid interconnection, especially for Southeast Asia. ERIA takes a three-step approach to identify the economic, financial, institutional, and even political barriers through academic research. This approach allows ERIA to propose policies to address not only the physical level of grid interconnection but also the sophisticated design integration of electricity markets and regulatory institutions in Southeast Asia. Such is exemplified by the collaboration between the Heads of ASEAN Power Utilities/Authorities and ERIA in several research projects to establish institutional infrastructure in Southeast Asia for electricity market integration.

ERIA, therefore, is eager to bring in the experience and knowledge on power grid interconnection and electricity market integration into the NEA region, and to contribute to efficient progress in this regard.

During the first year of research conducted on the issue, ERIA focused on the quantitative assessment of the economic benefits of power grid interconnection among the NEA countries. It addressed questions such as who will benefit and how much the benefit will be.

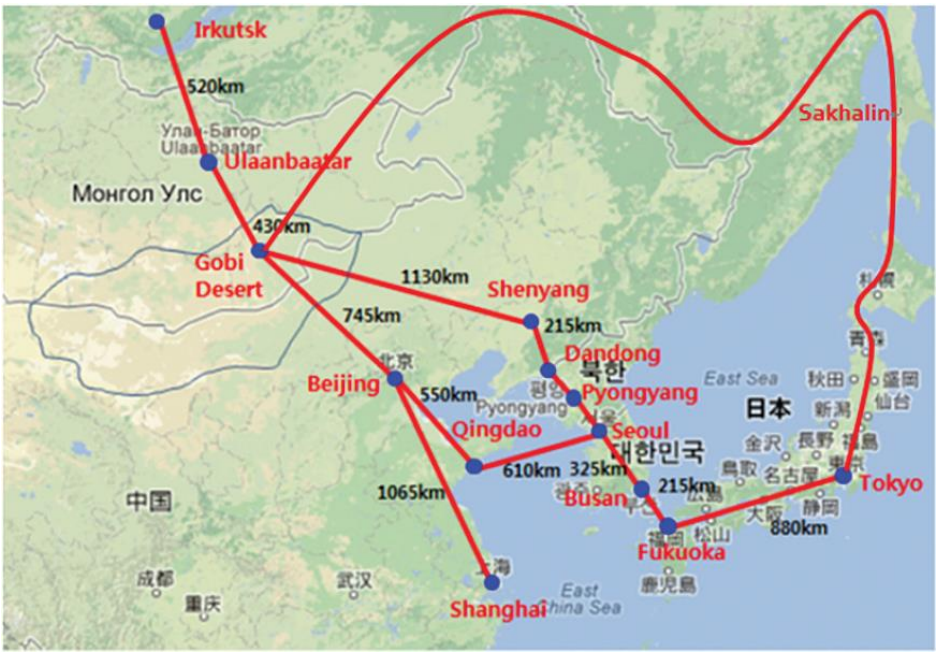
This study can be extended to shed light on the issue of whether the interconnection projects will be economically and financially feasible. Further studies can also indicate the optimal planning of the interconnection projects among NEA countries, especially in terms of routes and timing.

2.2 Literature Review

This study highlights several recent research progress made by other institutes and aims at building on these studies to push the NEA power grid interconnection further. The first report – the Energy Charter (2014) – was jointly produced by the Energy Charter Secretariat, Energy Economics Institute of the Republic of Korea, Energy Systems Institute of the Russian Federation, Ministry of Energy of Mongolia, Japan Renewable Energy Foundation, Fraunhofer Institute for Systems and Innovation Research, and Fraunhofer Institute for Solar Energy Systems. The report extensively presents the technological and legal challenges, thus comparing the costs and benefits of power grid interconnection in the NEA region under the concepts of Gobitec and Asian Super Grid (Figure 5). Specifically, it addresses the benefits and requirements for implementing the interconnection among Irkutsk in the north, Shanghai and Seoul in the south, and Tokyo in the east of the Asian Super Grid region with high voltage

direct current (HVDC) transmission lines and massive scale deployment of wind and solar PV systems.

Figure 5: Gobitec and Asia Super Grid Concepts



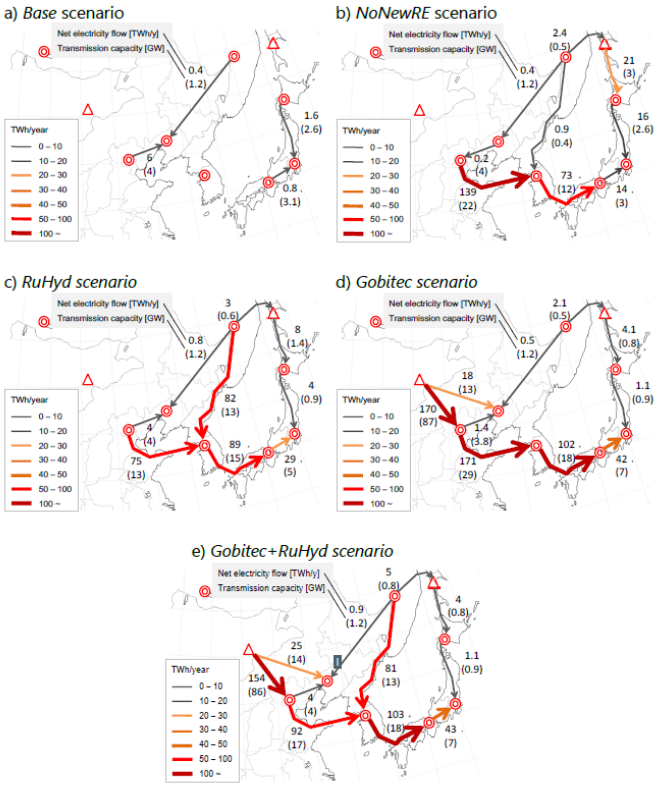
Source: Energy Charter (2014).

In general, the study implies that an HVDC with voltage higher than 1,000 kilovolt should be applied to the power grid interconnection in the region, considering the very long distances between connection points. The study also acknowledges the legislative and regulatory challenges and recommends the formation of an Energy Charter Treaty to facilitate the development of power grid interconnection in the region. Lastly, this study summarises the benefits of power grid interconnection in the region from several perspectives, including economic, social, and environmental aspects; job creation; poverty alleviation; and reduction of carbon dioxide emissions.

The other recent study was presented by APERC in 2015. This study mainly develops a multi-region power system model for NEA countries, based on linear programming. It is mainly a quantitative assessment of the economic viability of grid interconnections in NEA countries and renewable energy developments in the Gobi Desert and Eastern Russia. All grid interconnection scenarios indicate that economic benefits in the form of total cost reductions depend mainly on the fuel cost saved by shifting to cheaper fossil fuel or to renewables. Besides economic benefits, there is also the enormous potential for improving the environmental impact of the power

sector in the region. Active trade situation is discussed in this study (Figure 6). An earlier study by APERC in 2004 also indicated the significant economic cost saving due to power grid interconnection, although at that time, the significant potential of renewables had not come into consideration. Thus, the APERC study in 2015 is a timely revisit of the issue, reflecting the new technology developments in renewable energy and in power transmission.

Figure 6: Cross-Boundary Electricity Flows of Electricity in Northeast Asia



Source: APERC analysis.