Chapter 1

Introduction

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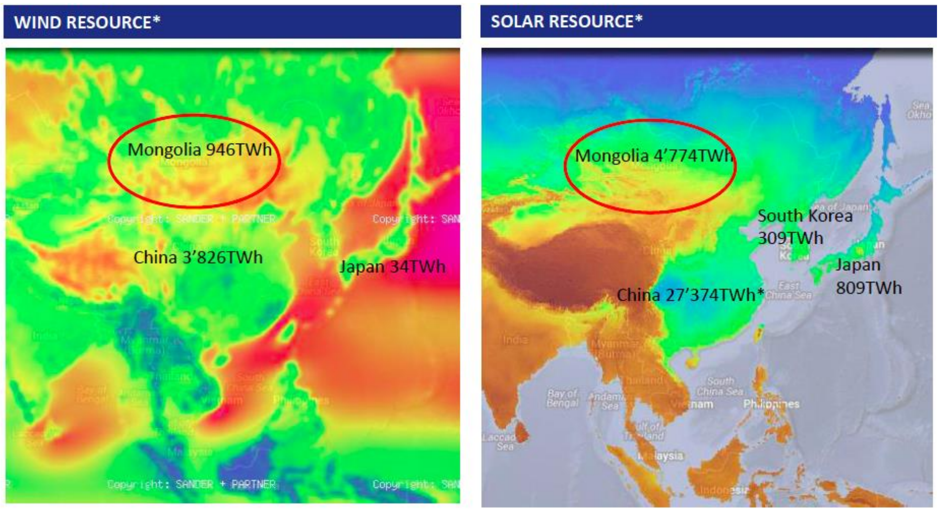
Chapter 1

Introduction

1.1 Background

Northeast Asia (NEA) has ample energy resources for power generation, including coal, oil, natural gas, and hydropower in Russia; and coal, wind, and solar resources in Mongolia. However, most of these resources are untapped due to the small population and small energy demand in Eastern Russia and Mongolia.

Figure 1: Wind and Solar Energy Resources in Northeast Asia



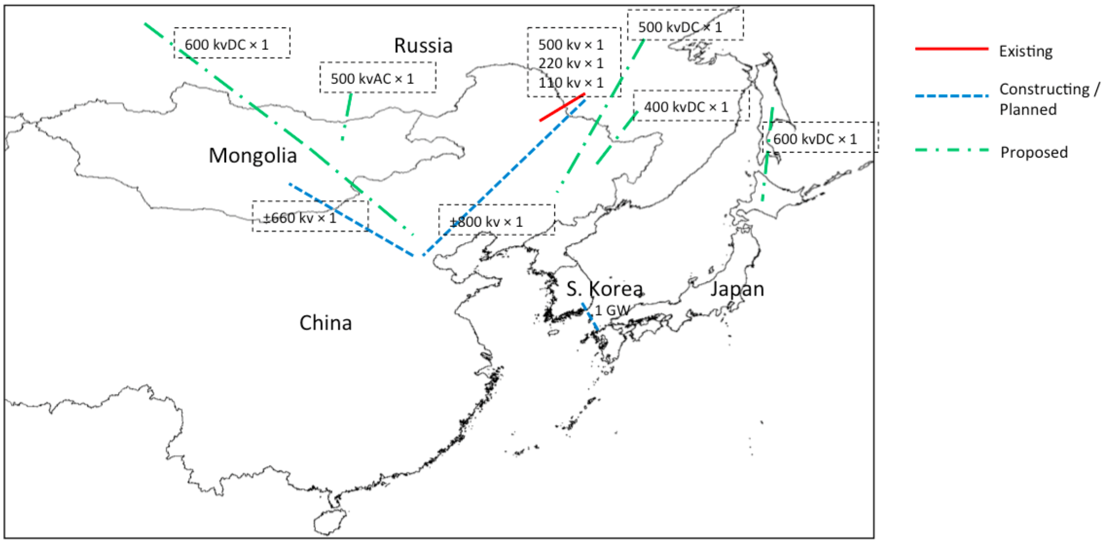
TWh = terawatt-hour.
Source: Newcom Group.

On the other hand, their three neighbours – China, Japan, and South Korea – are main energy consumers, especially of electricity. These three countries import large amounts of coal and natural gas to meet their electricity demand.

Thus, it makes sense to look into the idea of an Asian Super Grid for power grid interconnection among these countries. There are several types of potential benefits. First, it will diversify energy supply while creating new markets for the untapped energy resources. Second, it will avoid the building of expensive peak power generation capacities and using expensive fossil fuel, such as liquefied natural gas for peak power supply, to the extent that the interconnection capacity allows, as the wide geographical spread of these countries have differing peak hours and thus can mutually support each other through the power grid interconnection. Third, an integrated grid of several countries bears much higher capacity to absorb intermittent renewable energy. And fourth, the diversification and geographical proximity enhance the energy security of all participating countries.

In this regard, many institutes, such as the Asia Pacific Energy Research Centre (APERC), Japan Renewable Energy Foundation, Energy Systems Institute of the Siberian Branch of the Russian Academy of Sciences, and SoftBank have conducted studies. Many bilateral cross-border transmission projects are also being carried out, especially for Russia–China, Mongolia–Russia, and Japan–South Korea.

Figure 2: Existing and Planned Power Transmission Lines in Northeast Asia



DC = direct current, GW = gigawatt, kV = kilovolt.
Source: Economic Research Institute for ASEAN and East Asia.

While bilateral projects can be easily justified by the concentration of newly developed energy reserve, such as coal or hydropower on the one end and the concentration of demand by large cities with a large population on the other end, multilateral power grid interconnection is much more complicated in terms of potential benefits; risks; and technical, regulatory, administrative, and even political complications.

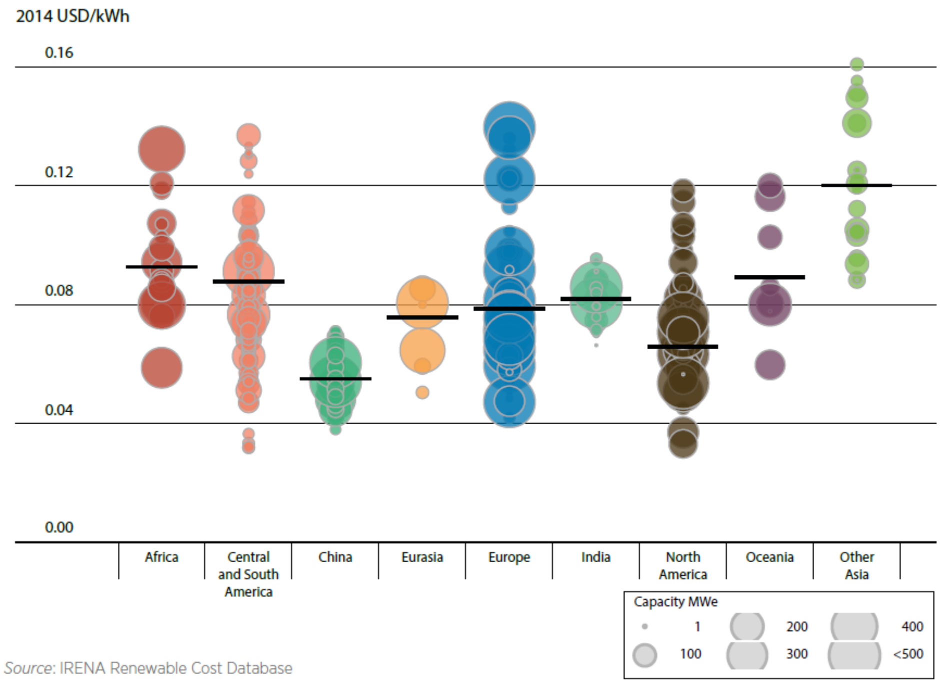
Existing studies on these issues are at preliminary stages. Thus, more detailed studies are required to establish firm grounds for policymakers as well as investors and financiers to make their decisions. Thus, the Economic Research Institute for ASEAN and East Asia (ERIA) proposes to conduct studies as described below, in collaboration with Mongolia partner institutes.

1.2 Economic Rationale

The rationale of this Mongolia-focused project is to identify feasible power grid interconnection plans so that electricity generated from the rich wind and solar resources of Mongolia could reach neighbouring countries at competitive costs. Therefore, both the costs of electricity and the transmission must be looked into.

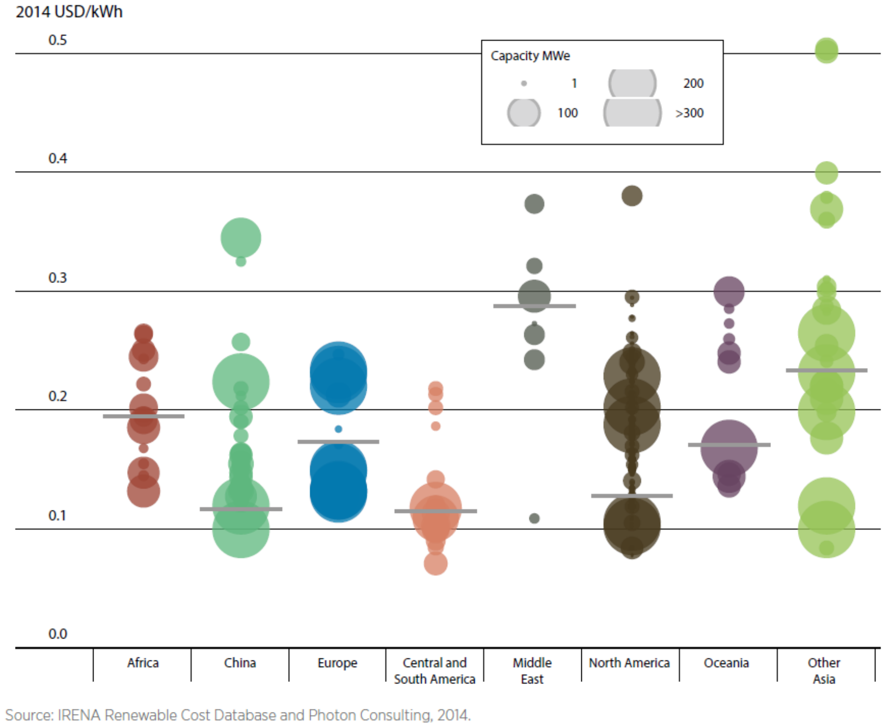
A recent study by IRENA (2015) shows the cost of electricity from utility-scale wind and solar (Figure 3).

Figure 3: LCOE and Weighted Averages of Commissioned and Proposed Wind Projects, by Country and Region, 2013 and 2014



kWh = kilowatt-hour, LCOE = levelised cost of electricity, MWe = megawatt electrical, USD = US dollar.
Source: IRENA (2015).

Figure 4: Levelised Cost of Electricity of Utility-Scale Solar Photovoltaic Systems, by Country and Region, 2013 and 2014



kWh = kilowatt-hour, MWe = megawatt electrical, USD = US dollar.
Source: IRENA (2015).

A recent study by ERIA (Li and Chang, 2015) shows the cost of transmission, which also considered establishing new trunk lines (Table 1).

Table 1: CAPEX of Power Transmission Lines and Simulated Cost of Transmission

Case	Voltage (kV)	Line Length (km)	Capacity	CAPEX (USD)	US$/MWh[a]
1	500	200	500	167,200,000	9.1
2	500	400	500	297,900,000	16.1
3	500	200	1,000	242,000,000	6.6
4	500	200	1,000	152,400,000	4.1
5	500	400	1,000	449,500,000	12.2
6	500	200	2,000	312,100,000	4.2
7	500	200	2,000	292,200,000	4.0
8	500	400	2,000	732,500,000	9.9
9	500	400	2,000	630,800,000	8.5

CAPEX = capital expenditure, km = kilometres, kV = kilovolt, MWh = megawatt-hour, USD = US dollar.

[a] Embedded assumptions include 40 years of asset life, 10 percent discount rate, load factor at 5,000 hours per year, operational costs as 2 percent of the CAPEX, and transmission loss at 2 percent.
Source: Hedgehock and Gallet (2010).

It can be observed that the levelised cost of electricity from wind and solar in Asia is mostly in the range of **US$0.05–US$0.10**/kilowatt-hour (kWh). This would especially be the case in the resource-rich areas of Mongolia. Long-distance transmission using high-voltage technologies increases the cost of transmission at less than US$0.01/kWh in most cases.[1] Thus, the cost of electricity from renewable sources from Mongolia could be cheaper than the electricity in China, Japan, and South Korea, under certain circumstances. However, such is subject to verification with careful modelling and accurate data, as the rest of this report reveals. Needless to say, the energy diversification effect will also add to the energy security of the receiving countries.

In addition, studies about power grid interconnection in other regions, such as Europe, Africa, and Southeast Asia, have all found net economic savings due to trade of electricity across the borders enabled by such interconnections. This study aims at identifying such economic rationale quantitatively for the NEA region.

[1] In the case of dedicated transmission line for power from wind and solar only, the actual utilisation will be lower than 5,000 hours per year, so the cost of transmission will be higher. In the case of very long distance transmission from Mongolia and Russia to South Korea and Japan, the cost of transmission could be 5–10 times higher, due to higher capital expenditure (CAPEX) and also higher transmission losses.