

The Development and Status of the Power Grid in China, and International Cooperation for Grid Integration in Northeast Asia

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1. Introduction

China's Power industry went through a substantial period of economic and organizational reform in 2002. At the same time, the State Grid Corporation of China (SGCC) has promoted a set of initiatives that can be described together as a "West to East Electricity delivery, Bi-directional Power supply between the South and the North, Interconnection nationwide" Strategy. But how might the development and status of SGCC, and the work toward this overall strategy of internal grid connections in China, affect the prospects for international cooperation for grid integration in China?

This paper covers seven major themes: the reform of China's power industry during 2002, current power supply and demand conditions in China as of 2002, prospects for sustainable and stable growth of power supplies in China, the short-term aspects of the focus on nationwide interconnection of SGCC grids, the status of electric power industry in Northeast of China, the transmission interconnection between Northeast China Power Network and the North China Power Network, and prospects for international transmission connections between China and other countries in Northeast Asia.

2. China's Power Industry Reform in 2002

The State Power Corporation of China was established in 1997. The power industry

reform scheme was approved by the State Council in March of 2002. As a part of the implementation of the reform scheme, new generation companies and new grid companies were established on Dec. 29, 2002. Subsequently, the State Council approved the formation of the State Electricity Regulation Commission (SERC) in February of 2003. The implementation of power industry reform is continuing rapidly today.

The major objectives of power industry reform in China are:

- a. Break up the current monopoly on generation and introduce competition into the power generation-side (wholesale) market.
- b. Reduce costs, improve efficiency, and improve tariff-setting mechanisms in the power sector.
- c. Optimize resources allocation in the sector, and promote nationwide grid interconnection.
- d. Establish an open power market with fair competition under government regulation.

The essence of the reforms is to restructure state-owned power assets, rationalize tariff structures, and establish a transparent and rational power market with fair competition under government regulation. As a part of industry reform, the State power grid was divided into two grid corporations—the State Grid Corporation of China (SGCC) and the China Southern Power Grid Co. Ltd—and five national generation companies (China Huaneng Group, China Datang Group, China Huadian Group, China Guodian Group, and China Power Investment Group) were established. The new power market is regulated by the State Council-approved State Electricity Regulation Commission (SERC). SERC is responsible for setting up regulations for power industry management, proposing tariff adjustments, issuing licenses for power plants and other facilities, and resolve disputes among different parties in the power sector, and other functions.

The responsibilities of SGCC in the newly reformed power market include:

- a. Trading and dispatching electricity between regional power grids.
- b. Coordination with regional power grid companies on daily production issues.
- c. Participating in investment, construction and operation of relevant trans-regional transmission and electricity transformation and interconnection projects.
- d. Construction and management of the Three Gorges Dam transmission and transformation projects.

3. Power Supply and Demand Conditions in China as of 2002

As of 2002, China's electricity supply-demand balance was overall in equilibrium, but leaning toward a slight supply shortage. As of the end of 2002, the total installed capacity for power generation in China had reached 356 GW (gigawatts), and power generation for the year totaled 1654 billion kWh. The unit utilization average during 2002 for all thermal power plants in China was 5270 hours, for an overall average capacity factor of just over 60 percent. It is expected that the unit utilization hours will increase somewhat in 2003, and that the

overall balance between supply and demand will remain in equilibrium.

Though overall supply and demand in China are more or less in balance, there are regional, seasonal and period shortages in generation and capacity. Electricity utilization in Guangdong province, North China, East China and some areas of Sichuan and Chongqing are increasing rapidly. In the Southern parts of Hebei, Shanxi, Wenzhou, and other areas of Zhejiang, the problem of electricity shortage is acute. On the other hand, the unit utilization in Hainan, Jiangxi, Northeast China, and Fujian average only about 4000 hours annually. Seasonal shortages denote shortages that occur during one or both of two peaks seasons, winter and summer, during the year. Period shortages denote shortages that occur during peak periods, and are measured by the number of hours of such shortages on average during a full year (8760 hours).

In 2003, it is expected that power consumption will continue to grow rapidly, and that as a consequence power supply shortages on some power grids will tend to be further intensified in some areas.

4. Sustainable and Stable Growth

By the year 2020, China's national GDP is likely to be quadruple that of the year 2000, which equates to an annual growth rate of 7.17 percent.

Accordingly, power industry growth will need to remain stable and sustainable in order to continue to meet the needs of the expanding Chinese economy:

- By the year 2005, installed capacity in China will need to reach 430 GW, with total power consumption will be 2058 billion kWh.
- By the year 2010, installed capacity will need to rise to 600 GW, and total power demand will be 2700 billion kWh.
- By 2020, the installed capacity in China will reach 900 GW, and the total power consumption that must be met by generation will be about 4300 billion kWh.

Based on these projections, from 2003 to 2010, total power generation (and consumption) in China will increase at a rate of 6.6 to 7 percent per year, and from 2010 to 2020, total power generation and consumption will increase at a rate of 4.5~5.5 percent per year.

5. Short-Term Focus on the Nationwide Interconnection of SGCC

At present, there are six regional power networks and three isolated provincial power grids on the mainland of China. The six regional power network are: the Northeast China Power Network (NEPN), the North China Power Network (NCPN), the East China Power Network (ECPN), the Central China Power Network (CCPN)—which includes the Chuanyu (Sichuan and Chongqing) Power Network (CYPN), the Northwest China Power Network (NWPN), and the South China Electric Joint Venture Power Network (SCPN).

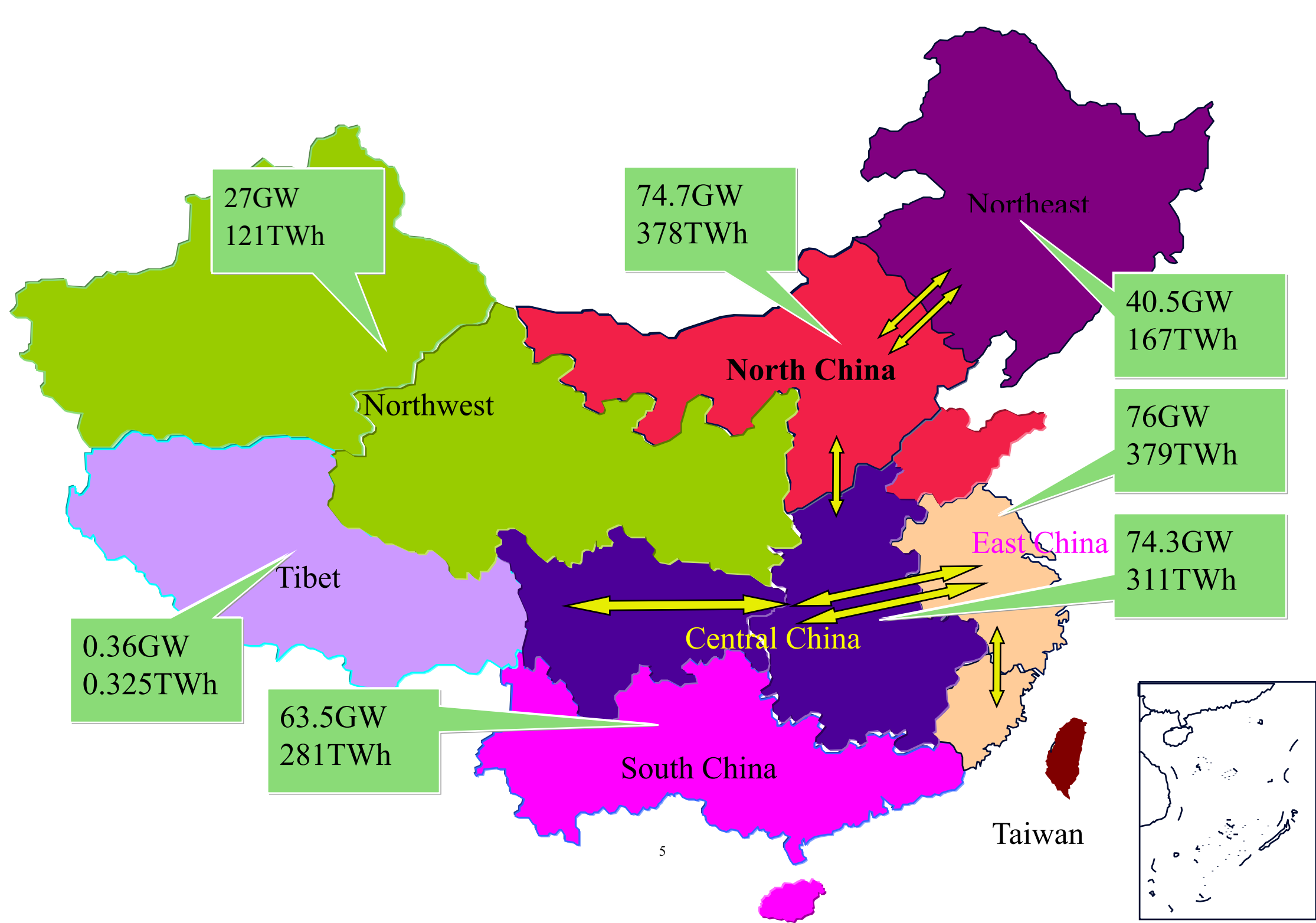
The three isolated provincial power grids include the Hainan Power Grid (HNPN), the Xinjiang Autonomous Region Power Grid (XJAR), and the Lhasa Power Grid (Tibet).

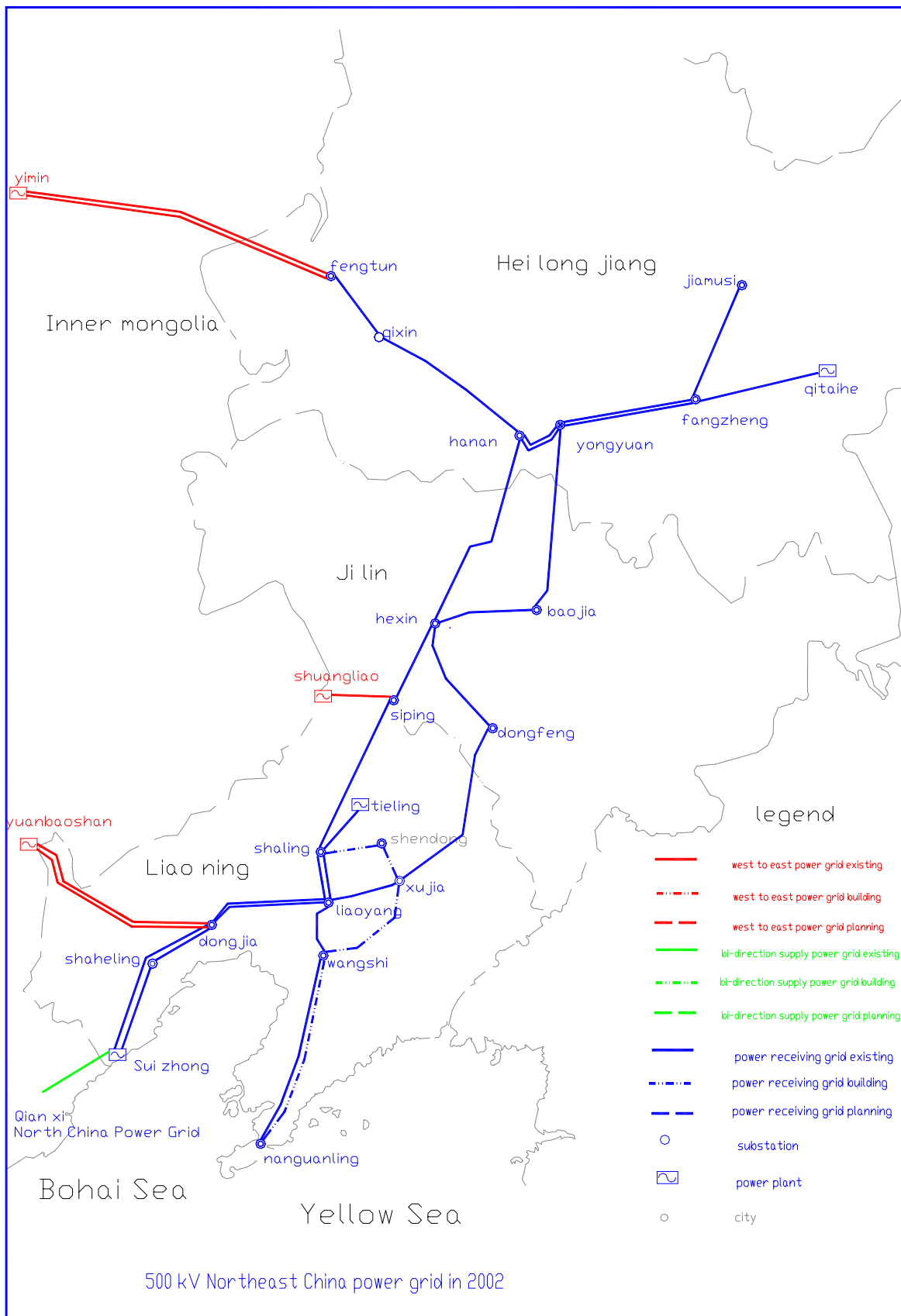
The "Nationwide Power Grid interconnection, West-to-East power transmission, and North-South power transaction" project is currently being implemented smoothly. An overview of past grid interconnections between the regions of China, and of more recent and ongoing grid interconnection projects, is provided below.

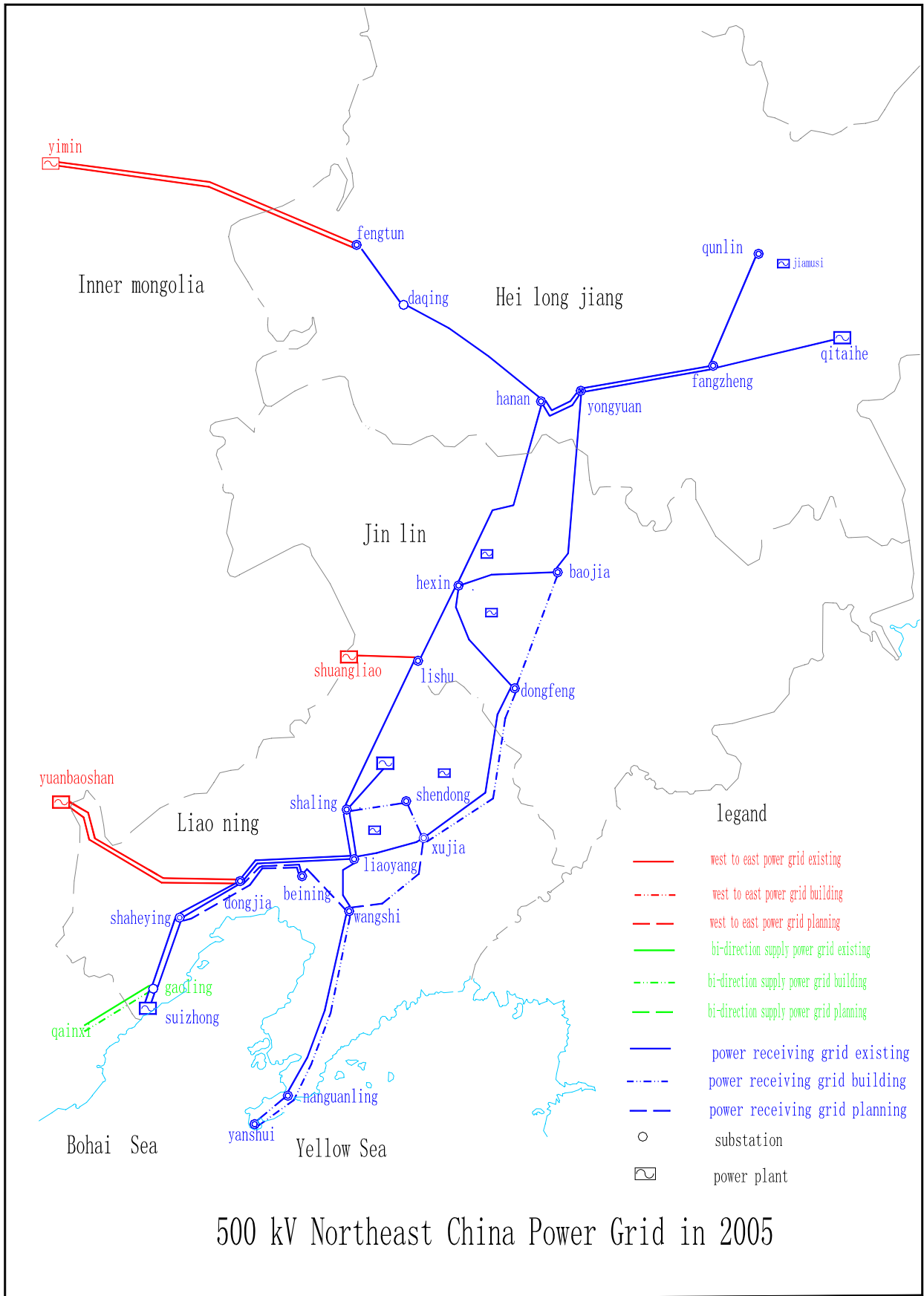
In China, the first regional transmission interconnection, built in 1989, was the 1,050 km, 500 kV (kilovolt) direct current (DC) line from the Central China Power Network (at the Gezhouba Hydropower Station) to the East China Power Network (at Shanghai) with a capacity of 1,200 MW. The second transmission interconnection built was the Yunnan-Guizhou-Guangxi-Guangdong transmission interconnection system. The third regional transmission interconnection project, completed in May 2001, was the 500 kV AC line that interconnects the Northeast China Power Network and the North China Power Network. The fourth regional interconnection project was a 500 kV, AC transmission line interconnecting the independent Fujian Power Grid and the East China Power Network to facilitate power transfer between these two power grids, a second AC line on this routing was finished on Jan 2003.

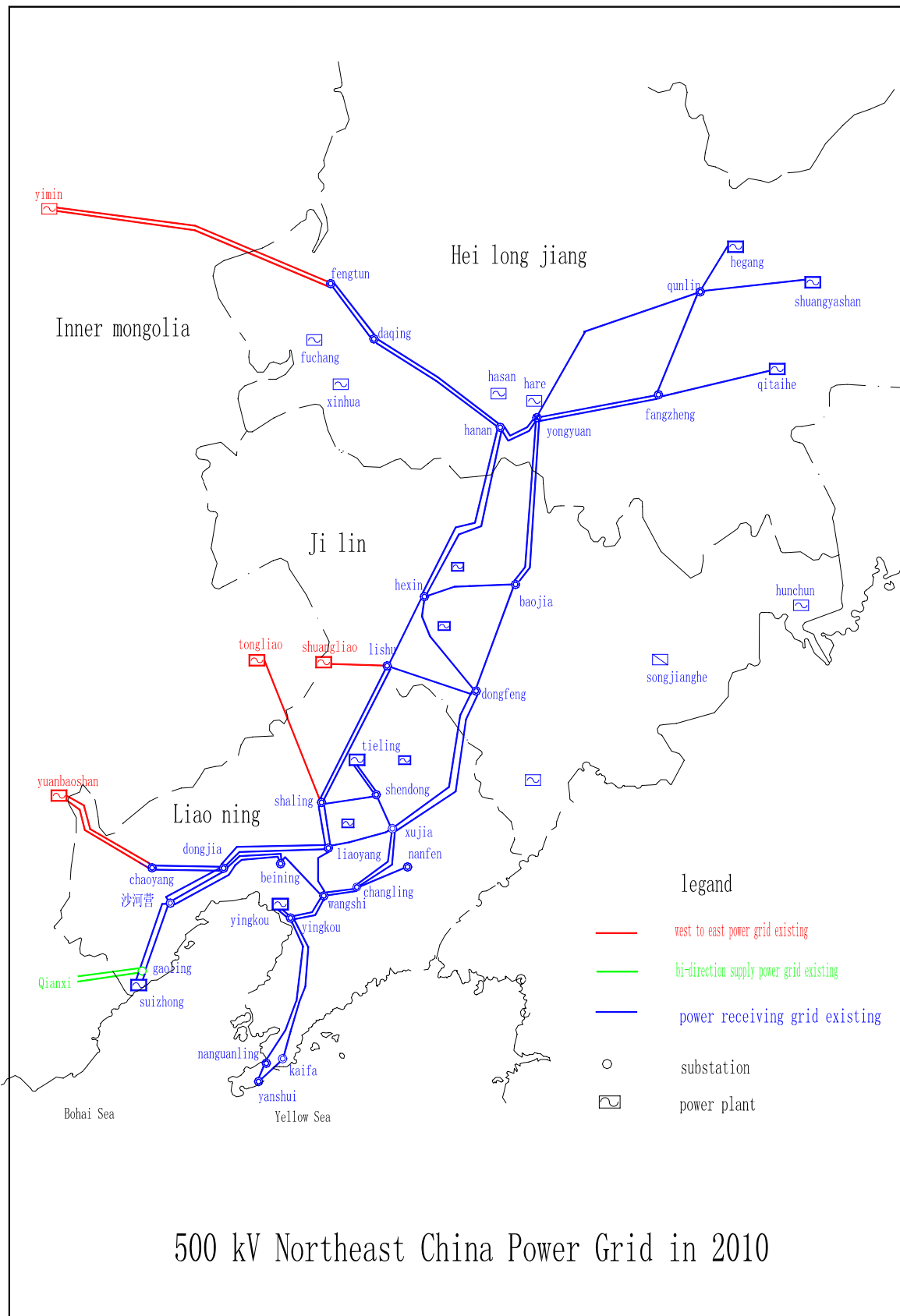
In 2002, SGCC interconnected the Central China Power Network and the Chuanyu Power Network through a single 500 kV AC line, a second line will be put into operation in June of 2004. In June 2003, SGCC completed the second DC line from Three Gorges to East China, and in August 2003, SGCC will build up first AC line between North China and Central China.

The map on the following page shows an overview of the different regional grid systems within China, showing year 2002 generation capacities and outputs in each region, as well as indicating interconnections between regional grids. The three figures that follow show, respectively, the Northeast China power grid as it was in 2002, and its projected configuration in 2005 and 2010 based on current plans for system expansion and reinforcements.









6. Status of the Electric Power Industry in Northeast China

By the end of the year 2002, the total installed electricity generation capacity in Northeast China had reached 40.5 GW, of which about 14 percent came from hydropower, with the remaining 86 percent from thermal power. Power generation totaled 167 TWh (Terawatt hours) during 2002, overall generation unit utilization reached an average of 4279 hours in North China over the year, and the average thermal power unit utilization reached 4749 hours per year.

By the end of 2002, there were 31 segments of 500 kV AC transmission line in North China, with for a total length of 5030 km. In addition, there were 473 segments of 220 kV line, with a total length of 22845 km. The total capacity of 500 kV substations in North China as of 2002 was 13806 MVA (meg volt-amps), consisting of 16 500 kV substations.

As of 2002, the electric power delivery direction is “North to South and West to East Electricity delivery” inside the Northeast China Power Network.

7. Transmission Interconnection between the Northeast China Power

Network and the North China Power Network

The Northeast China Power Network suffered from an over-expansion of generating capacity in the early 1990s. This over-supply problem was further aggravated by the reduced power demand resulting from the Asian financial crisis in the late 1990s. After a feasibility study, SP (State Power) decided to build a 500 kV transmission line between the Northeast China Power Network and the North China Power Network to transfer the surplus power from the former to the major load center in North China Power Network.

The line as constructed starts from the Suizhong plant and ends at the Jiangjiaying substation of Tangshan city in the Jing-Jing-Tang power Grid. Construction started on the transmission line in 1999, and the line was put into operation in May of 2001. This transmission interconnection provides bi-directional power supply, and the North China Network and Northeast China Network thus form a synchronized power network. The bi-direction power supply capacity of the line was limited to as 600 MW initially. After the second AC line is placed in operation in 2004, the bi-directional supply capacity of the line will be 1000 to 1200 MW.

In the long term, the line between the North China Network and the Northeast China Network will provide capacity backup, will improve system reliability for the power supply system, will facilitate potential power exchanges, and will provide improved grid support under emergency conditions.

8. Prospects for International Transmission Connection with Other Countries in Northeast Asia

8.1 The experience of power cooperation with Thailand

Proposed international transmission connection project in Southeast Asia involving Thailand and China required a great deal of time for feasibility studies, in large part because the transmission line was designed to pass through Lao PRC. Projects that result in improving international cooperation by developing trans-boundary power transmission connections, such as from China (Yunnan province) to Thailand, tend to be (or have been in the past) almost all hydropower transmission projects. In 1998, the Chinese government and the Thai government signed a electric power cooperation understanding memo, which states that the ultimate power transmission capacity of the line to be built will be 3000 MW by the 2020s.

As of now, it has been decided that the transmission project should use a ± 500 kV DC line, 1000 km long, starting in Yunnan province and ending in Thailand. About 150 km of this line will be located in China.

8.2 Possible power cooperation with Russia

In the Far East of Russia, based on recent feasibility studies, there are abundant supplies of energy resources such as hydropower, oil and natural gas, with resources far larger than are needed to fill the energy needs of the local populations. Energy demand, on the other hand, is large in other countries near the Russian Far East, especially in North China. As a result, based on resource availability and markets, cooperation on power sector development among Northeast Asian countries is possible and feasible.

In order to satisfy energy demand in North China, natural gas or electricity can be directly transferred into the load centers in North China from producing fields and power plants in the Russian Far East if the electricity price is competitive and the investment is possible and valuable.

8.3 SGCC will participate actively in relevant studies, and will exchange information and cooperate with other countries in northeast Asia.

This paper has discussed institutional reform in the Chinese power sector in 2002, described the current power supply and demand conditions in China as of 2002, presented projections for sustainable and stable growth of power supplies, discussed the near-term focus on nationwide interconnection of SGCC, summarized the status of the electric power industry in Northeast of China, reviewed the ongoing transmission interconnection between the Northeast China Power Network and the North China Power Network, and finally, presented a brief analysis of the resource status and the expect international transmission connection cooperation with other countries in Northeast Asia.

The author strongly hopes that collaborating researchers in Northeast Asia can share

the information on transmission interconnections needed to fully evaluate interconnection opportunities, and ultimately can share the energy resources in the region in a way that is efficient and profitable for all of the project partners.