People's Republic of China

Power Distribution System Rehabilitation Project (Chongqing)

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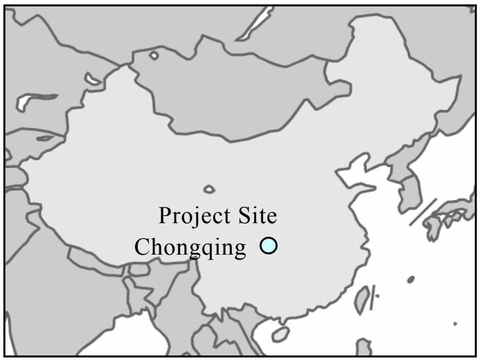
Field Survey: November 2006/June 2007

1. Project Profile and Japan's ODA Loan



Map of project area

Transformers Installed at the Shaping Transformer Substation

1.1 Background

Ever since initiating revolutionary liberation policies in 1978, China has consistently marked high economic growth. China's nominal gross domestic product (GDP) increased from 365 million yuan in 1978 to 8.44 trillion yuan in 1998, the year this project was initiated, meaning that growth over that period averaged as much as 10% per annum. Improved living standards together with so-called "heavy power consumption industries" such as metal refining and cement have played a significant role in this economic expansion. In line with the scale and proportion by which these sectors expanded, power demand also increased markedly.[1] The elasticity of GDP growth with respect to power consumption differs depending on country or economic conditions. But taking another economy that had achieved rapid growth as an example, Japan's elasticity during its period of rapid economic growth was on the order of 1.2. [2]

At the same time, China's energy consumption increased at a rate of 4.6% from 1980 to 2000, and the above-mentioned elasticity was only 0.47. While this

[1] "*Current Status of China's Politics, Economics and Demand and Supply of Energy and Electric*" by Kimura and Chang, Institute of Energy Economics, Japan, September 2004.

[2] See, for instance, "*Challenges and Future of China's Electricity Market*" by Yoshiaki Nishie, *Working Papers on Electrical Power Development*, 2005.

elasticity figure is rather low for a developing country, it is thought to reflect the fact that China could not meet the heightened demand for energy that accompanied the country's rapid economic growth.

Given the circumstances, the Chinese government stressed the importance of developing power resources that could respond to the heightened power demand accompanying the country's rapid economic growth. As a result, in the 10 years from 1986 to the end of 1996, electric power installed capacity increased by a factor of roughly 2.3, reaching 236.5 GW. Over the same 10-year period, power output generated through this installed capacity also increased by a factor of 2.2, reaching 1,079 TWh.

The power transmission and distribution network also continued to be outfitted to respond to the increase in power generation. By end 1996 the total extension of the network came to 598,962km, and some 2.3% of that consisted of 500-kV large-capacity power transmission lines. However, the ratio of investment in power generation to power transmission and distribution is 1:0.45. Because the investment in power transmission and distribution facilities was kept low, increased loss rates owing to power line overloads and deteriorated transformers had been a problem in some major cities.

1.2 Objective

By replacing, expanding, and improving power distribution facilities within the city of Chongqing, this project aims to reduce power generation by reducing power distribution losses by 430 million kWh per year, thereby contributing to reducing the amount of coal used for fuel and decreasing air pollution as a result.

1.3 Borrower/Executing Agency

Government of the People's Republic of China

State Power Corporation of China (after March 2002, State Grid Corporation of China)

1.4 Outline of Loan Agreement

Loan Amount/ Disbursed Amount	13.754 billion yen / 9.219 billion yen
Exchange of Notes Loan Agreement	December 1998 December 1998
Terms and Conditions - Interest Rate - Repayment Period	 0.75% 40 years

(Grace Period) - Procurement	(10-year) General untied
Final Disbursement Date	June 2004
Main contract	China National Machinery & Equipment Import & Export Corp (China),Mitsubishi Corp. (Japan)
Feasibility study (F/S) etc.	February 1998 Chongqing Electric Power Corporation

２． Evaluation Results (Rating: A)

2.1 Relevance (Rating: a)

2.1.1 Relevance at the time of appraisal

In terms of policies, the National Congress of the Communist Party of China in 1992 hammered out two fundamental changes. The first was transition from quantitative economic expansion to the pursuit of quality, public interest, and efficiency. The second was transition of the economic system from a planned economy to a market economy. Based on these changes in government policy, the Ninth Five-Year Plan stressed the need to improve power generation efficiency, reduce power distribution losses, and address environmental issues, while establishing new power plants that could meet demand.

In line with these trends, the National Electric Power Conference held in December 1997 hammered out a policy that prioritized projects to improve power transmission and distribution efficiency, taking Beijing, Shanghai, Guangzhou, Suzhou and Chongqing as trial cities to help reduce power distribution loss rates. Like Beijing, Shanghai, Guangzhou, and Suzhou, Chongqing is a major metropolis that consumes vast amounts of power, making the effects of any experiment easy to measure. Accordingly, the city was designated by the State Power Corporation of China as a model city for preferentially executing projects to improve the efficiency of the power distribution network.

Based on the government policy from the above Ninth Five-Year Plan for the Electric Power Sector stressing the improvement of power generation efficiency, reduction of power distribution losses, and consideration for environmental issues, this project aimed to reduce power distribution losses by 430 million kWh/year and achieve a reduction in power generation with the reduced usage of coal as fuel and reduction in air pollution. As this project was congruent with government policy in two aspects—namely reduction of power distribution losses and environmental effects brought about by saving raw materials (that is, energy conservation)—this was a relevant plan. In addition, the target region (city) selected for the project was also relevant.

2.1.2 Relevance at the time of evaluation

Recent government policies at the national level have stood behind the improvement of power generation efficiency. For instance, the Eleventh Five-Year Plan (Chapter 13, Section 2 of Outline) announced in March 2006 cites the goal of intensified construction and restructuring of urban power grids. [3] Likewise, at the sector level, the Eleventh Five-Year Plan for the Electric Power Sector and the 2020 Development Plan, the fourth of eight major policies, cites the need for improving efficiency in the electric power system. As such, the relevance of this project is high.

On the other hand, regarding changes in government policy pertaining to energy conservation, during project execution, a whole slew of government measures and regulations and policies based thereon relating to energy conservation have been hammered out. Some major examples of these are cited below.

- In 1996, the National Planning Committee and National Science and Technology Committee announced the Outline of China Energy Conservation Technology Policy. This became the basis for establishing related government policy and regulations for each sector of the government.
- In 1997, the National Planning Committee, National Economics and Trade Committee, and Ministry of Construction jointly proclaimed Regulations Governing Fixed-Assets Investment Projects. The regulations stipulated the need to have a specialist third party organization conduct an energy efficiency study prior to executing important national projects.
- In November 1997, the People's Republic of China Energy Conservation Law was enacted. The law has provisions on the rational use of energy and the promotion of energy-saving technologies.
- The Chinese Energy Conservation Product Certification Managing Committee and the Chinese Energy Conservation Product Certification Center were established in November 1998, with underlying provisions set forth in the Chinese Energy Conservation Product Certification Management Law.
- March 1999 saw the promulgation of the Energy Consumption Management Law for Major Industries, and some local governments began to provide

[3] Original title: "*Intensifying the Construction and Restructuring of the Power Grid in Urban Areas and the Countryside*." Administrative levels in China can be broken down as follows: 1) provinces, autonomous regions, and direct-control cities; 2) prefecture-level cities; 3) counties; 4) villages and towns. Below that level are so-called "natural villages." The above expression "Urban Areas and the Countryside" refers to the administrative categories 1 - 4 just described, and encompasses all urban areas from large-scale cities to small- and mid-sized towns.

ordinances on energy conservation.

In addition, prior to the start of this project, State Power Corporation of China planned to study project efficacy by selecting, from among major power-consuming cities, one whose effects would be easy to measure. Subsequently, a succession of similar projects was to be conducted in the other cities. For this reason, this project is considered necessary as a leading case.

Although how Chongqing's positioning in this respect transitioned during the project's execution up to the end was not clearly hammered out at the central policy level, it is considered that the expertise obtained through this project is put to practical use in similar projects in other cities.

From the above, both before and after project execution, the policies of improving China's energy efficiency (including that of power generation, power distribution) and of stressing environmental protection brought about by such savings were consistent. Regardless of whether viewed from the standpoint of improved energy efficiency, resulting reductions in environmental pollution, or the positioning of model cities with regard to improved power grid facilities, this project's plan can be seen as having been relevant both before and after project execution.

2.2 Efficiency (Rating: b)

2.2.1 Outputs

Table 1 shows planned and actual figures for the replacement, expansion, and new installation of power distribution facilities.

Table 1. Planned and Actual Output

Planned (at time of appraisal)	Actual (at time of ex-post evaluation)
1) Expansion and replacement of 135-kV and 110-kV transformers ・110-kV transformer expansion: 10 units / 10 locations / 292 MVA[4] ・110-kV transformer replacement and reinforcement: 18 units / 12 locations ・683.5 MVA (added capacity 292 MVA) ・35-kV transformer expansion: 4 units / 4 locations / 24.6 MVA ・35-kV transformer replacement and reinforcement: 4 units / 2 locations ・20.6 MVA (added capacity 8.7 MVA)	**1) Expansion and replacement of 135-kV and 110-kV transformers (nearly as planned)** ・110-kV transformer expansion: 10 units / 10 locations / 292 MVA ・110-kV transformer replacement and reinforcement: 18 units / 12 locations ・683.5 MVA (added capacity 292 MVA) ・35-kV transformer expansion: 4 units / 4 locations / 24.6 MVA ・35-kV transformer replacement and reinforcement: 4 units / 2 locations ・20.6 MVA (added capacity 8.7 MVA)
2) Replacement of 35-kV power distribution lines ・Replacement and reinforcement of 35-kV power distribution lines: 9 lines / total 139 cct•km	**2) Replacement of 35-kV power distribution lines (some additions made)** ・Replacement and reinforcement of 35-kV power distribution lines: 12 lines
3) Voltage increases at existing transformer substations ・Conversion of 35-kV substations to 110-kV substations: 2 locations	**3) Voltage increases at existing transformer substations (nearly as planned)** ・Conversion of 35-kV substations to 110-kV substations: 2 locations
4) Replacement of deteriorated (inefficient) 35-kV and 110-kV transformers	**4) Replacement of deteriorated (inefficient) 35-kV and 110-kV**

[4] VA: the electrical energy conducted into transformers and other devices. Just as with the amount of work W (measured in watts), it is obtained by multiplying voltage V (measured in volts) with current A (measured in amperes). But whereas W is used to express used energy (effective power), VA expresses the sum of effective power and the loss (reactive power) when an electric current flows through a system.

[5] cct•km: A unit used to express the extended distance for a line or circuit through which current flows.

・Replacement of 110-kV transformers: 8 units / 7 locations / 249 MVA (added capacity: 4 MVA) ・Replacement of 35-kV transformers: 19 units / 12 locations / 106.75 MVA (added capacity: 22.1 MVA) **5) Expansion and replacement of 10-kV power distribution lines** ・New installation of 10-kV power distribution lines: 949.3 cct-km[5] (underground: 139 cct•km; bare lines: 792.3 cct•km; disconnected lines: 18 cct•km) ・Replacement and reinforcement of 10-kV power distribution lines: 962.02 cct•km (underground: 139 cct•km; bare lines: 792.3 cct•km; disconnected lines: 18 cct•km) ・10-kV switchyards: 14 locations newly installed / 4 locations repaired ・10-kV power substations: 12 locations newly installed / 51 locations repaired **6) Replacement of low-voltage (380-V) power distribution lines** ・Replacement and reinforcement of 380-V power distribution lines: 5,240 cct•km (disconnected lines) ・Establishment of transformers for power distribution use (10 kV / 400 V): 1,515 units / 465.975 MVA **7) Expansion of reactive power compensators** ・Additional installation for reactive power compensators: 28 locations / 282.3 Mvar ・New installation for reactive power	**transformers (nearly as planned)** ・ Replacement of 110-kV transformers: 8 units / 7 locations / 249 MVA (added capacity: 4 MVA) ・Replacement of 35-kV transformers: 19 units / 12 locations / 106.75 MVA (added capacity: 22.1 MVA) **5) Expansion and replacement of 10-kV power distribution lines (some additions made)** ・New installation of 10-kV power distribution lines: 1450 cct•km (underground 158 cct・km; bare lines: 792.3 cct•km; disconnected lines: 499.6 cct•km) ・Replacement and reinforcement of 10-kV power distribution lines: 1215 cct•km (underground: 139 cct•km; bare lines: 909 cct•km; disconnected lines: 167 cct•km) ・10-kV switchyards: 14 locations newly installed / 4 locations repaired ・10-kV power substations: 12 locations newly installed / 51 locations repaired **6) Replacement of low-voltage (380-V) power distribution lines (some additions made)** ・ Replacement and reinforcement of 380-V power distribution lines: 9,028 cct•km (disconnected lines) ・ Establishment of transformers for power distribution use (10 kV / 400 V): 2,735 units / 913.475 MVA **7) Expansion of reactive power compensators (nearly as planned)** ・Additional installation for reactive power compensators: 28 locations / 282.3 Mvar ・New installation for reactive power compensators: 36 locations / 341.7 Mvar

compensators: 36 locations / 341.7 Mvar **8) Replacement of measuring instruments** ・Electronic three-phase watt-hour meter with remote recording feature: replacement of 1000 units ・Mechanical single-phase watt-hour meter with remote recording feature: replacement of 25,000 units ・Mechanical single-phase watt-hour meter: replacement of 30,000 units	 **8) Replacement of measuring instruments (some additions made)** ・ Electronic three-phase watt-hour meter with remote recording feature: replacement of 2000 units ・ Mechanical single-phase watt-hour meter with remote recording feature: replacement of 25,000 units ・ Mechanical single-phase watt-hour meter: replacement of 53,000 units

As shown in the table, all planned replacements or new installations of power distribution facilities were carried out, and the following additions were also made.

Additional work conducted
・35 kV power line replacement: 3 lines (Table 2)
・10-kV power line replacement: 753.7km (Table 5)
・Power meter replacement: 24,000 units (Table 5)
・Low-voltage distribution line replacement: 3,788km (Table 6)
・10-kV power distribution transformer replacement: 1,220 units, 447.5 MVA (Table 6)
・Electronic three-phase watt-hour meter with remote recording feature: replacement of 1000 units(Table 8)
・Mechanical single-phase watt-hour meter: replacement of 23,000 units(Table 8)

The machinery and parts procured in this project were for the most part replacements for existing parts, with a portion consisting of new extensions or additions. However, in the cases of the above-mentioned additional work, each addition concerns the replacement of a portion of existing facilities. Accordingly, these additions do not involve an expansion of the project area.

Initially, only a portion of the scope of this project as outlined in the feasibility study was covered by Japanese ODA loans. During project execution, however, additions were made to the loan target with an agreement by the Japan Bank for International Cooperation (JBIC). As a result, nearly the entire scope of the project was ultimately covered by Japanese ODA loans.

2.2.2 Project period

At the time of the appraisal, the project was scheduled to run from December 1998 to December 2000, for a total of two years. In fact, the project ran until June 2004. The additional time can be regarded as resulting from the fact that deciding on the specifications due to the implementation of above-described additional procurement took longer than what was initially planned. If additional procurement work is taken into consideration, then one would expect the work to last until August 2003, meaning that the project ran about 138% the plan.

2.2.3 Project cost

Actual project cost came to about 75% of the plan (Table 2). The foreign currency portion (Japanese ODA loan target portion) was planned to be 13,754 million yen, whereas the actual amount came to 9,220 million yen. Moreover, if we look at total project cost, including that paid for through local currency, in yen terms, whereas planned cost was 28,161 million yen, the actual figure was 21,010 million yen. Thus, despite the fact that additional procurement was made, project cost was lower than expected regardless of whether local or foreign currency.

The reason for this reduction in cost is that the bid price for the portion to be covered by Japanese ODA loans was far lower than initialprojection. The fall in bid price is thought to be for the most part attributable to a drop in the international price of copper. When the substantial preparations for this project were conducted—that is, from 1997 to 1998—the price of copper ran from $2,200 to $2,600 per ton. But if we look at changes in market conditions during the period when the project was being conducted—namely, from December 1998 to June 2004—the price of copper ranged from $1,400 to $2,000 during the period up to 2003, which makes up a substantial portion of the project period. ("Trend in International Price of and Supply and Demand for Copper and Zinc" Japan Oil, Gas and Metals National Corporation, 2005). It is conceivable that such market condition of cooper accounts for the decreased bid price.

Table 2. Planned and actual project cost

Planned cost (at time of appraisal)	Actual cost (at time of ex-post evaluation)
28.161 billion yen (Japanese ODA loan portion: 13.746 billion yen)	21.010 billion yen (Japanese ODA loan portion: 9.220 billion yen)

2.3 Effectiveness (Rating: a)

2.3.1 Reduction in power distribution loss rate

At the time of project planning, it was estimated that if the project were not conducted, power distribution loss rate would reach 10.7%. The need to take immediate steps to reduce these losses, improve network reliability, and increase the efficiency of the entire Chongqing power distribution network was thus recognized.

Looking at the loss rate after project execution we see that there was substantial improvement. In particular, if we take 2004, the year of project completion, as a boundary line for comparison, there is a clear decrease in loss rate, which achieved 7.18% in 2005. Further, while this data is for 2002, in Japan power distribution loss rate came to a little over 5%; the US recorded 7.0%, France 6.8%, and Italy 6.4% (published Feb. 2005 by the Federation of Electric Power Companies of Japan). Thus, the power loss rate for the target power distribution network following project completion compares favorably with those of the developed countries cited.

In addition, when the feasibility study was conducted, the reduction in lost power achieved by the improved power distribution loss rate was projected to be 263 million kWh and 430 million kWh in the first and second years following project completion, respectively. In fact, the actual reduction in losses in years 1 and 2 came to 291 million kWh (2004) and 417 million kWh (2005), respectively. The results therefore basically met target figures.

Table 3. Estimated power distribution loss rates prior to project execution

Year	1997	1998	1999	2000
Power distribution loss rate				
- assuming project is not conducted (%)	9.09	9.76	10.2	10.7
- assuming project is conducted (%)	–	8.71	8.11	7.4

Table 4. Actual power distribution loss rates as a result of project execution

Year	1998	1999	2000	2001	2002	2003	2004	2005
Loss Rate (%)	9.01	8.91	8.61	8.89	9.18	8.44	7.49	7.18

Source: Chongqing Electric Power Corporation

2.3.2 Savings in coal used for fuel[6] and resulting reduction in air pollution

Whereas prior to project execution, the loss rate for the power distribution grid was 8.81%, after project execution, in 2005, the rate was 1.63 percentage points lower, or 7.18%. Meanwhile, the Chongqing Electric Power Corporation sold 25.791 billion kWh of power in 2005, which means that the resulting savings can be calculated as 25.791 billion kWh times 1.63% (or 420.4 million kWh). Taking a normal year's operation to be 4,000 hours, this corresponds to 105.1 MW of power generation savings (420,400 MWh / 4,000 hours).

Taking this a step further, the 420.4 million kWh in reduced power losses in 2005 can be viewed in terms of the reduction of thermal power generated[7], and this calculation corresponds to a savings of 157,000 tons of coal.[8] Planned reductions due to the implementation of this project for SOx, NOx, and CO_2 were 5,616 tons, 2,263 tons, and 750,000 tons, respectively. By contrast, in years 2003 and after, when effects could first be appreciated, the reductions were as shown in the table below. By 2005, reductions for all three substances reached their target figures. [9]

Table 5 Reductions for SOx

Year	2003	2004	2005

[6]For a given amount of power supply, the improvement in power distribution loss rate and the accompanying reduction in lost electrical energy results in an equivalent savings in the amount of power that has to be generated.

[7] Given the nature of power distribution networks, it is difficult to specify at which power plant or of which manner of power generation the supplied power leads to the savings of generated power, but adjustments to the amount of power generated are generally made using thermal power generation. The reason for this is that, unlike with hydroelectric power or nuclear power generation, in thermal power generation, reductions in the amount of power generated correlate directly to cost reductions owing to the savings in fuel consumption. Consequently, the improvement (reduction) in power distribution loss rate resulting from execution of this project can be thought to bring about savings in thermal power generation—namely, savings in fuel consumption.

[8]There are two ways to convert electrical energy into standard charcoal. One is to convert electrical energy into standard charcoal based on the average coal consumption for thermal power generation nationwide in the given year. The conversion factor is not a constant. The other is to convert it based on the caloric work value of electrical energy itself. In this case, the conversion factor is constant: 1 kWh = 860kcal = 3601kJ = 0.1229kg of standard coal. If calculated using the former method, the conversion factor for Chongqing city in 2005 was 0.376kg/kWh (the nationwide average was 0.343 kg/kWh). There is a wide difference between this and the conversion factor of the latter method. It can be considered that when calculating savings in fuel, the former method is closer to the truth.

[9] According to the statistical standards set by the Chinese National Environmental Protection Bureau used at the time of the project's appraisal, emissions of air pollutant corresponding to 1 kWh/year of power generated by coal-fired power plants amounted to 10.85g of SOx, 4.38g of NOx, and 1.477kg of CO_2.

SOx reduction (t)	1,646	1,710	5,781
NOx reduction (t)	663	689	2,330
CO_2 reduction (t)	219,457	227,989	770,699

Source: Calculated based on power savings together with air pollution emissions per unit power generation figures given at the time of appraisal (Chongqing Electric Power Corp.)

2.3.3 Reliability

Prior to project execution, power outages were frequent, and the reliability of the power supply was a problem. At the time this project was planned, no targets were set for improvements in the duration and scale of power outages, but it is possible to confirm that the duration of power outages[10] has decreased and the reliability of the power supply has improved.

In addition, regarding the issue of whether power conditions improved after December 1998, judging from the results of a survey of beneficiaries[11] conducted as a part of this study, 91.3% of individuals and 100% of businesses responded affirmatively. The above-mentioned objective improvement in power conditions is considered to be backed up by the subjective evaluations of beneficiaries.

Table 6 Duration and Scale of Power Outage (Hours)

Year	1998	1999	2000	2001	2002	2003	2004	2005
Duration of Power Outage (hrs)	35.04	30.66	28.03	26.28	24.53	23.65	22.78	21.9

Source: Chongqing Electric Power Corporation

[10] This duration of power outages shown are calculated per transformer substation existing in the power distribution network. In other words, they are calculated as the total of duration of power outages at each transformer substation divided by the number of transformer substations. Consequently, because the duration of power outages also involves the scale of outages, it can be said that a reduction in the duration of power outages means that there is a comprehensive improvement in power outage conditions.

[11] For the survey, simple random sampling of beneficiaries (individuals and businesses) was performed over the region covered by the power distribution network. (For the sample, twenty sites in the main part of Chongqing city and surrounding areas were selected.) Out of 120 survey forms distributed to individuals, 96 were returned, and out of 30 survey forms sent to businesses, 22 were returned. In total, 150 forms were distributed, of which 118 were returned. Thus, the recovery rate was 67%.

2.3.4 Recalculation of internal rate of return (Reference)

At the time of the preliminary appraisal, the financial internal rate of return for this project was 2.4%. This project constitutes a project to finance a portion of the power distribution grid. While benefit of this project can be perceived as stemming from the improvement in power distribution loss rates, it is inherently difficult to discriminate operation and maintenance expenses relating specifically to this project alone from other fees. Accordingly, in this evaluation, the earnings rates were calculated expediently according to the reasoning given below. First, regarding operation and maintenance expenses, total project costs, including both Japanese ODA loan and domestic currency portions, occupied roughly 2% of the Chongqing Electric Power Corporation's investment in power distribution facilities during the period that this project was executed. Accordingly, we used this rate for the operation and maintenance costs for the entire power distribution grid under the company's jurisdiction. That resulted in FIRR being 5.7%. There are two main reasons that this figure so much higher than initially projected. First, electricity rates rose considerably. (At the time of the appraisal, calculations assumed a fixed fee structure of 0.346 yuan/kWh, whereas in fact, at the time of the evaluation electricity fees were 0.520 yuan/kWh.) Secondly, project costs were lower than projected. (Whereas in yen terms, costs were projected to be 28.161 billion yen, the actual figure was only 21.010 billion yen.)

2.4 Impact

2.4.1 Promotion of regional development and increased employment

It is recorded that a total of 35,020 businesses were new targets of the electricity supply from 1997 to 2006. It is considered that among these businesses, there are those whose business activity was possible due to the substantively increased power supply resulting from this project, but it is difficult to calculate quantitative figures for that increase.

Regarding the question of whether they considered the power supply conditions prior to choosing Chongqing as their location for business, the results showed that 55% replied positively. This suggests that the execution of this project contributed to a certain extent to the promotion of increase in the above businesses and also to an indirect increase in employment.

2.4.2 Degree of contribution to improvement in air pollution[12]

Table 7 Changes in SOx emissions in Chongqing City before and after project execution

Year	1998	2005

[12] As described earlier, pollutant reduction targets were set at the time of project planning. Data cannot be confirmed for NOx and CO_2, however.

SO_X Emissions (t)	930,700	837,100

Source: Chongqing City Environmental Protection Bureau "*Environmental Conditions Report*" for the Respective Fiscal Years

Although it is influenced by other factors such as the fluctuations in the amount of emission of pollutant from other sources of pollution, as long as SOx, whose amount of emissions can be confirmed chronologically, is concerned, changes in emissions before and after the project are as shown in the table above, and one can see that conditions in Chongqing city as a whole improved. At the same time, trial calculations were made to assess the reductions thanks to this project as described in 2.3.2, and this is a level equivalent to 6.2% of the reductions in the city as a whole.

2.4.3 Spillover effect on similar cases

As was described in the section on relevance, prior to the start of this project, the State Power Corporation of China was scheduled to study project effects in model cities which are major cities that had high power consumption levels and where the results would be easy to measure. A series of similar projects was to be conducted successively in other cities, and so the importance of this project was judged high as a leading case.

There is no need for a particularly high level of technology to renovate a power distribution network or maintain or manage it, so when a project has the characteristics of a model case, it is thought to be important that the expertise accumulated through project execution spill over into other similar projects, but in the case of this project it is difficult to point out such elements.

At the same time, this project was the first in China to improve the power distribution network using foreign capital, and it has been confirmed that accumulated expertise was transferred to other similar projects. Specifically, various forms of expertise were acquired in areas of project execution based on the infusion of foreign capital, such as the selection of traders via competitive international competitive bidding, or experience relating to the handling of borrowed capital. Such expertise can be applied to similar cases in other cities within China. (For example, public competitive bidding has been introduced even in cases where projects used local finance, and not just for projects where foreign capital was brought in.) Through meetings between the domestic power grid management sectors, such expertise is shared with other cities in China including Beijing, Shanghai, Guangzhou, and Suzhou, which had been initially positioned as model cities for power distribution network facilities improvement alongside with Chongqing.

2.5 Sustainability (Rating: a)

2.5.1 Executing agency

2.5.1.1 Technical capacity

The materials and equipment purchased for this project, excepting some of the meters, were items which were familiar to the executing agency. Because they do not involve any special technology, at the time of the appraisal it was presumed that there would be no particular problems with respect to the operation and maintenance system.

The Chongqing Electric Power Corporation had power supply units in 10 locations (Power Supply Bureau: 500 - 800 personnel).

Table 8. Overview of no. of personnel at each power supply bureau (branch) prior to project execution

	Power Supply Bureau	No. of Personnel
1	Wanzhou	513
2	Chengqu	580
3	Shapingdi	818
4	Nan'an	635
5	Yangjiaping	747
6	Beibei	518
7	Jiangbei	688
8	Yongchuan	617
9	Changshou	536
10	Qinan	561

The company had its own training centers. Each of the above power supply bureaus would in turn dispatch 20-30 of its personnel for about a month's training peridically.

By contrast, by the time of the evaluation, the number of power supply bureaus had increased to twelve.

Table 9. Overview of no. of personnel at each power supply bureau after project execution

	Power Supply Bureau	No. of Personnel
1	Wanzhou	753
2	Chengqu	550
3	Shapingdi	756
4	Nan'an	703
5	Yangjiaping	544
6	Beibei	566
7	Jiangbei	750

8	Yongchuan	658
9	Changshou	609
10	Qinan	583
11	Bishan	572
12	Jiangjin	741

As initially planned, each of the power supply bureaus in turns dispatched 20 - 30 of their personnel to the company's own training center for about a month's training periodically. (For the most part, they went to the Chongqing Electric Power Corporation's Educational Training Center.)

In terms of its execution as well as its operation and maintenance, there were no special problems on the technology front as a whole, as initially presumed.

2.5.1.2 Operation and maintenance system

State Grid Corporation of China, which was the executing agency for the this project, was established by inheriting the power distribution grid management operation that State Power Corporation of China has been in charge of following reforms to the power system undertaken in March 2003. In March 2002, the central government announced "Electric Power System Reform Bill," and decided to separate the power generation from the power transmission industry. Management of this project was to be transferred to State Grid Corporation's control.

Changes to the electricity supply system such as those described above (namely, separation of the generation and transmission industries) are aimed at reducing power generation costs in the long term, which leads to cost reduction and improving the efficiency of the power supply system.[13]

Following these organizational changes, the Chongqing Electric Power Corporation, which is the actual executing agency for this project, became a wholly owned subsidiary of State Grid Corporation. The corporation takes charge of all affairs for this project, including construction, operation, and management under the supervision of State Power Corporation of China. Up until this project was begun, the corporation had been a department (supply branch) of the Sichuan Province Electric Power Company that was in charge of the Chongqing region. But in June 1997, the corporation inherited all aspects of the Chongqing City portion of the project from the Sichuan Province Electric Power Company, and was made an independent entity that exclusively manages the state grid of the city. Although this project got underway almost immediately after the corporation acquired its

[13] "Unbundling" in the power sector means the separation of power generation, transmission, and distribution. Such unbundling is thought to be effective when introducing competition into the electrical power market. The process was first introduced in Europe in the 1980s.

independence, in its former state prior to independence as a department under the Sichuan Province Electric Power Company the company had plenty of achievements in the field of operation and maintenance for power distribution projects, and so it was considered that the corporation had plenty of capability for executing a project of this kind.

Although there were great changes to the executing organization during the execution period of this project as described above, the changes can be positioned within structural reforms for the entire electric power sector of China as a whole, and so the deeper meaning of all these changes can be appreciated.

2.5.1.3 Financial status

The major financial indicators for Chongqing Electric Power Corporation before and after project execution are given below.

Table 10 Main Financial Indicators

	1997	2005
1. Net profit ratio of total capital	0.8%	3.93%
2. Current ratio	120.9%	56.0%
3. Capital adequacy ratio	40.8%	31.2%
4. Ratio of interest paid to sales	1.1%	4.6%

Source: Chongqing Electric Power Corporation Appraisal Report

Net profit ratio of total capital, which is a general indicator of overall profitability, was approximately 0.8% at the time of project planning. This was a low figure compared to that of other developing countries or the average standard for China as a whole (2.0%). Improving the profit ratio by raising electricity rates and rationalizing business operations was required. Following project execution, the figure improved to 3.93%.

In addition, the current ratio at the time of the appraisal was 120%, but following project execution the current ratio fell to 104% in 2004 and 56% in 2005. It is considered that it was related to the increased expenditure for new power grid construction. Current ratios below 100% are often considered to be a concern. In the power and gas sectors, however, recovery speed is fast and confidence levels are deemed to be high and therefore this can be judged to be a level which is not necessarily a problem.

Moreover, the capital adequacy ratio was relatively high at 40%. Looking at conditions after project execution, the capital adequacy ratio dropped somewhat in 2004 and 2005 to around the 30% level. The ratio of interest paid to sales at the time of planning was low compared to other power sector enterprises within China. In addition, as the company had up until that time been under the aegis of the Sichuan Province Electric Power Company, it had not had the burden of building new power plants. After this project was executed, it was expected that the repayment burden accompanying the building of power plants would suddenly increase, and it was judged that systematic investment planning would be required.

As a result of the above system changes, however, the Chongqing Electric Power Corporation did not inherit the asset or management regarding power generation facilities in the project area; it became an entity with power transmission and distribution as its primary focus of business. [14] Consequently, the company's electric power duties can be said to revolve around the transmission and distribution of power, and initial concerns over a possible increase in burden owing to the construction of power plants proved unfounded. As for the future, it is difficult to envision such an increase in burden, at least not under the current system. The ratio of interest paid to sales following project execution was 4.6%. Judging from the fact it is considered that generally there is no problem with ratios below 5%, or from the fact that as described above this ratio is not likely to have any reason to worsen, this figure poses no special problems.

In addition, it has been pointed out that at the time of the appraisal for this project, accounts receivable owing to non-recovery of electricity charges amounted to a relatively high 15% of total assets. Non-recovery almost never occurs with residents, but is sometimes seen with large-scale factories and the like. At the end of 1997 there were 1 billion yuan in uncollected fees, and while all of this amount was expected to be recovered in the ensuing five years, improvement in the above-described non-recovery rate was seen as a main item requiring follow-up. Looking at conditions afterwards, non-recovery in 2001 and thereafter was zero. In explaining this improvement, the Chongqing Electric Power Corporation sites the fact that it introduced a client management system as one of reasons.

Table 11. Changes in electricity rates

Year	1997	2000	2002	2004	2006
Rate (yuan/kWh)	0.319	0.396	0.432	0.463	0.520

Source: Chongqing Electric Power Corporation

As can be seen from the above table, electricity rates were raised over the years. The policy for electricity charges was in principle to establish a price structure whereby it would be able to recover costs, including investment costs. While it is estimated that at the present time there are no particular financial concerns regarding the fee levels, at least when judging the company by its net profit ratio of total capital. But regarding the manner in which electricity fees are set, because

[14] Actually it possesses some power plants under direct control, but the percentage of power generated by direct-control power plants was no more than 12.4% in 2004 and 11.1% in 2005. Moreover, ever since 2003, when the above system reforms were implemented, the company has not had to participate in the construction of new power plants.

the fees are decided, based on local needs, by conducting public hearings with users and representatives of local corporations and upon ratification by the Development Reform Committee, it is desirable that continuous monitoring of changes over the long term be conducted. Moreover, in a survey of beneficiaries, 68.8% of individuals and 75% of businesses expressed satisfaction with the fees charged. Although electricity fees may be acceptable for the time being, it is hard to assess what sort of response there might be in the future should fees again be raised.

2.5.2 Operation and Maintenance Status

At the time of the appraisal, the Chongqing Electric Power Corporation had just become an independent entity in June 1997, and so it had little experience in managing an entire power grid. As such, the need was felt to verify the company's capacity to administer operation, maintenance and management through appropriate supervision. As far as can be seen from the company’s operation, maintenance and management capabilities during project execution and after project completion, the company has had its own training center and has performed periodic training.

In the area of customer service, there were certainly steps—such as the creation of a hotline for customers and the rapid introduction of social responsibility reports—which were not clearly confirmed at the time of the appraisal. In a survey assessing satisfaction towards the response by the hotline system in cases when there was a problem with the power supply, 93.8% of individuals and 85.0% of businesses expressed satisfaction. This suggests that there is no particular problem with the service system's performance.

3. Feedback

3.1 Lessons Learned

None.

3.2 Recommendations

None.

Comparison of Original and Actual Scope

Item	Plan	Actual
(1) Outputs	1) Expansion and replacement of 135-kV and 110-kV transformers 2) Replacement of 35-kV power distribution lines 3) Voltage increases at existing transformer substations 4) Replacement of deteriorated (inefficient) 35-kV and 110-kV transformers 5) Expansion and replacement of 10-kV power distribution lines 6) Replacement of low-voltage (380 V) power distribution lines	1) Expansion and replacement of 135-kV and 110-kV transformers (nearly as planned) 2) Replacement of 35-kV power distribution lines (some additions made) 35-kV power line replacements added along 3 lines 3) Voltage increases at existing transformer substations (nearly as planned) 4) Replacement of deteriorated (inefficient) 35-kV and 110-kV transformers (nearly as planned) 5) Expansion and replacement of 10-kV power distribution lines (some additions made) 753.7km of 10-kV power lines were additionally replaced, and 24,000 wattmeters were also additionally replaced. 6) Replacement of low-voltage (380 V) power distribution lines (some additions made)

	7) Expansion of reactive power compensators 8) Replacement of measuring instruments	An additional 1,220 power transformers for use on 10-kV lines were replaced (447.5 MVA) 7) Expansion of reactive power compensators (nearly as planned) 8) Replacement of measuring instruments (nearly as planned)
(2) Period	December 1998 - August 2003 (4 years 8 months)	December 1998 - June 2004 (5 years 6 months)
(3) Project Cost Foreign currency Local currency Total ODA loan portion Currency exchange rate	 13,754 million yen 900 million yuan (local currency) 28,161 million yen 13,746 million yen 1 yuan = 16 yen	 9,220 million yen 786 million yuan (local currency) 21,010 million yen 9,220 million yen 1 yuan = 15.89 yen