SUPER GRID IN NORTH-EAST ASIA THROUGH RENEWABLE ENERGY

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Abstract
Objectives of Super Grid is to construct large scale renewable power plants and transmission network in Gobi desert for sharing generated electricity with neighboring countries in North-East Asia. In addition, the driving force for Republic of Korea is the need for energy independence, moving away from the dependence on fossil fuel import and nuclear power plant. Currently moving from the price-feasibility to feasibility study, the challenge is to build consensus among the participating countries and stakeholders.

Introduction
Energy remains as the key driver of social and economic development at national and international level. The energy demand is growing very fast. To meet such high energy demand without damaging the environment, significant increase in the share of renewable energy among all kinds of energy resources is happening.

It is very fortunate that many of developing countries in Asia and Africa have abundant resources of solar energy, low-cost desert and arid land. Wider utilization of renewable energy should provide the foundation for not only reliable energy supply, but it may also bring renaissance in the development of energy in developing countries. It can significantly contribute to enhancing their social and economic development.

Renewable energy is becoming more important in the Republic of Korea with rapidly changing domestic business environment due to frequent fluctuation of international petroleum price and UN framework convention on climate change.

Though Republic of Korea has started to focus on renewable energy industry later than other advanced countries, it is expected that the industry would be a national growth engine in the near future as the Korean government has made maximum efforts to support renewable energy technology development and deployment in order to realize Green Growth.

Significant technology advances and dramatic cost reductions have been achieved in renewable energy over last decade in the Republic of Korea. It is clear that supporting high level research and facilitating exchange of information and experiences are crucial. If renewable energy technologies are to be continually expanded, its costs would reduce. Technology cost reduction can be realized through the active collaboration of all stakeholders on local, regional, and global level.

Status of renewable energy in Republic of Korea
Because of rapid economic growth accelerated by the heavy and chemical industries, the Republic of Korea’s energy consumption has increased rapidly since the mid-1970s. Total primary energy consumption (TPES), which stood at 43.9 million tons of oil equivalent (toe) in 1980, increased more than six-fold to 275.7 million toe in 2011. Republic of Korea became the 10th largest energy consuming country in the world. Energy consumption per capita in the Republic of Korea also increased rapidly from 1.1 toe in 1980 to 5.1 toe in 2011. But its energy resources are limited to low-quality anthracite with small amount, which accounted for less than one percent of total primary energy supply. With poor indigenous energy resources, the Republic of Korea has to import almost entire required energy. The dependency on imported energy was 96.4 percent in 2011 and the cost of energy import amounted to US$ 1,725 billion, which accounted for 32.9 percent of total inbound shipments.

Oil Demand of Republic of Korea has been growing rapidly since 1970s, except the two oil crises period of 1973 and 1979. Coal demand has also increased by annual average increasing rate of 5.2 percent for the past 30 years, due to the large amount of industrial use including power generation. But the main use of domestic anthracite has been shifted dramatically from residential sector to industrial sector. Natural gas was imported from 1986 in the form of LNG and it accounted for 17 percent of the primary energy consumption in 2011.

Energy conservation and efficiency policies for reducing energy consumption aim at all components of energy system ranging from primary energy production to end-use. In public procurement, the government gives preference to commodities produced using clean energy technology. Despite nationwide efforts by the government to encourage energy conservation and energy efficiency, increasing demand of energy is expected to persist in the future due to the rapid growth of national economy.

At the end of 2011, the amount of new and renewable energy (NRE) supply
was 7,583,000 toe, which comprised 2.75 percent of the total primary energy consumption, 275,688,000 toe. Of the total supply of NRE, waste utilization contributed the largest proportion with 67.54 percent, followed by hydro power with 12.73 percent, and other types of renewable energy with 19.73 percent. NRE power generation has also increased rapidly, PV and wind, in particular. In terms of PV, power generation has increased nearly 30 times to 917,198 Mwh in 2011 from 31,022 Mwh in 2006, and wind has increased to 862,884 Mwh from 238,911 Mwh. Fuel cell appeared as an electricity source in 2006 and its output in 2010 was almost 44 times higher than that of 2006, achieving 294,621 Mwh. Total NRE power generation accounted for 17,345 GWh which is about 1.24 percent of total 501,527 Gwh of electricity generated in 2011 (Figure 1).

According to the statistics of the OECD, annual average growth rate of renewable energy by 6.8 percent in the Republic of Korea was 14th among OECD countries during 2008–2011, but in 2011, the penetration rate of 1.6 percent was ranked the lowest among the OECD countries. The average of technical standard is 86.2 percent compared to Europe countries, which is about 10 percent lower than Japan and about five percent higher than China. It must invigorate the system export-oriented business model to overcome the gap between these technologies and price competitiveness and weakness of domestic foundation market. Especially in order to improve the share of renewable energy technology in global market, it must be performed not only to strengthen price competitiveness and technology deployment but also implementation of the Super Grid technologies for the expansion of application and development of new utilization technology.

The third basic plan for NRE technology development and deployment established in December 2008, which handles Republic of Korea’s medium-long term target for NRE development and deployment, provides action plans and basic strategies. It aims at facilitating the NRE industries into a new growth engine for the Korean economy.

The background of basic plan is as follows:

- It divides into the fields of NRE focusing on accomplishment of the supply and R&D activities and suggests supply goals with concrete standards to meet international trends and domestic goals;
- The fundamental direction of the plan is to classify renewable energy sources into deployment-oriented groups: wind, bio-energy, waste and geothermal;
- R&D-oriented group: PV, hydrogen and fuel cell; and
- Responding to the climate change and exhaustion of fossil fuels.

According to the Business As Usual (BAU) scenario of the basic plan, the NRE share of primary energy supply will account for 3.6 percent in 2015, 4.2 percent in 2020 and 5.7 percent in 2030, and by the target scenario, the NRE share of primary energy supply will account for 4.3 percent in 2015, 6.1 percent in 2020 and 11 percent in 2030.

Achievement of renewable energy in each area from 2007 to 2011 has been increased sharply.

The number of manufacturing companies in the NRE industries in the Republic of Korea has increased from 100 in 2007 to 224 in 2011. It means it has increased 224 percent with an annual growth rate of 45 percent. The number of companies by resources as of 2011 was 98 PV companies, 48 bio-energy companies, and 38 wind companies.

The number of employees in the NRE industries has increased from 3,691 employees in 2007 to 17,161 in 2011. It is an increase of 4.6 times with the annual growth rate of 92 percent. As PV and wind power industries are expected to become a core growth engine for the future, the employment effect will also be significant in these fields.

The sales of the NRE industries have increased from US$ 1.25 billion in 2007 to US$ 14.5 billion with an increase of 14.5 times, and the export sales have increased from US$ 0.78 billion in 2007 to US$ 8.42 billion in 2011 with an increase of 79.5 times (Figure 2).

As an effort to improve the energy supply and demand condition and to promote the development of regional economies by supplying region specific NRE that are environment-friendly, the government has been promoting regional deployment subsidy program designed to support various projects carried out by local governments.

The government provides subsidy for NRE facility users to accelerate NRE deployment. The objective of the subsidy program is to create an initial market for new technologies and systems developed domestically, and to establish and activate the deployment infrastructure for technology and equipment commercialization. These subsidies are classified into two categories: (1) test-period deployment subsidy, and (2) the general deployment subsidy. The

Figure 1: Energy Consumption in Republic of Korea
The government provides the subsidy up to 50 percent of installation cost for commercialization of these systems.

**International cooperation with North-East Asian countries**

Renewable energy has been currently considered as an effective mean for the climate change protection as well as major driving force for sustainable economic growth. Recognizing such importance of renewable energy, the Korean government has been involving in a variety of international cooperation activities with international organization and various overseas counterparts.

The Government has maintained close relations with neighboring countries in North-east countries, mainly China, Japan, and Mongolian organizations to exchange information and develop collaborative programs. In order to promote cooperative programs, joint seminars, business matchmaking, cooperation agreements and to carry out joint research projects development, inter-governmental collaboration committees are organized.

Many joint seminars have been organized to build up relations with those countries by exchanging current key policies and technological information in various areas such as PV, wind energy, solar thermal, and biomass. With regard to follow up actions for these partnerships, this would be a great opportunity to identify beneficial areas in the field of NRE.

In order to construct Super Grid in Gobi desert, promotion of international cooperation, establishment of cooperation network among North-East Asian countries is required. However, North-East (NE) Asian countries show many differences in the frequency and transmission voltage of electricity as well as power consumption amount and power generation capacity. Because of the poor power status and the size of the economy, North Korea and Mongolia, especially, would require Super Grid immediately for interconnection to power system with one of the North-East Asian countries (Figure 3).

The historical background of international cooperation on renewable energy begins in 1995. Since 1995, Republic of Korea-Japan and Republic of Korea-China have been holding a joint seminar on renewable energy among North-East Asian countries. A joint forum on renewable energy (RE) was held in Seoul, and an International RE Conference and Exhibition took place in Busan in 2003. Also, Asia-Pacific Forum on RE (AFORE) and Global Photovoltaic Conference (GPVC) were held in 2011. NE Asia Consortium for Super Grid in Gobi desert was launched in 2012. AFORE is a regular event which began in 2008, and the main topics of the forum are renewable energy in terms of policy and strategy, technology toward low carbon sustainable society, but not limited to these topics only.

Symposium on Super Grid was held in 2012. Four countries such as Republic of Korea, China, Japan, and Mongolia have agreed for establishment of consortium for Super Grid in NE Asia and signed at this symposium. Joint seminar and cooperation plan were discussed on February 2013.

During the international joint workshop on Super Grid, a consortium and a working group were composed with representatives of each four NE Asia countries in March 2013 and ADB financial support proposal was completed at a round table discussion for Asian Super Grid which was held in Seoul in May 2013.

The consortium will have a steering committee consisting of four member countries such as Republic of Korea, China, Japan, and Mongolia and a working group will consist of representative experts of each technical areas from member countries and relevant international institutions such as IEA/PVPS, IRENA, ADB, DESERTEC as observers.

For the promotion of the Super Grid, the Republic of Korea is running the demonstration test through operating supervisory control system with IT technology. China constructed Super Grid on the basis of demonstration experiences of large-scale PV, wind farm, HVDC, etc., and Japan
Super grid in North-East Asia through renewable energy

Recent Publications from IRENA

Renewable Energy Country Profiles for Asia
The latest volume in the IRENA Renewable Energy Country Profiles series covers Asia, with profiles for Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, India, Indonesia, Japan, Kazakhstan, the Republic of Korea, Kyrgyzstan, the Lao People’s Democratic Republic, Malaysia, the Maldives, Mongolia, Myanmar, Nepal, Pakistan, the Philippines, Singapore, Sri Lanka, Tajikistan, Thailand, Timor-Leste, Turkmenistan, Uzbekistan and Viet Nam. IRENA Renewable Energy Country Profiles take stock of the latest developments in the field of renewables at country level around the world. Each profile combines analysis by IRENA’s specialists with the latest available country data and additional information from a wide array of sources. The resulting reports provide a brief yet comprehensive picture of the situation with regard to renewable energy, including energy supply, electrical generation and grid capacity, and access.

Renewables Readiness Assessment: Design to Action
The Renewables Readiness Assessment (RRA) is a comprehensive tool for assessing the conditions existing in a country for the development and deployment of renewable energy, along with the actions required to improve those conditions. Designed and refined by the International Renewable Energy Agency (IRENA) since 2011, the RRA is a country-initiated, country-led process that identifies short- to medium-term actions for the rapid scale-up of renewables.

Smart Grids and Renewables: A Guide for Effective Deployment
The steady growth of renewable energy technologies and cost-competitiveness of solar and wind power call for a smarter approach to power-grid management. This working paper from the International Renewable Energy Agency (IRENA) provides a technical overview of smart-grid technologies as a way to accommodate larger shares of renewable energy in the electricity sector. Smart Grids and Renewables: A Guide for Effective Deployment finds that:

- Smart-grid technologies are already deployed cost-effectively in many instances today, enabling higher penetration of renewable energy sources.
- Policies and regulations need to be developed for smart grids and renewable energy sources as soon as, if not before, large-scale deployment takes off.

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SUPER GRID

Super grid in North-East Asia through renewable energy

Developed a proposal of business model based on mega solar project including Asia Super Grid Plan after Fukushima nuclear disaster. Mongolia established monitoring centers at Super Grid candidate area to measure and collect whether data collection.

The main concept of Super Grid is related to electricity transmission system, based on HVDC, designed to facilitate large scale sustainable power generation in desert area for transmission to the center area of consumption.

Core Technologies of Super Grid are as follows: (1) Large scale RE power generation in Gobi desert, (2) IT, WAMS, ESS, HVDC, and (3) Electricity transmission. Expected effects of Super Grid through the international cooperation in North-East Asia countries are technical benefits, economic benefits, social benefits and environmental benefits. The key challenges could be the following: (1) Consensus among participating countries and system sustain-ability, (2) Developing implementation road map with action plan with member countries, and (3) To develop managing rules and organizations needed.

The VLS-PV systems can play an important role as well as wind farms for clean and safe power generation. At present, a practical project proposal for “Super Grid in Gobi desert” has been proposed to raise funds for a feasibility study, and the study will implement site selection, field test and demonstration, economic and socio-environmental effects analysis, among others.

Conclusion
In the near future, renewable energy should become an economically viable option to meet the electricity needs of communities in remote or mountainous regions around the world where conventional power plants cannot be built. The rate of deployment of renewable energy is greatly influenced by the perception of general public and utilities, local, national and international policies, as well as the availability of suitable standards and codes to govern it.

In long term period with a solid strategy for implementing Super Grid in desert area, further expansion of large scale renewable power generation can provide increasing energy demand of the North-East Asian region in a sustainable way. In addition, diffusion of the various kinds of high-tech knowledge and experiences, know-how will be transferred to local renewable energy institutes, utilities and energy companies in order to keep track of worldwide technology developments, technology exchange between universities and scientific institutes in North-East Asian region countries.

To realize our dream, we must try to build consensus with convergence, integration and harmonization based on neighborhood.