China

Harbin Electric Network Construction Project

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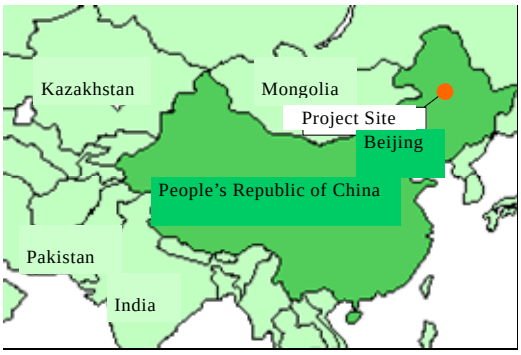
Field Survey: September 2007, March 2008

1. Project Profile and Japanese ODA Loan



Map of project area

Transformer facilities constructed in Harbin

1.1 Background

Harbin is the provincial capital of Heilongjiang Province, and an important industrial city of Northeast China. The electric power consumption volume of the city has increased from 7.5TWh in 2000, to 11.2TWh in 2006, an average annual increase of 6.9%. The principal electric power network of Harbin is composed primarily of 220kV electric power transmission networks, and of 110kV, 63kV and 10kV electric power distribution networks. At the time of appraisal, the following problems were found: (1) the capacity is inadequate, including electric power transmission lines, electric power distribution lines and substations; (2) the low-voltage substations are aging; and (3) the automatization of the electric power distribution control systems is lagging behind. There were concerns that if the electric power network is left as it is, the overloading and declining reliability of its electric power transmission and distribution network will advance further, and that it will be difficult to respond to new demands for electric power in the future.

As such, the project planed to do the following: (1) establish new substations and electric power distribution lines, thereby lessening the burden placed on each distribution line; (2) expand the installed electric power distribution capacity by changing electric power distribution lines to heavy lines and increasing establishment of transformers; and (3) in order to prevent accidents, improve the supply reliability of the entire electric power network through the replacement of

facilities which are remarkably aged.

1.2 Objective

To improve the supply-reliability of the entire electric power network through the establishment/enhancement of electric power transmission/distribution networks in Harbin, Heilongjiang Province, which is an important industrial city in China, and thus contribute to the economic development of the city.

1.3 Borrower/Executing Agency

The Government of the People's Republic of China/State Grid Corporation of China (SGC)

1.4 Outline of Loan Agreement

Loan Amount/Disbursed Amount	6,070 million yen/4,119 million yen
Exchange of Notes/Loan Agreement	March 2000/March 2000
Terms and Conditions - Interest Rate - Repayment Period - Grace Period Procurement	 2.2% 30 years 10 years General Untied
Final Disbursement Date	July 2005
Main Contractors (over 1 billion yen)	CHINA NATIONAL ELECTRIC WIRE & CABLE IMPORT AND EXPORT CORP. (China)
Consulting Services (over 100 million yen)	N/A
Feasibility Study (F/S), etc.	1999 F/S Heilongjiang Electric Power Company (HEPC)

2. Evaluation Result (Rating: A)

2.1 Relevance (Rating: a)

2.1.1 Relevance at the time of appraisal

The establishment of an electric power network connecting the entire country by 2000 was set out in the 9th National Five-Year Plan (1996-2000). In the wake of this, Heilongjiang Province's 9th Five-Year Plan (1996-2000) set out on the objectives of promoting greater efficiency and development of the electric power sector, promoting the construction of an electric power network, and improving the electrification rate.

Harbin is the city in the heart of Northeast China, and its electric power network occupies an important position in the electric power network of the Northeast region. However, the electric power network of the city had problems, including inadequate capacity of its electric power transmission lines, distribution lines and substations, and the aging of the existing electric power distribution facilities. It was forecast at the time of appraisal that electric power demand will increase by an average of around 6% a year. The importance of this project was high, considering the fact that it would improve the reliability of the entire electric power network of Harbin, respond to the imminent increase in demand for electric power and contribute to the economic development of the city.

2.1.2 Relevance at the time of evaluation

The objectives of the establishment of and the improvement of facilities for electric power networks in cities were set out in the 11th National Five-Year Plan (2006-2010). The objective of promoting the full implementation of electric power networks throughout the entire province is also set out in Heilongjiang Province's 11th Five-Year Plan (2006-2010).

From 2000 to 2006, the annual average electric power consumption volume of Harbin increased by 6.9% a year, a higher rate than the forecast at the time of appraisal. In the 11th Five-Year Plan for the economic and social development of Harbin (2006-2010), the target figure for the average economic growth rate for Harbin was set at the high level of 12%, and it is forecast that the electric power consumption volume will also increase further in line with this economic growth. The need for facility improvements for Harbin's electric power network and transformer facilities will therefore continue to be high.

The implementation of this project is in accordance with the national plans and

development needs at both the time of appraisal and the time of evaluation, and its relevance is thus extremely high.

2.2 Efficiency (Rating: b)

2.2.1 Outputs

Essentially, the electric power transmission and distribution facilities were constructed along the lines of the initial plan, but the 220kV electric power transmission and transformer facilities were not installed. This was because this project was positioned as part of the electric power transmission system enhancement plan across Heilongjiang Province as a whole, and because of the adjustment of the budget for the Chinese electric power sector as a whole, the scale of the project was reduced from 1.5 billion yuan to 1 billion yuan. The construction of the 220kV substations (four new establishment and one additional establishment) and the establishment of related electric power transmission facilities was thus excluded from the scope of this project. Following this, the abovementioned component was constructed as part of another project before the time of the ex-post evaluation. Other than this, the 66kV electric power transmission and transformer facilities, the 10kV and the 380V electric power distribution facilities were established essentially according to the plan. The planned and actual outputs are shown in Table 1.

Table 1: Planned and actual outputs

Items		Plan	Actual	Reason for Change
220kV Transmission & Transformer Facilities	Substation	New : 4 locations Additional : 1 location	Not Installed	This project was positioned as part of the electric power transmission system enhancement plan across Heilongjiang Province as a whole, and because of the adjustment of the budget for the Chinese electric power sector as a whole, the scale of the project was reduced from 1.5 billion yuan to 1 billion yuan. As a result, the construction of the 220kV substations and the establishment of related electric power transmission facilities was excluded from the scope of this project.
	Overhead Transmission Lines	70.0km		
	Culvert	1.0km		
66kV Transmission & Transformer Facilities	Substation	New : 7 locations Additional : 1 location New (underground): 2 locations	As Planned	No Change
	Overhead Transmission Lines	31.3km		
	Underground Transmission Lines	64.5km		
10kV Distribution Facilities	Overhead Distribution Lines	New : 57.0km Exchange: 275.0km	Total: 1,127.6km	Large increase due to the increase of residential land.
	Cables	353.0km	As Planned	No Change
	Columnar Switch	538		
	Aboveground Transformers	111		
	Aboveground Switch	49		
	Maintenance Car	8		
380V Distribution Facilities	Overhead Distribution Lines	Exchange: 760.0km	Exchange: 1,507.3km	Overhead distribution lines and underground lines were extended in line with municipal planning and increased demand. Because much of the project costs were spent on the extension of distribution lines, the number of condensers newly established and exchanged was reduced.
	Underground Lines	New : 67.5km Exchange: 25.0km	Total: 372.2km	
	Transformers	Exchange: 528	Exchange: 543	
	Condensers	New : 200	New : 15	
	Transformer Condensers	Exchange: 1,500	Exchange: 16	
	Maintenance Car	New : 1	As Planned	No Change
Other Facilities	Automatization of the power distribution control system	1	As Planned	No Change
	Optical fiber communications facilities	1		
	Transformer inspection	4		

2.2.2 Project period

The implementation period of the project was planned to run for 34 months from March 2000 to December 2002. However, the project actually required 70 months from March 2000 to December 2005, meaning that the project exceeded the plan by 36 months (106%). This project was almost completed by December 2003, but the 10kV electric power distribution lines were installed in accordance with the progress of Harbin's municipal facility planning, and there was a delay in the municipal facility plan in two locations. This caused a significant delay in the time

period for the completion of the installation compared with the plan. Furthermore, because of a rise in the price of copper, the negotiations over price with the Chinese company which was awarded a contract to supply the electric power lines required long time. There were also delays in the procurement of the raw materials and delivery of the electric power lines by this company, which was another factor for delay. Due to the abovementioned reasons, the installation was completed in December 2005.

2.2.3 Project cost

The total project cost estimated at the time of appraisal was 21,843 million yen (of which Japanese ODA loan was 6,070 million yen), but the actual total cost was 17,674 million yen (of which Japanese ODA loan was 4,119 million yen), 81% of the original plan. The main reason for this was the efficient awarding of contracts through international competitive bidding. However, the payments (domestic currency portion) for the parts which were not completed by December 2003 have not yet been made, and the executing agency has forecast additional payments of around 50 million yuan in its approximate budget. This 50 million yuan is included in the actual cost figure given above.

Although the project cost was more economical than the plan, the project period was longer than the plan, and the efficiency of this project is judged to be moderate.

2.3 Effectiveness (Rating: a)

A comparison of the planned and actual figures for the operation and effect indicators, a verification of the qualitative effects, and a recalculation of the internal rate of return were carried out. It was judged from this analysis that the effects had been realized largely as planned by the implementation of this project and that the effectiveness of the project was therefore high. The analyses of each item are shown below.

2.3.1 Effects of the Harbin Electric Network Construction Project

Using the operation and effect indicators of an electric power transmission and distribution project, the planned figures stipulated by the executing agency and actual figures regarding the facilities established in this project were compared and compiled in Table 2.

Overall, the actual figures for the operation and effect indicators show a large improvement over the figures at the start of the project, achieving the target

figures in 2005. In the project target area, the electrification rate of households had already reached 100% before the start of the project, but in 2000, when the project started, there were approximately five outages a year, representing around 30 hours of outage per consumer household. After project completion in 2007, this had been reduced to 1.2 power outages a year, representing an average of 0.8 hours of outage per consumer household, a significant decrease. The project thus contributed significantly to the reduction in outages in the target area. The transmission and distribution loss rate, sales volume, peak load and voltage acceptance rate also improved greatly since before the start of the project, realizing results over and above the target figures.

Table 2: Planned and actual figures for operation and effect indicators

Indicators	Unit	Baseline Figures (1998)	Target Figures (2005)	Actual Figures		
				2005	2006	2007
Electrification Rate of Households	(%)	100	100	100	100	100
System Average Interruption Duration Index	(Hours/Year, Household)	29.4 (2000)	17.3	0.7	1.9	0.8
Outage Times	(Times/Year)	5.0 (2000)	2.7	0.9	1.4	1.2
Transmission and Distribution Loss	(%)	8.9	7.0	5.9	5.9	6.6
Sales Volume	(GWh)	5,268	7,641	10,600	11,239	10,300
Peak Load	(MW)	1,069	1,740	1,973	2,010	2,012
Voltage Acceptance Rate	(%)	98.0 (2000)	98.2	99.0	99.2	99.0

Source: Harbin Power Supply Bureau

* System Average Interruption Duration Index = hours of outage of one household in the project target area
* Outage Times = number of outages which continued for more than one minute within the project target area
* Transmission and Distribution Loss = (net electric energy production (kWh) - volume of electric energy consumption within a plant (kWh) - receiving end electric energy production (kWh)) / net electric energy production (kWh)
* Electrification Rate of Households = (number of electrified households) x 100 / (total number of households)
* Voltage Acceptance Rate = (accepted hours for voltage standard value) / (hours of power distribution per year)

2.3.2 Recalculation of internal rate of return (IRR)

2.3.2.1 Financial internal rate of return (FIRR)

Because there were difficulties in specifying the scope of the project effects and undertaking a financial evaluation, the financial internal rate of return (FIRR) was not calculated at the time of appraisal. The project scope was roughly computed using the following method at the ex-post evaluation, and the internal rate of return (IRR) was estimated.

The project's construction costs and operation and maintenance costs were used as costs for computing the IRR. However, it was not possible to obtain any figures for the operation and maintenance costs other than the figures of Harbin Power Supply Bureau as a whole, which was the agency responsible for operation and maintenance. As a result, the following method was used to compute the maintenance costs. Harbin Power Supply Bureau manages 16 sites of 220kV high-voltage substations and the project uses the electric power transmitted from five of these substations. A constant level of electric power was assumed to be produced per each high-voltage substation, and the operation and maintenance costs of the project were calculated using the rate (5/16) of the number of high-voltage substations.

Similarly, no figures for benefits were obtained other than those of Harbin Power Supply Bureau as a whole, so the amount of increase in benefits since 2000 was multiplied by the proportion of 220kV substations (5/16), and the result was considered to be the benefits of the project. As a result, the FIRR at the time of ex-post evaluation was 19.3%. Even though this is only an approximate calculation, it can be said that this is a high rate of return.

2.3.2.2 Economic internal rate of return (EIRR)

In order to calculate the indirect benefits of the project, beneficiaries' willingness to pay (WTP) for the benefits of a reduction in outages was taken from a beneficiary survey. The survey was carried out targeting 421 residents (from whom 230 valid replies were received) of Harbin. It calculated the WTP for the reduction in outage times and the reduction in outage hours individually, and then calculated the benefits of the actual improvement in outage times and outage hours which was actually achieved. EIRR was calculated based on the assumption that the benefit in terms of reduction in outages through this project have had a wide-ranging ripple effect on Harbin city as a whole. As a result, EIRR was calculated at 19.4%, which shows a good level of benefit.

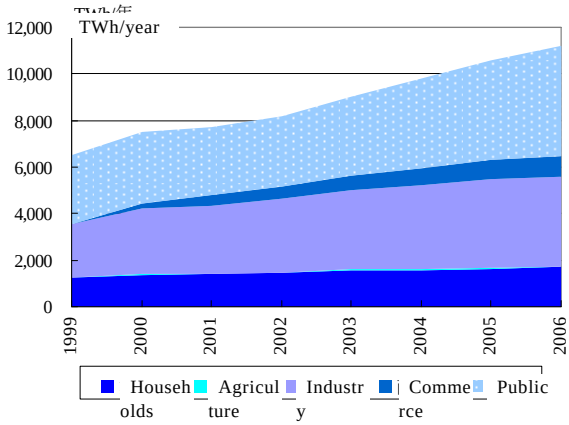
2.4 Impact

2.4.1 Benefits to target region and residents

This project improved the electric power supply capacity and the supply reliability of the electric power network in Harbin city, advancing the regional economy through these achievements.

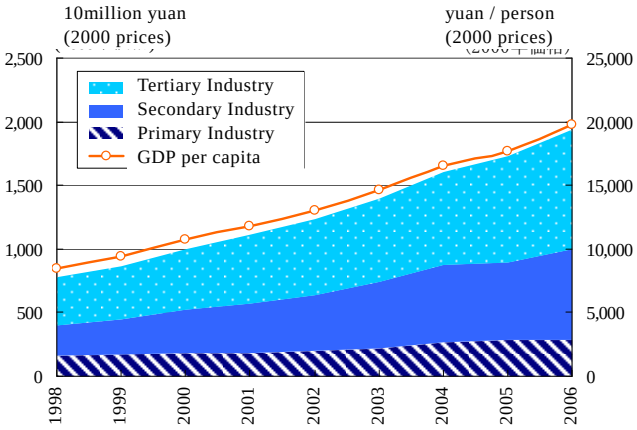
Since the project started in Harbin, the electric power consumption volume of the industrial sector and public sector has significantly increased (Figure 1), and there has been considerable growth in the economic status of secondary and tertiary industries (Figure 2). Over this period, a high rate of economic growth has been maintained, 11.6% on average, and this is a result of the support to the industrial base through the stable supply of electric power by the enhancement of the electric power network.

Figure 1: Electric power consumption volume by industry in Harbin



Source: Harbin Power Supply Bureau

Figure 2: State of the economy in Harbin



Source: China Statistic Yearbook for each year

2.4.2 Impact on the natural environment

No pollutant discharges have been reported from the transformers or related facilities established in this project. At the implementation of the project old transformers were exchanged for new ones, and the old transformers were sold to a recycling company. The copper and steel were collected for use as materials, in consideration for the environment.

2.4.3 Resident resettlement/land acquisition

At the time of appraisal, transformer facilities were planned to be installed indoors, but in the detailed design it was judged necessary to install them outside. It became necessary to acquire a larger area of land than what had been planned (the original plan was for 12,954m^2). There were eight such substations which

were subject to this change, requiring the acquisition of a total of 18,500m^2. In order to acquire the land resident resettlement was necessary and the land acquisition/resident resettlement was carried out by the Government of China.

2.5 Sustainability (Rating: a)

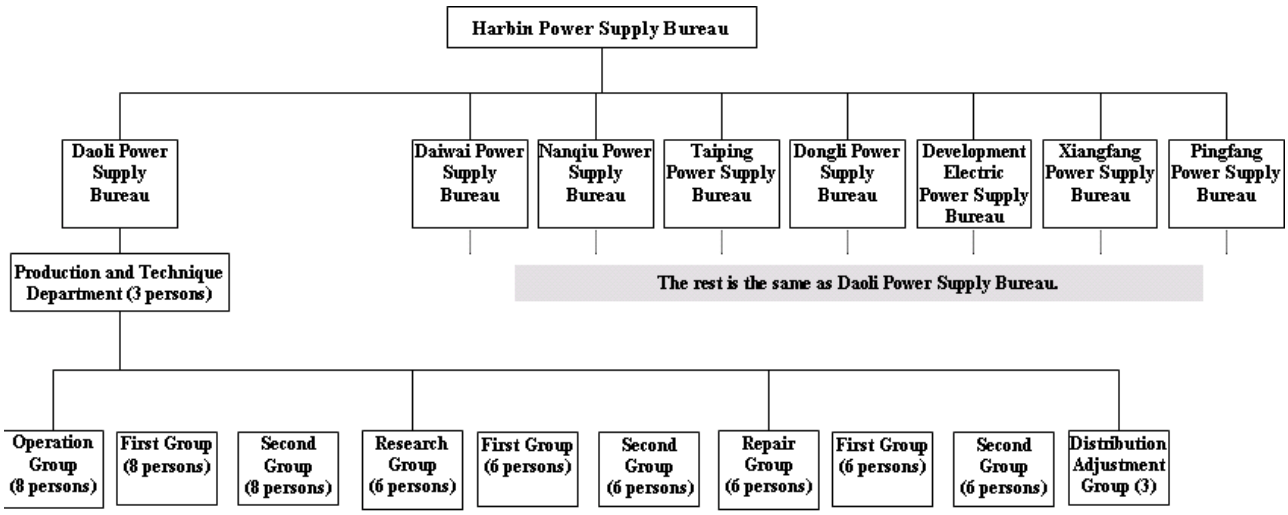
There are no issues concerning either the capabilities or operation and maintenance system of the executing agency and a high level of sustainability can be expected. The analysis of the operation and maintenance system, technical capacity and financial status of the executing agency and operation and maintenance status is shown below.

2.5.1 Executing agency

2.5.1.1 Operation and maintenance system

Harbin Power Supply Bureau is responsible for the operation and maintenance of this project. Harbin Power Supply Bureau manages eight electric power supply bureaus, and the maintenance is mainly carried out by a total of 66 people: three people in the Production and Technique Department, 24 in the Operation Group, 18 in the Research Group, 18 in the Repair Group, and three in the Distribution Adjustment Group. There are no particular problems in the structure of the operation and maintenance.

Figure 3: The operation and maintenance departments of each supply bureau of Harbin Power Supply Bureau



2.5.1.2 Technical capacity

With a training center established at Harbin Power Supply Bureau, it is possible to carry out simulations of all the machinery of the electric power transmission and transformer facilities operated in Harbin. Personnel receive training to enable them to respond to a variety of problems. The engineers of Harbin Power Supply Bureau are supposed to receive training at the training center when they join the bureau, and all management-level personnel receive 3-4 days of technical training each year. As manuals, training system, and training facilities are in place, there are no problems in the technical capacity regarding operation and management.

Figure 4: Training center

Figure 5: Manuals in place

2.5.1.3 Financial status

Harbin Power Supply Bureau is a branch organization of Heilongjiang Electric Power Company (HEPC), and when Harbin Power Supply Bureau does not have sufficient funds for operation and maintenance, HPEC assists it. The fluidity of HEPC at the time of appraisal was around 130%; by the time of the ex-post evaluation, this rate had gone down, but with the ratio of net profit to sales at a stable level, and operation and maintenance costs being maintained at a stable level, no particular problems exist with regard to the finances of maintenance.

Table 3: Financial indicators of HEPC

	2004	2005	2006
Current assets (million yuan)	11,528	10,421	9,770
Fixed assets (million yuan)	17,354	16,934	17,917
Total assets (million yuan)	29,230	27,786	28,067
Current liabilities (million yuan)	8,579	6,753	7,677
Total liabilities (million yuan)	20,811	19,197	19,152
Sales volume (million yuan)	16,969	18,736	23,579
Net profit (million yuan)	177	159	184

Operation and maintenance costs (million yuan)	2,041	2,180	2,391
Liquidity rate (%)	74.4	64.8	78.6
Ratio of net profit to sales (%)	1.0	0.8	0.8
Ratio of net profits to total assets (%)	0.6	0.6	0.7

Source: Harbin Power Supply Bureau

2.5.2 Operation and maintenance status

The substations are inspected twice a week and the electric power lines are inspected once a month; in the event that a breakdown occurs, the Repair Group has a structure which allows it to carry out repairs promptly. The production and technique department carries out management of equipment as security against a breakdown. No particular problems are seen in terms of operation and maintenance.

3. Conclusion, Lessons Learned and Recommendations

3.1 Conclusion

Because the project period was extended, efficiency of this project is evaluated as moderate, but as there are no problems in relevance, effectiveness or sustainability, the evaluation for the project as a whole is extremely high.

3.2 Lessons Learned

N/A.

3.3 Recommendations

N/A.

~ Column: After Completing the Ex-Post Evaluation ~

In the ex-post evaluation of this project, we had difficulties in obtaining cooperation from the executing agency for the evaluation of the project as whole due to the fact that Japanese ODA loan's portion of the project cost was relatively small. Also, the project completion date and project scope (output details) described in the project completion report for this project submitted by the executing agency are different from the actual results, and it required considerable amount of manhours to verify the details. It is desirable to conduct evaluation upon obtaining understanding of an executing agency on the policy and importance of ex-post evaluation.

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Outputs 1) 220kV electric power transmission and transformer facilities		Due to a change in scope, 220kV electric power transmission and transformer facilities were not established.
• Substations	• New : 4 locations, Additional : 1 location	
• Overhead transmission lines	• 70km	
• Culverts	• 1km	
2) 66kV electric power transmission and transformer facilities		Same as left
• Substations	• New : 7 locations, Additional : 1 location, New(underground) : 2 locations	
• Overhead transmission lines	• 31.3km	
• Underground transmission lines	• 64.5km	
3) 10kV electric power distribution facilities		
• Overhead distribution lines	• New: 57km, Exchange: 275km	• Total: 1,127.6km
• Cables	• Total: 353km	Same as left
• Columnar switch	• New: 538	

• Aboveground transformers	• New: 111	
• Aboveground switch	• New: 49	
• Maintenance car	• New: 8	
4) 380V electric power distribution facilities		
• Overhead distribution lines	• Exchange: 760km	• Exchange:1,507.3km
• Underground lines	• New: 67.5km, Exchange: 25km	• Total: 372.2km
• Transformers	• Exchange: 528	• Exchange: 543
• Condensers	• New: 200	• New: 15
• Transformer condensers	• Exchange: 1,500	• Exchange: 16
5) Automatization of the electric power distribution control system	• 1 group	Same as left
6) Optical fiber communications facilities	• 1 group	Same as left
7) Transformer inspection equipment	• 4 groups	Same as left
Consulting services	None	Same as left
(2) Project Period	March 2000-December	March 2000-December 2005

	2002 (34 months)	(70 months)
(3) Project Cost Foreign currency Local currency Total Japanese ODA Loan Portion Exchange rate	 6,070 million yen 15,773 million yen (1,051 million yuan) 21,843 million yen 6,070 million yen 1 yuan = 15.0 yen (as of July 1999, the time of appraisal)	 4,119 million yen 13,555 million yen (964.2 million yuan) 17,674 million yen 4,119 million yen 1 yuan = 14.5 yen (2002 rate; however, the unpaid portion of 50 million yuan is converted according to the 2006 rate)