

PERSPECTIVES ON POWER GRID INTERCONNECTION IN NORTHEAST ASIA

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1. The driving forces for international connections

National wide and international interconnection is a general tendency of modern power systems worldwide. It is well known that interconnections of power grids can produce many benefits to the involved parties, and some of the main benefits can be summarized as:

- Export of electricity from a country with surplus supply to another country with energy deficiency. Both countries can benefit from such an electricity transaction.
 - Utilization of most favorable energy resources. This will be helpful for the sustainable economic development of the resources in the involved countries.
- Use of larger and more economical power plants
- Flexibility of building new power plants at favorable locations. Interconnections can lead to environmental benefits by sufficiently utilizing green energy among these countries, and hence avoiding the production of high pollution coal-fired generating plants.
- Sharing generation to take advantage of non-coincidental load demand.
- Cost reduction through joint economic dispatch and coordination of hydro and thermal resources among these countries.
 - Improvement of supply reliability with emergency support from the neighboring grids.
- Sharing spinning reserve.
 - Stimulating economic cooperation and growth throughout the involved countries.

Different countries may have different views about the relative importance of these benefits due to the differences in geographical, natural and economic conditions.

In the last two decades, many international grid connections have been completed or committed in North America, Europe and Africa. The process of grid interconnections in the Northeast Asia countries (China, Japan, South Korea and Russia) is lagged than that in other regions. However, this does not mean that the potential benefit of grid interconnections in these countries is less than that in other areas. Actually, the potential benefit of interconnections in the Northeast Asia countries is huge due to differences in availability of energy resources, economic and technical development and other conditions in these countries. For example, the annual load maxima in Japan and South Korea take place in summer, whereas in North China and Russia they are in winter.

2. Future scenarios of power industry in the Northeast Asia Countries

2.1 China

In the last two decades, following successful economic reform, the progress of China's power industry has been phenomenal. Now there are 7 regional power systems with installed capacity ranging from 15 GW to 43 GW, and also several isolated provincial power grids. The total installed generation capacity and annual electric productions are respectively 277 GW and 1167 TWh in 1998.

For optimal utilization of energy resources and improving power system economical and security operation, it is a strategic target of China to build a national wide interconnected grid in one or two decades. National wide grid interconnection will form a basis for the establishment of the future national electricity market in China.

Development of large hydro power projects such as the Three-Gorge power station (with installed capacity 18200 MW), Jinshajiang (67400 MW), Lancangjiang (28900 MW), Yalongjiang (24300 MW) and Daduhe (17720 MW) along the Yangtz river provides a great incentive of national wide interconnections for optimal energy utilization, environmental protection and sustainable economic development, in addition to other benefits such as river flow compensation, thermal-hydro units coordinated operation, power reserve sharing.

The proposed grid interconnections include North China with Northeast China, Central China with North China, Northwest China with Central China, East China with Fujian province. Extensive study has been carried out by several organizations especially EPRI, China on some important issues concerning the national interconnections in China.

East China power grid is already interconnected with Central China power grid by a ± 500 kV bipole DC link with the capacity of 1200 MW. Until recently, the actual electricity exchange between these two grids is only 1/3 of the designed capacity.

The Three-Gorge power system will be established by the year 2003 which will consist of the power grids of East China, Central China and Southwest China regional power systems. There will be 3 large bipole DC links between Central China and East China power grids.

2.2 Russia

The territory of Russia has an abundance of fuel resources, represented by 38% of the prospected world gas reserves, 13% of oil, and 12% of coal. This energy potential is massive. It will allow Russia to play a special role in the development of grid interconnections with the other Northeast Asia countries.

The unified power system (UPS) of Russia, the world's largest centrally managed grid, has been created and successfully operated for 40. There are 75 power systems operating within the territory of the Russian Federation. As of January 1998, the installed capacity of power plants in the UPS of Russia, along with the interconnected power system (IPS) of the East, consisted of 199.6 million kWh. The types of generation in the UPS of Russia and the IPS of the East and their shares of the total are:

- a. 41.3 million kW (21%) in hydro power plants (HPP) and pumped-storage plants (PSP)
- b. 21.3 million kW (11%) in nuclear power plants (NPP)
- c. 137.0 million kW (68%) in thermal power plants (TPP).

Electric energy produced by the power plants of the UPS of Russia and the IPS of the East in 1997 totaled 802.7 billion kWh, including 149.2 billion kWh produced by HPP, 108.1 billion kWh produced by NPP, and 545.4 billion kWh produced by TPP.

External electric ties of the UPS of Russia consist of interstate ties with the power systems of the states belonging to the UPS of the former USSR and other countries. The IPSs of Russia have

efficient interstate ties with Ukraine, Transcaucasia, Kazakhstan, Belarus, and the Baltic countries. The use of the grid ties is determined by economic and political agreements. Electric power exports to the republics of the former USSR in 1997 totaled 15.6 billion kWh.

Electric power is also exported to other countries: to Finland via the dc link, to the islanded areas in Norway and Finland, and to the power system of Bulgaria via the electric networks of the Ukraine. In 1997, the UPS supplied 5.0 billion kWh of electric power to foreign countries, and this volume of exported electricity is below the export capacity of the UPS and can be increased further.

3. Northeast Asia Interconnection

There have been several studies on interconnection of Northeast Asia countries. One is the "Russia-Japan" link with power transmission from Uchursk hydro power plants. Another one is the "Russia-China-South Korea" from Primorsk nuclear power plant. The third one is "Russia-Mongolia-China" from Bratsk hydro plants.

The Russia-Japan link is intended to take advantage of non-coincidental demand of Russia and Japan, where peak demand for the former is in winter and for the latter is summer. A ± 650 kV HVDC line with 10GW capacity and 300km long was envisioned. The Russia-China-South Korea link is also intended to replace summer fossil fuel plants in South Korea. The suggested connection is a ± 500 kV HVDC line with 3GW capacity and 1800km long.

Another possible interconnection between China and Russia has been studied. The main purpose of such an interconnection is the sale of power from Russia to China. A feasibility study of the project was completed in May 1998. The main conclusions include: 1) it will be beneficial to both China and Russia if in the years 2010-2020 China purchases 2000-3000 MW from Russia; 2) ± 600 kV DC lines are recommended for interconnections, and the terminals of the proposed interconnection at both sides are respectively in Tangshan city and Trkutsk city (2500 km); 3) the investment will be around 1.1 billion USD; 4) the electricity price proposed by the China side is 4 US cents/kWh, while by the Russia side is 4.5-5 US cents/kWh.

Some preliminary research about the grid interconnections among the Northeast Asia countries demonstrates that it is only a matter of time before the means of international trade in electricity will be demanded among these countries. An interconnected Northeast Asia power grid will be one major contribution to simulating sound economic development for every country concerned.

4. Important issues

There are many challenges for the grid interconnections among the Northeast Asia countries. These issues can be classified into the following categories, which will be discussed in this workshop:

- Economic considerations
- Institutional considerations
- Environmental considerations
- Technical considerations
- Political considerations
- Financial considerations

5. Concluding remarks

In planning an interconnection project among adjacent countries, it is necessary to take into account of the potential political problems, traditional international relationship and disputes among these countries, social and environmental impacts, management and investment, and the future pictures in these countries after deregulation, as well as the supply and load demand trend in the coming several decades, the cost/benefit analysis and the involved technical issues.

Specific to the grid interconnections in Northeast Asia countries, it is expected that the potential benefit is huge although there do exist many potential political and economic risks. It is believed that in this process the government of each involved country will play a vital role and a coordination organization is necessary for dealing with specific issues.