

**ASIAN DEVELOPMENT BANK**

**PCR: PRC 26454**

**PROJECT COMPLETION REPORT**

**ON THE**

**QITAIHE THERMAL ENERGY AND ENVIRONMENTAL IMPROVEMENT  
PROJECT  
(Loan 1328-PRC)**

**IN**

**THE PEOPLE'S REPUBLIC OF CHINA**

**September 2004**

## CURRENCY EQUIVALENTS

Currency Unit – yuan (CNY)

		<b>At Appraisal</b> (as of 1 July 1994)	<b>At Project Completion</b> (as of 1 Jan 2003)
CNY1.00	=	\$0.115	\$0.121
\$1.00	=	CNY8.70	CNY8.27

## ABBREVIATIONS

ADB	–	Asian Development Bank
CDT	–	China Datang Corporation
CO <sub>2</sub>	–	carbon dioxide
DSCR	–	debt service coverage ratio
DSM	–	demand side management
EA	–	Executing Agency, the Heilongjiang Electric Power Company
EIA	–	environmental impact assessment
EIRR	–	economic internal rate of return
ESP	–	electrostatic precipitator
FIRR	–	financial internal rate of return
GNP	–	gross national product
GDP	–	gross domestic product
HEPC	–	Heilongjiang Electric Power Co., Ltd.
HFES	–	Heilongjiang First Electrical Energy Service Company, Ltd.
IA	–	Implementing Agency, the Qitaihe Heating Company
ICB	–	international competitive bidding
IDC	–	interest during construction
I&C	–	instrumentation and control
IRP	–	integrated resource plan
IS	–	international shopping
MEP	–	Ministry of Electric Power
MOF	–	Ministry of Finance
NO <sub>x</sub>	–	nitrogen oxide
PPA	–	power purchase agreement
PPTA	–	Project preparatory technical assistance
PRC	–	People's Republic of China
QEPGC	–	Qitaihe No. 1 Electric Power Generating Company
QHC	–	Qitaihe Heating Company
QMG	–	Qitaihe city municipal government
QTPP	–	Qitaihe No. 1 Thermal Power Plant
SEIA	–	summary environmental impact assessment
SP	–	State Power Corporation
SSTA	–	small-scale technical assistance
SO <sub>2</sub>	–	sulfur dioxide
SOE	–	state-owned enterprise
TA	–	technical assistance
TG	–	turbine-generator
TSP	–	total suspended particulates
WACC	–	weighted average cost of capital

## WEIGHTS AND MEASURES

GJ	(giga-joules)	–	1,000,000, Kilo Joules
GW	(gigawatt)	–	1,000 MW
GWh	(gigawatt-hour)	–	1,000,000 kWh
km	(kilometer)	–	1,000 meter
kV	(kilovolt)	–	1,000 V
kVA	(kilovolt-ampere)	–	1,000 VA
kW	(kilowatt)	–	1,000 W
kWh	(kilowatt-hour)	–	1,000 Wh
m <sup>2</sup>	square meter(s)		
MW	(megawatt)	–	1,000 kW
MVA	(megavolt-ampere)	–	1,000 kVA
t	(metric ton)	–	1,000 kg
TWh	(terawatt-hour)	–	1,000 GWh

### NOTE

In this report, "\$" refers to US dollars.

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## BASIC DATA

### A. Loan Identification

1.	Country	People's Republic of China
2.	Loan Number	1328-PRC
3.	Project Title	Qitaihe Thermal Energy and Environmental Improvement Project
4.	Borrower	People's Republic of China
5.	Executing Agency	Parts A and B: Heilongjiang Electric Power Company (HEPC) Part C: Qitaihe City Municipal Government
6.	Amount of Loan	\$165 million
7.	Project Completion Report Number	PCR: PRC 801

### B. Loan Data

1.	Appraisal	
	– Date Started	11 Jul 1994
	– Date Completed	29 Jul 1994
2.	Loan Negotiations	
	– Date Started	26 Sep 1994
	– Date Completed	29 Sep 1994
3.	Date of Board Approval	27 Oct 1994
4.	Date of Loan Agreement	21 Apr 1995
5.	Date of Loan Effectiveness	
	– In Loan Agreement	20 Jul 1995
	– Actual	21 Jul 1995
	– Number of Extensions	0
6.	Closing Date	
	– In Loan Agreement	30 Jun 2000
	– Actual	13 May 2003
	– Number of Extensions	3
7.	Terms of Loan	
	– Interest Rate	Pool-based variable lending rate for US\$
	– Maturity	25 years
	– Grace Period	5 years
8.	Terms of Relending	
	– Interest Rate	Pool-based variable lending rate for US\$
	– Maturity	25 years
	– Grace Period	5 years
	– Second-Step Borrower	Parts A and B: HEPC

## 9. Disbursement

## a. Dates

Initial Disbursement	Final Disbursement	Time Interval
15 September 1995	13 May 2003	92 months

Effective Date	Original Closing Date	Time Interval
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21 July 1995	30 June 2000	58 months
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## b. Amount (\$ million)

Category	Original Allocation	Last Revised Allocation	Amount Cancelled	Amount Disbursed
Equipment and Materials (turbine generators, pulverized coal handling system, instrument and control system, electrical and mechanical auxiliary equipment, including installation)	121.00	95.61	1.18	94.43
Consulting Services	0.81	0.35	0.00	0.35
Interest During Construction	15.33	26.18	0.00	26.18
Unallocated	27.86	0.00	0.00	0.00
<b>Total</b>	<b>165.00</b>	<b>122.14<sup>a</sup></b>	<b>1.18</b>	<b>120.96</b>

<sup>a</sup> Last revised allocation is after 3 loan cancellations; (i) \$33.05 million in July 2000 on account of lower awarded cost of main equipment; (ii) \$3.0 million in January 2002 due to favorable fluctuation of contract currency (Japanese Yen); and (iii) \$6.81 million in March 2003 due to lower awarded cost of auxiliary equipment.

Source: Asian Development Bank.

## 10. Local Costs (ADB-Financed)

– Amount (\$)	0
– Percentage of Local Costs	0
– Percentage of Total Cost	0

## C. Project Data

## 1. Project Cost (\$ million)

Cost	Appraisal Estimate	Actual
Foreign Exchange Cost	220.00	147.86
Local Currency Cost	320.00	339.23
<b>Total</b>	<b>540.00</b>	<b>487.09</b>

Source: Helongjiang Electric Power Company.

## 2. Financing Plan (\$ million)

Item	Appraisal Estimate			Actual		
	Foreign	Local	Total	Foreign	Local	Total
<b>Financing Plan</b>						
1. Foreign Financing						
a. ADB Loan	165.00	0.00	165.00	120.96	0.00	120.96
b. Cofinancing Loan	55.00	0.00	55.00	26.90	0.00	26.90
2. Domestic Financing						
a. HEPC	0.00	261.14	261.14	0.00	200.88	200.88
b. HEPC Equity	0.00	54.82	54.82	0.00	128.70	128.70
c. QHC Loan and Own Funds	0.00	4.04	4.04	0.00	9.65	9.65
<b>Total</b>	<b>220.00</b>	<b>320.00</b>	<b>540.00</b>	<b>147.86</b>	<b>339.23</b>	<b>487.09</b>

ADB = Asian Development Bank, IDC = interest during construction, QHC = Qitaihe Heating Company, HEPC = Heilongjiang Electric Power Company.

## 3. Cost Breakdown by Project Component (\$ million)

Item	Appraisal Estimate			Actual		
	Foreign	Local	Total	Foreign	Local	Total
<b>Project Cost</b>						
1. Part A: Thermal Power Plant	166.43	201.44	367.87	115.22	289.90	405.12
a. Land	0.00	2.32	2.32	0.00	4.10	4.10
b. Equipment	164.59	109.38	273.98	114.87	185.66	300.53
c. Civil Works	0.00	47.98	47.98	0.00	75.70	75.70
d. Consulting Services	0.81	4.78	5.60	0.35	5.48	5.83
e. Project Administration	1.02	7.70	8.72	0.00	8.20	8.20
f. Taxes and Duties	0.00	29.27	29.27	0.00	10.76	10.76
2. Part B: Heating, Stage 1	0.20	1.34	1.54	0.00	2.68	2.68
a. Equipment	0.20	1.09	1.29	0.00	1.96	1.96
b. Civil Works	0.00	0.05	0.05	0.00	0.56	0.56
c. Taxes and Duties	0.00	0.20	0.20	0.00	0.16	0.16
3. Part C: Heating, Stage 2	0.00	2.99	2.99	0.00	9.65	9.65
a. Equipment	0.00	2.56	2.56	0.00	9.65	9.65
b. Taxes and Duties	0.00	0.43	0.43	0.00	0.00	0.00
<b>Total Base Cost</b>	<b>166.63</b>	<b>205.77</b>	<b>372.40</b>	<b>115.22</b>	<b>302.23</b>	<b>417.45</b>
4. Contingencies	33.02	72.39	105.41	0.00	0.00	0.00
Physical	18.63	12.35	30.98	0.00	0.00	0.00
Price	14.39	60.06	74.43	0.00	0.00	0.00
5. Total before IDC	199.65	278.16	477.81	115.22	302.23	417.45
6. IDC	20.35	41.84	62.19	32.64	37.00	63.18
<b>Total Project Cost</b>	<b>220.00</b>	<b>320.00</b>	<b>540.00</b>	<b>147.86</b>	<b>339.23</b>	<b>487.09</b>

IDC = interest during construction.

#### 4. Project Schedule

Milestone	Appraisal Estimate	Actual
<b>Part A. Thermal Power Plant</b>		
Tendering and Evaluation (start)	June 1994	July 1995
Contract Awarding (start)	January 1995	March 1996
Rail Diversion	December 1994	December 1997
Power Plant Building	June 1996	September 1999
Boiler 1	June 1998	June 2001
Boiler 2	December 1998	September 2001
Turbine 1	June 1998	September 2001
Turbine 2	December 1998	May 2002
Instrumentation, Unit 1	June 1998	September 2001
Instrumentation, Unit 2	December 1998	March 2002
Electrical Equipment	September 1998	September 2001
Stacks	September 1996	June 2000
Central Control Building	March 1998	June 2001
Coal Conveying System	March 1998	September 2000
Hydraulic Building and Equipment	June 1998	March 2001
Chemical Water Treatment	December 1997	September 2001
Ash Yard and Pipelines	June 1998	March 2000
500kV/220kV Switchyard	March 1998	September 2001
<b>Part B. Heating, Stage 1</b>		
Equipment	March 1998	March 1999
Pipeline	June 1998	June 1999
<b>Part C. Heating, Stage 2</b>		
Main Pipeline	December 1999	March 2002
Consumer Pipeline	December 1999	June 2002

kV = kilovolt.

#### 5. Project Performance Report Ratings

Period	Rating <sup>a</sup>	
	Development Objectives	Implementation Progress
From Jan 1999 to May 2003	Satisfactory	Satisfactory

<sup>a</sup> From October 1994 to December 1998, Project rating was "AAA", which is equivalent to satisfactory rating.

## D. Data on Asian Development Bank Missions

Name of Mission	Date	No. of Persons	No. of Person-Days	Specialization of Members <sup>a</sup>
Fact-Finding	8–26 Mar 1994	4	72	a, b, c, d
Appraisal	11–29 Jul 1994	7	126	a, b, c, e, f, g
Special Administration	3–6 Dec 1994	1	3	a
Specific Consultation	7–8 Mar 1995	1	1	a, b, j
Disbursement	16–18 Aug 1995	2	4	j, k
Review 1	22–25 Nov 1995	1	3	a
Review 2	3–6 Sep 1996	2	6	l, m
Review 3	10–12 Dec 1996	1	2	g, l
Review 4	14–17 Dec 1998	2	6	a, b, l
Review 5	6–10 Nov 2000	2	8	g, k
Procurement Review	5–10 Sep 2001	5	25	c, f, g, h
Review 6	28 Nov–3 Dec 2001	2	12	o, p
Project Completion Review <sup>b</sup>	28 Mar–3 Apr 2004	4	24	a, b, c, e, k

<sup>a</sup> a = engineer, b = energy specialist c = financial analyst, d = counsel, e = economist, f = procurement specialist, g = environment specialist, h = programs officer, i = young professional, j = cofinancing officer k = analyst, l = administrative assistant, m = staff consultant.

<sup>b</sup> The mission comprised A. Bhargava, energy specialist and mission leader; M. Pajarillo, energy specialist (financial); M. Kawashima, assistant project analyst; and P. Xiadong, local staff consultant.

## I. PROJECT DESCRIPTION

1. The electricity shortage was severe in the People's Republic of China (PRC) in the 1990s. Capacity was insufficient to meet requirements of the rapidly growing economy, and periods of peak demand required load shedding.<sup>1</sup> Electricity interruptions constrained economic growth. Insufficient electricity was a major constraint to economic growth in Heilongjiang Province, one of PRC's most heavily industrialized provinces. Also, Heilongjiang's economy was forecast to grow at more than 9%/year from 1995 to 2010. During the same period, the annual energy demand and the system peak in the province were forecast to grow at 10.8%/year. Based on these forecasts, the Heilongjiang Electric Power Company (HEPC) developed a capacity expansion plan to install 9,337 megawatts (MW) by 2010 to support the province's future economic development.

2. The Government identified construction of a 700-MW conventional coal-fired power plant, comprising two 350-MW units, as the least-cost option to meet part of Heilongjiang's projected capacity shortfall in 1998 and 1999. That would be the first stage of a 2,800-MW plant near the coal mines of Qitaihe city of Heilongjiang. Qitaihe's air quality was bad—double the national standard for particulates, mainly due to emissions from domestic and industrial coal use. During project processing, policy discussions were held with the Government, which resulted in adoption of the cogeneration<sup>2</sup> feature in the coal-fired power plant. Cogeneration allows utilization of partly expended heat from turbines as a source of bulk heat for an expanded district heating network, such as in Qitaihe city. The cogeneration power plant addressed environmental and energy-efficiency objectives, which provided the rational framework for support from the Asian Development Bank (ADB) for a coal-fired power facility to promote economic growth. The main objectives of the Project were: (i) to support economic growth in Heilongjiang Province by providing cost-effective, base-load, and coal-fired capacity to generate electric power, using modern technology with enhanced environmental safeguards to reduce emissions, and (ii) improve air quality in Qitaihe city by substituting heat from small, inefficient, and polluting boilers with heat derived from the cogeneration. The Project also aimed to enhance the institutional capability of the Heilongjiang First Electrical Energy Service Company, Ltd. (HEPC), and to develop energy conservation measures in Heilongjiang Province.

3. The Project had three parts:

- (i) Part A: construction of a 700 (2 x 350) MW cogeneration power plant;
- (ii) Part B: provision of centralized bulk heat supply facilities including a heating substation to utilize heat from the cogeneration power plant for district heating, and construction of a local heating network for 300,000 square meters (m<sup>2</sup>) of floor space as the first stage of district heating; and
- (iii) Part C: construction of the second stage of district heating through extension of the network from the heating substation under part B to cover an additional 1.5 million m<sup>2</sup> of floor space in Qitaihe city.

4. In October 1994, ADB approved a \$165 million loan from its ordinary capital resources to fund the Project. The loan included a 25-year repayment term, with a 5-year grace period, with interest determined in accordance with ADB's variable lending rate system for dollar loans, plus

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<sup>1</sup> "Load shedding" is switching off the electricity supply to selected consumers during periods of peak demand, to balance power demand and supply.

<sup>2</sup> "Cogeneration" is the simultaneous generation of electricity and heat from the same fuel.

an annual commitment fee. The ADB loan was to finance consulting services and plant and equipment for project parts A and B only. ADB also provided an advisory technical assistance (TA) grant<sup>3</sup> with the loan to assist HEPC, the Executing Agency (EA) for the Project, to strengthen its institutional and management capabilities, and to develop a resource plan to integrate its supply- and demand-side options. ADB approved another small-scale technical assistance (SSTA) grant<sup>4</sup> to assist the Ministry of Electric Power (MEP) in assessing suitability of a sector loan to fund rehabilitation of small- to medium-sized coal-fired power plants throughout the PRC to improve energy efficiency and enhance environmental improvement in the power sector.

5. The loan became effective on 21 July 1995, and the Project was to be completed by 31 December 1999. After an initial delay of almost 3 years, mainly due to the delays in “launching”<sup>5</sup> and associated delays in mobilizing counterpart funds for the Project, the cogeneration power plant under part A was implemented smoothly. Unit 1 was commissioned in September 2001 and Unit 2, in May 2002. Both generating units now operate commercially. Transmission facilities needed to evacuate power from the cogeneration power plant—a crucial element not funded by ADB—were completed in time to match with the commissioning of generating units. The bulk heat supply system and district heating networks under parts B and C were affected by the implementation delay in part A. Nevertheless, parts B and C were implemented smoothly, and completed in time to match with the commissioning of the first generating unit.

6. The loan was closed on 13 May 2003 after an extension of almost 3 years from the original schedule of 30 June 2000. Loan funds of \$120.96 million were disbursed, and the unutilized \$44.04 million was canceled. The EA refinanced the ADB loan through domestic commercial borrowing and prepaid<sup>6</sup> it on 15 December 2003, including the prepayment premium of \$3.38 million. Appendix 1 lists the chronology of major events during project implementation.

## II. EVALUATION OF DESIGN AND IMPLEMENTATION

### A. Relevance of Design and Formulation

7. At appraisal, the Government’s main objective in the power sector was to develop adequate capacity to address the recurring power shortages and support the PRC’s economic growth. Priority was placed on improving efficiency in the supply and use of electricity, with particular importance given to larger and more efficient mine-mouth,<sup>7</sup> coal-fired generating units such as in the Qitaihe area of Heilongjiang Province.

8. Providing assistance to achieve economic growth in an efficient, equitable, and sustainable manner was the central theme of ADB’s country operational strategy for the PRC. The ADB strategy focused on three strategic objectives: efficiency improvement, environmental protection, and poverty reduction. The strategy supported the PRC’s market-oriented reform programs, which are geared to increase productivity and efficiency, address disparities in regional income, and alleviate environmental degradation. ADB’s assistance by providing funds to build additional generating capacity to support economic growth in Heilongjiang Province was

<sup>3</sup> ADB. 1994. *Technical Assistance to the People’s Republic of China for Institutional and Management Strengthening of Heilongjiang Electric Power Company*. Manila.

<sup>4</sup> ADB. 1994. *Technical Assistance to the People’s Republic of China for Energy Efficiency and Environmental Improvement*. Manila.

<sup>5</sup> “Launching” is the formal approval by the State Council, which is given after loan approval.

<sup>6</sup> The higher interest rate of the ADB loan was the incentive for its prepayment.

<sup>7</sup> “Mine-mouth” refers to a coal-fired power plant located close to a coal mining area.

relevant to the Government's program and to ADB's strategy at appraisal and at completion. Inclusion of complementary objectives regarding energy efficiency improvement and environmental protection, as well as the development of energy conservation reforms in Heilongjiang, enabled support for a coal-fired project.

9. During project processing, ADB proposed design improvement in the conventional coal-fired power plant to incorporate the cogeneration feature in conjunction with cost-effective and enhanced environmental safeguard measures such as smokestack height of 210 meters (m), use of low-sulfur coal (0.24%), installation of high efficiency (99.5%) electrostatic precipitators, incorporation of low nitrogen oxide (NOx) burners, appropriate bulk ash disposal design,<sup>8</sup> and extensive recirculation of water within the power plant to minimize water demands and ensure no thermal discharge. These measures reduced emissions from the power plant. The project components were implemented as designed. Performance under the Project demonstrated the appropriateness of the technical and environmental safeguard design parameters.

## **B. Project Outputs**

10. **Part A 2 x 350 MW Qitaihe No. 1 Thermal Power Plant.** The main and auxiliary components of the new power plant, which were clearly established and adequately assessed at appraisal, were implemented with no major changes. All targeted project outputs were achieved. The first unit was commissioned in September 2001 and the second unit, in May 2002. Both generating units are operating commercially. The other main and auxiliary components, including cooling towers, a coal-handling system and stockpiling yard, 500/220 kV switchyard, and instrumentation and control systems, were constructed or installed, and are fully operational. The railway spur to the Qitaihe No. 1 Thermal Power Plant (QTPP), and new access roads to the station and ash disposal sites, were constructed and roads to the coalmines were upgraded. Although not funded by the loan, the transmission facilities required to evacuate power from the Project, consisting of 180 circuit kilometers (km) of 500 kV and 25 circuit km of 220 kV lines, were built in time to connect the power plant to the nearest grid substations.

11. The generating units now run normally, with no major defects. Well-trained plant operators now operate and maintain the plant competently. The generating units can operate at the rated capacity, and are at full load during peak periods. The current plant factor<sup>9</sup> of about 55% is likely to improve substantially, subject to load dispatch considerations.

12. The environmental protection measures identified in the environmental impact assessment (EIA) report submitted to ADB at appraisal were incorporated in the design, construction, operation, and maintenance of the facilities built under the Project (para. 9). The sociocultural impacts of the Project were adequately addressed. These included ensuring that land for the power plant, ash disposal areas, water pipelines, dedicated railways, access roads, and transmission lines had no settlements. No relocation was necessary for the Project. Two families affected by the Project were compensated through relevant PRC laws. HEPC confirmed that the associated transmission line construction did not cause any resettlement. Crop compensation was paid to the farmers for using farmland for transmission line towers. The EA also confirmed that the transmission line construction did not affect ethnic minority/indigenous people. More than 100 company officials, technical staff, and operators were trained in operation and maintenance of the plant, both abroad and in the PRC.

<sup>8</sup> Handling technology to hydraulically transfer the ash-slag mix to a remote and safe area.

<sup>9</sup> The "plant factor" is a ratio of the average load on a plant to the aggregate rating of generators installed in the plant.

13. **Part B: Centralized bulk heat supply facility at the cogeneration power plant, and district heating network in the power plant area.** Under this part of the Project, a centralized bulk heat supply system including a heating substation was constructed to utilize heat from the cogeneration power plant for district heating in Qitaihe city. The facilities constructed were complete with heat exchangers, steam pipe networks, a district heating bulk water pumping system and hot water transmission pipework up to the heating substation. The district heating transmission and distribution network for about 300,000 m<sup>2</sup> of floor space within 2 km radius of the cogeneration power plant was also completed as the first stage of district heating, primarily within a complex built for HEPC and the Qitaihe No. 1 Electric Power Generating Company (QEPGC). This part of the Project was completed as designed at appraisal, and reached full performance in its first year of operation.

14. **Part C: Expansion of the district heating network in Qitaihe city.** Under this part of the Project, the hot water transmission pipework from the heating substation built in stage 1 (part B) was further extended in Qitaihe city to cover an additional floor area of 1.8 million m<sup>2</sup>, compared to appraisal estimate of 1.5 million m<sup>2</sup>, mainly in Taoshan and Qiezihe districts of Qitaihe city. The Qitaihe city municipal government (QMG) was EA for this part of the Project. The cogeneration power plant is the source of heat for this expanded district heating network. In April 2001, QHC also shut down all old and inefficient boilers in its four heating stations. QHC has employed the redundant staff of the closed heating stations to help operate the district heating network.

### **C. Project Costs**

15. At appraisal, the project cost, including contingencies and interest during construction (IDC), was estimated at \$540.0 million equivalent. That comprised \$220.0 million in foreign exchange costs (40% of the total), and \$320.0 million equivalent in local currency (60% of the total). The actual project cost was \$487.09 million equivalent, including \$147.86 million in foreign exchange and \$339.23 million equivalent in local currency. The actual cost was about 90% of the appraisal estimate. Appendix 2 compares the estimated and actual project costs, and the financing plan.

16. The foreign currency base cost was \$51.41 million lower than estimated, mainly due to favorable competitive bidding, substantial depreciation of contract currency (Japanese yen) for the turbine-generator (TG) package, and reduced scope of foreign currency items. But IDC increased by \$12.30 million due to delays in project implementation. Lower awarded costs also obviated the need for foreign currency contingencies, which were estimated at \$33.02 million. These cost deviations led to a net foreign currency cost underrun of \$72.13 million.

17. The local currency base cost overrun of \$96.46 million was mainly attributed to the transfer of some foreign currency cost items to local currency items, delayed project implementation, and expansion of the district heating network to 1.8 million m<sup>2</sup> against 1.5 million m<sup>2</sup> envisaged at appraisal. The local currency contingencies of \$72.39 million balanced off most of these higher costs, resulting in a net overrun of \$24.07 million.

18. The financing plan at appraisal consisted of an ADB loan of \$165 million to cover 30% of the project cost, including 75% of the foreign exchange cost. A \$55 million loan through commercial cofinancing was to be obtained to fund the remaining foreign exchange costs. The local currency requirements were to be provided through a combination of domestic loans and equity from HEPC. In June 1996, ADB approved the Government's request to change the

financing arrangements for some critical auxiliary equipment<sup>10</sup> from cofinancing to ADB financing, to utilize savings of about \$47 million from bidding of the TG package. Some locally financed items were transferred to cofinancing to fully utilize the cofinancing loan. This resulted in ADB financing the TG package, the pulverized coal preparation system, the instrumentation and control system, and electrical and mechanical auxiliaries of the power plant. In the end, ADB financed \$120.96 million, or 25% of the project cost. A syndicate of international banks provided commercial cofinancing totaling \$26.90 million, or 5% of the project cost, while domestic loans and equity contributions accounted for \$339.23 million, or 70% of the project cost.

#### **D. Disbursements**

19. Disbursements under the ADB loan began in September 1995 with payment to the implementation consultant. Payments to the main equipment supplier for the TG package started in April 1996. Disbursements were low in 1996 and 1997, but peaked in 1998, immediately after project launching. Disbursements were also high from 1999 to 2000 when most of the major equipment was delivered and project implementation was in full swing. The last disbursement, for the retention payments on the contract for supply of the TG package, was in May 2003. When the loan was closed on 13 May 2003, disbursements totaled \$94.78 million, and IDC and commitment fees totaled \$26.18 million. The unutilized balance of \$44.04 million was canceled in 4 stages. Overall, utilization of the ADB loan was 73.3%. Disbursements were mainly through letters of credit and direct payments. Disbursements were basically in line with projections, except during the first 2 years when they lagged behind. Appendix 3 compares projected and actual disbursements.

#### **E. Project Schedule**

20. **Part A: Constructing 2 x 350 MW Qitaihe No. 1 Thermal Power Plant.** At appraisal, project implementation was envisaged to take 5 years. For part A, site preparation and construction work on the railway line to haul heavy equipment to the plant site, and on the coal conveying system, were expected to start in 1994. The first generating unit was scheduled for commissioning in June 1998 and the second unit, in December 1998. The construction work started as scheduled, but was slow. Procurement under the Project started as scheduled and the TG package was awarded in March 1996. Construction picked up pace immediately after the launching in August 1997, and the completion date of Unit 1 was revised to December 2000 and for Unit 2, to August 2001. Construction work was further delayed by almost 1 year, mainly due to a procurement<sup>11</sup> delay in the instrumentation and control (I&C) package,<sup>12</sup> and some defects with supplies under the TG package. The delay in finalizing the I&C package had direct impact on erection work under the TG package, and thus pushed back project completion. Procurement of the transformer package<sup>13</sup> was also delayed, but this was not on the critical path, so it did not directly affect the project schedule. The first 350-MW generating unit was commissioned in September 2001 and the second unit, in May 2002. The 500- and 220-kV

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<sup>10</sup> Auxiliary equipment included pulverized coal preparation system, instrumentation and control system, oil treatment plant, 500 kV circuit breaker, transformers, air compressors, water treatment plant, and pumps.

<sup>11</sup> Procurement under the Project was reviewed as part of the PRC Procurement Review 2001. It was rated generally satisfactory.

<sup>12</sup> The main reasons for this delay was that the first-ranked bidder was not in the approved list of manufacturers authorized to operate in the PRC. The Government's internal approval for this package delayed the bid evaluation by 18 months.

<sup>13</sup> This was due to a difference of opinion between the ADB Procurement Committee and the EA's evaluation on the post qualification of the first-ranked bidder, resulting in a reevaluation of bids. The transformer package was finally awarded in June 1999, almost 2 years after the bids were opened.

transmission lines connecting QTPP to the grid substations were operational before commissioning of the generating units. Appendix 4 shows the projected and actual implementation schedules.

21. **Part B: Central bulk heat supply and district heating in power plant area.** At appraisal, construction of the bulk heat supply system from the cogeneration power plant and the first stage of district heating network within a 2-km radius of the power plant was to begin in 1997 and finish in June 1998, with commissioning of the first generating unit. Construction began in November 1997 and was completed in October 2000, before commissioning of the first generating unit.

22. **Part C: Expansion of the Qitaihe city district heating network.** At appraisal, under part C, the Qitaihe city district heating network was to be expanded by 1.0 million m<sup>2</sup> by June 1998, and by another 0.5 million m<sup>2</sup> by December 1999, to coincide with commissioning of the two generating units under part A. The 1.0 million m<sup>2</sup> expansion was completed in December 1999 and was further extended by 0.8 million m<sup>2</sup> by May 2001, ahead of commissioning of the generating units.

## F. Implementation Arrangements

23. At appraisal, HEPC was designated EA for parts A and B of the Project, and QMG as EA for part C. QHC was designated as the Implementing Agency (IA) for part C. Implementation of part C was carried out as envisioned at appraisal. But for parts A and B, for which HEPC was to be EA and responsible for overall supervision and coordination of project implementation (including plant operations), a new company was created to handle these responsibilities. In October 1995, QEPGC was established, as a joint venture of HEPC and the Heilongjiang Provincial Electric Power Development Corporation, to take responsibility for the construction, operation, and maintenance of QTPP. But ownership of QTPP was still vested in HEPC, and was not transferred to QEPGC. Considering this contracting arrangement between QEPGC and HEPC, no changes were made in the loan documents. After the unbundling and restructuring of HEPC, ownership of QTPP was transferred to the China Datang Corporation (CDT) in January 2003 as part of reorganization at the national level (para. 26).

24. Changes in implementation arrangements during project execution have occurred in other PRC projects such as in Loan 1318-PRC: Hunan Lingjintan Hydropower Project; Loan 1400-PRC: Henan Power Project; and Loan 1582-PRC: Northeast Power Transmission. In each case, responsibilities for implementation and operation of an ADB-funded project were transferred to newly created subsidiary companies. But in this case, unlike in other projects, ownership of QTPP was not transferred to QEPGC. This approach has since been refined in the PRC and in a recent power project—Loan 2032-PRC: Gansu Clean Energy Project—a subsidiary project company was established at the project feasibility stage itself, to ensure management focus and to determine the true cost of project development. Project companies are generally mandated to operate on a self-sustaining basis.

25. Initially, a project implementation unit, supervised by a general manager, was established. Subsequently, monitoring and implementation activities were transferred to the new company. Appendix 5 shows the organizational setups of QEPGC and QHC.

26. The sector-wide restructuring that the Government implemented in late 2002 resulted in the breakup of the State Power Corporation (SP), HEPC's former holding company, into 11 smaller companies. These included five power-generating companies, two grid-management companies, and four auxiliary companies. The State Power Grid Corporation, one of the newly

created grid-management companies, is now the holding company for HEPC. To separate power generation from transmission and distribution, HEPC's shares in QEPGC were transferred to CDT, one of the new power-generating companies. CDT controls 32,490 MW of power-generating capacity and CNY72.1 billion in assets.<sup>14</sup> QEPGC's operational structure did not change after the restructuring.

## **G. Conditions and Covenants**

27. The loan covenants were generally complied with. Key exceptions were the financial covenants, which were partially complied with. The covenant on debt service coverage was generally met, but the covenant on self-financing ratio was not met due to HEPC's high level of capital expenditures. CDT, the new owner of the power plant, has been instrumental in refinancing the ADB loan through local commercial borrowing and prepayment. Notwithstanding QEPGC's current weak financial performance, its ability to repay debts is of little concern, as the power plant is expected to significantly improve the plant factor and consequent revenue earning. Appendix 6 gives the status of compliance with covenants in the Loan Agreement.

## **H. Related Technical Assistance**

28. ADB approved a SSTA grant (footnote 4) for preliminary assessment of the suitability of a sector loan to rehabilitate small- to medium-sized (125–150 MW) coal-fired thermal power plants, which are inefficient and polluting, throughout the PRC. This SSTA<sup>15</sup> was to lead to a full-scale Project Preparation Technical Assistance (PPTA) for detailed preparation of a sector loan. The SSTA review found the sector loan appropriate, and identified 290 coal-fired thermal units for rehabilitation. But considering the ongoing restructuring of the Ministry of Electric Power (MEP) into State Power (SP) at the time, the Government found it useful to borrow on MEP's successful transition to SP. MEP's transition was slow, with many postponements. Subsequently, the PRC Government decided to shut down all old and polluting boilers of less than 50 MW capacity, which led to cancellation of the follow-on PPTA and the loan project. The TA also provided sufficient materials, guidelines, documents, and information for HEPC to prepare relevant bidding documents, and to initiate procurement activities to maximize benefits through energy-efficiency and environmental protection. The SSTA produced a high-quality report, and was rated as successful.

29. ADB also approved an advisory TA (footnote 3) in conjunction with the loan, to help HEPC become an efficient and financially sound utility. Specifically, the grant<sup>16</sup> provided assistance to HEPC to (i) recommend an organizational structure consistent with an efficient and autonomous company; (ii) improve accounting, financial management, and management information systems, using modern utility-management practices; (iii) strengthen tariff-setting capabilities to secure adequate revenues to meet its system expansion plan, maintain financial soundness, and provide right-cost signals to consumers; (iv) improve power system planning capabilities; and (v) training and human resource development. The TA support was timely, as HEPC has since been unbundled and restructured, largely following TA recommendations. The TA strengthened the capacity of HEPC staff in essential skills, including in management systems and methods needed for reorganized HEPC functions. The TA was rated<sup>17</sup> successful because the objectives set in the terms of reference were met.

<sup>14</sup> China Datang Corporation. 2003. *Company brochure*. PRC.

<sup>15</sup> The SSTA included 3.5 person-months of international, and 10 person-months of domestic, consultant input.

<sup>16</sup> The advisory TA included 12 person-months of international, and 14 person-months of domestic, consultants input.

<sup>17</sup> The technical assistance completion report was completed in 2002.

## **I. Consultant Recruitment and Procurement**

30. As envisaged at appraisal, HEPC hired an international consulting firm to supervise project implementation. The international consultant helped HEPC in the bid evaluation and preparation of the bid evaluation report, contract negotiations, supervision and administration, quality control, and in the installation, testing and commissioning of the imported equipment. The international consultant was engaged in accordance with ADB's *Guidelines on the Use of Consultants*. HEPC also used the services of a domestic design institute for the engineering design of the Project, and services of an environmental research institute for the EIA.

31. International manufacturers supplied and supervised installation of the TG package, pulverized coal handling system, ash handling equipment, instrumentation and control equipment, main transformers, switchgears, and miscellaneous protection equipment. Local contractors supplied boilers, standby transformers, and constructed the civil works—including cooling towers, the smokestack, and the coal-conveying system—and installed the auxiliary equipment. Local contractors also built the access roads and transmission lines. HEPC used its own funds to hire a domestic supervision firm for certain aspects of site supervision and equipment installation. To procure imported equipment, HEPC used an experienced procurement agency that helped draft the bidding documents, conduct bidding, evaluate bids, and award contracts. The agency was familiar with both the Government's and ADB's bidding procedures, so this arrangement resulted in smooth and effective implementation. The ICB procedures produced tangible savings for the EA; the lowest bid for the TG package was substantially lower than appraisal estimates.

32. There were some delays and problems with procurement (para. 20). Under part A, the ADB loan was expected to mainly fund the TG package, which was the biggest single component. The ADB loan was also to be used to engage an implementation supervision consultant. But the savings in the TG package allowed funding of other power plant auxiliaries, using the ADB loan. Twenty contract packages—10 ICB and 10 IS for equipment supply and installation, with a combined value of \$98.85 million, were procured internationally. Heat exchangers under part B, and IDC, were also to be funded from the ADB loan. But the heat exchangers were procured through local financing, so the amount allocated for part B was canceled. Procurement was in accordance with ADB's *Guidelines for Procurement*. Equipment with a contract value of \$500,000 or more was procured following ICB procedures. Equipment with a value of less than \$500,000, but no less than \$50,000, was procured using IS procedures. Appendix 7 lists contract packages financed by ADB.

## **J. Performance of Consultants, Contractors, and Suppliers**

33. The performance of the international and domestic consultants was generally satisfactory. The consulting services were performed in accordance with the terms of reference, and contributed to successful project implementation. The technical design that the domestic design institute developed was used optimally, with consideration of the PPTA consultants' recommendations. No major problems were encountered. The international consultants effectively coordinated activities at the site, ensured quality control, and addressed problems during implementation. Their performance was rated as satisfactory.

34. The contractors for boilers, civil works, and equipment installation, who were selected through local competitive bidding, were competent. Their work was generally completed on schedule, with generally good quality. The performance of equipment suppliers, selected

through ICB or IS, was also generally satisfactory. There were some defects and deficiencies<sup>18</sup> in the supplies under the TG package, but they were subsequently rectified. The TG contract was awarded timely, but delays in civil work construction and award of the I&C package resulted in long site storage of its equipment. The EA has advised of some contractual performance problems<sup>19</sup> with the TG package, which are now being discussed and resolved.

#### **K. Performance of the Borrower and the Executing Agency**

35. The performance of the Borrower—the Government, through the Ministry of Finance (MOF)—was generally satisfactory. The signing and effectiveness of the loan, as well as the subsidiary loan agreement for the relending of loan proceeds to HEPC, were within 9 months of loan approval. MOF helped facilitate completion of the requirements for loan effectiveness. After initial involvement in evaluation of the winning bidder for the TG package, government supervision and monitoring of the Project were minimal. HEPC and then QEPGC, which was staffed mostly by former HEPC personnel, were technically qualified and experienced in project implementation.

36. The performance of HEPC and, subsequently, of QEPGC, was generally satisfactory. Project implementation was carried out within budget and in a systematic and timely manner, except for the initial delay in launching, which QEPGC could not control. Similarly, procurement delays were beyond the control of HEPC and QEPGC. Although the project evaluation committee completed the evaluation of the bids within a reasonable time, approval by the state government took longer than expected.

#### **L. Performance of the Asian Development Bank**

37. ADB's performance on project monitoring was satisfactory. Project implementation was monitored through 10 review missions and frequent consultations and briefings with MOF. ADB staff spent adequate time reviewing physical progress and resolving implementation issues with HEPC and QEPGC staff. ADB promptly approved ADB-financed contracts and fund disbursements. ADB also immediately approved the request for reallocation of the loan to utilize loan savings to finance critical auxiliary items of the power plant. HEPC and QEPGC expressed appreciation for ADB's timely action in resolving outstanding project implementation issues. But neither HEPC nor QEPGC were fully satisfied with ADB's performance on the delayed approval for award of the transformers package (para. 20).

### **III. EVALUATION OF PERFORMANCE**

#### **A. Relevance**

38. The Project was consistent with ADB's and the Government's priorities (para. 8) at appraisal. But after ADB approval of the Project, the Government reassessed the demand forecast and the Project's priority. This unanticipated assessment delayed project launching. Therefore, the Project was assessed as relevant. The mine-mouth, coal-fired power plant at Qitaihe was the least-cost option to address the power shortage in Heilongjiang Province, and to provide adequate reserve generation to improve security and reliability of the power system.

<sup>18</sup> Minor defects with pipe and fittings, supply of incorrect welding rods, defects in generator end shields, and technical problems with the turbine lubricating oil system—were corrected at the site; deficient materials were replaced.

<sup>19</sup> An efficiency test on the turbine suggests that its value was lower than guaranteed under the contract.

Adoption of the cogeneration feature further enhanced the relevance of the Project by allowing significant increase in area under central district heating. The advisory TA was timely, and prepared HEPC for its unbundling and restructuring, and improved HEPC's capability for system planning. The environmental and technical audit of coal-fired power plants under small-scale TA identified generating units that required rehabilitation. Although the follow-up work was not carried out through ADB financing, it brought the Government's attention to environmental and energy efficiency issues associated with small- to medium-sized coal-fired power plants. The training programs under the TA enhanced the system planning and environmental protection perspective of HEPC and QEPGC.

## **B. Efficacy in Achievement of Purpose**

39. The Project achieved its objectives. Part A provided urgently needed additional power generation capacity in Heilongjiang Province. By providing 700 MW of base-load generation capacity, the Project helped to avoid power shortages<sup>20</sup> in Heilongjiang Province and thus supported economic growth. The gross domestic product (GDP) of Heilongjiang Province had increased to CNY443.3 billion in 2003, compared with CNY199.8 billion in 1995—an average growth rate of more than 10%. But the growth in electricity demand has been far lower<sup>21</sup> than the 10.8% estimated at appraisal. By the end of 2003 (in 2 years), the cogeneration power plant had generated 4.246 trillion watt-hour (TWh) of electricity compared with the plant's annual generation capacity<sup>22</sup> of 3.7 TWh. As per the proposed dispatch scheduling and the ongoing interconnections of the Heilongjiang provincial grid to the northeastern grid, the plant is expected to achieve its full generation capacity by mid 2005. Meanwhile, the power plant is improving the generation reserve margin in the provincial power system, thereby enhancing its security. The Project was assessed as highly efficacious in meeting its primary objective of improving the demand-supply imbalance and improving generation system security.<sup>23</sup>

40. The continued impressive GDP growth in Heilongjiang Province will continue to increase electricity demand. The ongoing and planned strengthening of the northeastern grid and its transregional interconnection with the northern grid will enable transmission of power from Qitaihe power plants to power-deficient provinces. This will require additional capacity at the Qitaihe power plants. The second phase of QTPP, which involves construction of two 600-MW units, is to begin in 2006. The preliminary feasibility study has been submitted to the State Planning Committee. The new plant will be built beside the existing power plant, and will share common plant facilities.

41. The cogeneration power plant under part A has been providing bulk heat to the district heating area of 2.1 million m<sup>2</sup> under parts B and C. The cogeneration power plant has reached its designed heat output of 1.5 million giga-joules (GJ). This led to closure of 32 small and inefficient coal-fired boilers in the Qitaihe city area, including boilers in four heating stations of QHC. The Project achieved the corollary objective of enhancing stakeholders' environmental awareness and prompted QMG to initiate stricter air quality control measures in Qitaihe city. This resulted in prohibition of chimneys in all new buildings, and closure of all 32,000 small and inefficient domestic and commercial combustion heaters in Qitaihe city. The air quality in Qitaihe city has improved significantly and, compared with national standards, now complies with 98%

<sup>20</sup> Heilongjiang is one of the few provinces in the PRC that have avoided recent power shortages. Heilongjiang is a net exporter of power in northeastern grid.

<sup>21</sup> The electricity demand growth was 6.2% in 2003.

<sup>22</sup> Annual generation capacity is based on 5,400 hours of full-load operation or 62% plant factor, a standard norm for base-load, coal-fired power plants in the PRC.

<sup>23</sup> The generation reserve margin was expected to fall below 5% without capacity addition.

requirements for particulates, and 100% requirement for NO<sub>x</sub> compared to 50% and 80% compliance, respectively, at appraisal.

### **C. Efficiency in Achievement of Outputs and Purpose**

42. Project implementation under part A was smooth, despite the transfer of major responsibilities for project implementation from HEPC to QEPGC. The organizational setup as well as the management and approval processes of HEPC and QEPGC were responsive to project requirements. Commercial cofinancing and counterpart funds were adequate. While the cofinancing funds were available within the scheduled period, the prolonged delay in project launching delayed availability of counterpart funds. But counterpart funds were adequate after project launching. The project facilities were constructed properly, and the generating units were installed and commissioned generally within the adjusted time frame. The generating units, which were put into commercial operation within a few months after commissioning, reached their design capacity. The Project was completed within the estimated cost. The current power plant tariff<sup>24</sup> of CNY0.234 per kWh is lower than some of the existing power plants of HEPC and indicates efficiency in achievement of project output. QTPP is in a strong competitive position, because it is a mine-mouth, base-load generating facility with modern and reliable equipment and low generation costs. The Project was assessed as efficient.

43. Parts B and C were carried out efficiently. About 2.1 million m<sup>2</sup> of floor area was covered under district heating compared with 1.8 million m<sup>2</sup> estimated at appraisal.

#### **1. Financial Performance**

44. Appendix 8 summarizes the financial performance of HEPC.

45. The financial internal rate of return (FIRR) for the Project was calculated jointly for parts A, B, and C. The FIRR was reevaluated on the basis of actual financial performance of QEPGC and QHC up to 2003, and financial projections based on information and assumptions that the companies provided. Electricity revenues were projected based on target generation output and current tariff level, while heat revenues consider present heating area and current and projected tariffs. Operating and maintenance costs were assumed to remain at current levels. Capital cost was based on expenditures incurred for the Project. Capital cost, revenues, and expenses were valued at 2003 prices. The reevaluated FIRR for the Project is 8.7%, lower than the appraisal estimate of 10.6%, but higher than the real weighted average cost of capital (WACC) of 4.9%. The lower FIRR is due to lower initial benefits, partly offset by lower actual investment for the Project. Appendix 9 summarizes the calculations.

#### **2. Economic Performance**

46. An economic evaluation was also done jointly for parts A, B, and C. Incremental project costs and benefits were determined. Imported equipment was valued at its actual cost. Other tradable and nontradable components were converted to their economic costs by applying the standard conversion factor.<sup>25</sup> Taxes, import duties, and all financial charges, including IDC, were excluded. The economic life of 25 years, with zero residual value, was maintained. Capital cost, benefits, and expenses were expressed in 2003 constant prices. The economic benefits were derived from (i) incremental energy supplied to consumers, and (ii) coal savings from the

<sup>24</sup> In the PRC, the power plant tariff is a regulated tariff approved by the Price Bureau, and based on the actual project cost and a reasonable return.

<sup>25</sup> The standard conversion factor used in this evaluation is 0.99.

displacement of small coal-fired boilers for heating. Other economic benefits<sup>26</sup> were identified, although they were not quantified at appraisal or at project completion. The economic price of coal was calculated using its border price, adjusted by the transportation and handling costs in Heilongjiang Province.

47. The recalculated economic internal rate of return (EIRR) for the Project is 19.1%, lower than the appraisal estimate of 21.5%, but higher than ADB's hurdle rate for economic opportunity cost of capital of 12%. The lower EIRR is due to the reduced benefits in the initial years of operation and more realistic values used in the valuation of benefits. Appendix 10 summarizes the calculations.

#### **D. Preliminary Assessment of Sustainability**

48. The technical design, construction, and operation of the Project were sound and appropriate. QEPGC has the institutional capability to manage the power plant effectively and efficiently. Both QTPP generating units have passed the acceptance tests. In the first year of commercial operation, both units operated with no major problems. The relative strength of the company's workforce, which is about 75% young but highly trained engineers and technical staff, is another positive factor.

49. QEPGC's financial performance, although not robust, is projected to improve once the power plant achieves its designed generation output. The mine-mouth power plant has the advantage of cheaper coal due to negligible transportation costs, and fewer transport risks<sup>27</sup> for coal. The cogeneration power plant has already achieved its rated output for the bulk heat supply to 2.1 million m<sup>2</sup> of floor area. To meet the rapidly growing demand for district heating in Qitaihe city, QHC is demanding even more heat supply from the cogeneration power plant. QHC, QMG, and QEPGC are currently discussing options to improve heat supply from QTPP. Strengthening of the transmission lines (para.40), which is now underway, will increase the project's power output. QTPP, as a base-load facility with relatively low generating costs, is also seen as a strength in the emerging competitive power market. The northeastern power grid has recently started experimenting with competition among generators, which augurs well for the QTPP.

50. The recalculated FIRR and EIRR of the Project exceed the WACC and the assumed economic opportunity cost of capital, respectively, indicating that the Project is financially and economically viable. The Project is rated as likely sustainable.

#### **E. Environmental, Sociocultural, and Other Impacts**

51. **Environmental impact.** A summary environmental impact assessment (SEIA) report for the Project was prepared and circulated to the Board on 14 June 1994. The measures recommended in the SEIA for mitigating environmental degradation were carried out during project implementation. An environmental protection unit was established in 2001 within the plant's organizational structure to monitor and ensure compliance with applicable environmental and safety standards. Environmental safeguards and management measures were identified and included in the project design to ensure that the proposed power generating facility would

<sup>26</sup> Other benefits identified, but not quantified, both at appraisal and at PCR include: (i) improved district heating efficiency, (ii) reduced health care expenses and reduced maintenance costs for public structures affected by acid rain resulting from improved air quality, (iii) additional jobs created by businesses using steam, and (iv) increased recreational activities from new greenbelt areas.

<sup>27</sup> Haulage of bulk coal to power plants has been an issue in some coal-fired power plants located close to load center, but away from coal mines. This has led to the Government's priority for mine-mouth power plants.

be environmentally acceptable. Pollution control and monitoring equipment were procured, and measures were adopted to minimize emissions from the coal-fired generating plant. About 5.4% of the project cost, or CNY218 million, was spent for pollution control devices and facilities, and environmental protection management. Appendix 11 lists the environmental equipment and facilities installed in the power plant.

52. Flue gas desulfurization equipment was not incorporated in the design, as it was envisioned that the coal would have low sulfur and ash content.<sup>28</sup> As designed, each boiler had two dual-chamber, four-field electrostatic precipitators, with a collection efficiency<sup>29</sup> of 99.5%. An advanced online automatic analysis device was also installed to monitor the emission indices through a digital communication system. Equipment and facilities for industrial wastewater treatment, waste oil treatment, coal water treatment, and living sewage treatment were also provided. Extensive tests on power plant emissions were conducted by the state, provincial, and city environmental protection agencies in March 2004, which confirmed the power station's compliance with the PRC's environmental standards. Appendix 12 summarizes the data on air, water, and noise pollution indices and power plant emissions. A remote ash disposal site was developed about 18 km from the power plant, as envisaged at appraisal. The ash is being hydraulically transported from the power plant to the disposal site. More than 60% of the ash transport water is being recycled. The ash dam design ensures that there is no routine discharge from the ash system into local waterways. Today, only 10% of fly ash is being utilized by other industries.

53. QTPP has set up an environment management unit, headed by a senior deputy chief engineer, and has full-time staff engaged in routine environmental monitoring of the power plant. The stack emissions are continuously monitored. For wastewater, a well for drain amount calculation has been installed; a report on discharge water quality is submitted regularly to the city environmental protection bureau.

54. QMG is implementing a district environment management plan to improve the air quality in the Qitaihe area. The area in Qitaihe city covered by vegetation has increased to 40% through the program. New greenbelts have been developed as part of the greening of public areas in and around QTPP.

55. **Social impact.** The Project did not have resettlement issues, as it was not necessary to relocate people or remove dwelling units. Land acquired for the Project was agricultural and wasteland. Two affected families were compensated in accordance with the PRC's compensation policy for the transfer of their land use rights. HEPC advised that the construction of transmission lines associated with the power plant did not result in any resettlement. During project processing, an extensive public information campaign was launched and the power plant site was finalized through a participatory approach involving key stakeholders: farmers, the general public, and political and environmental groups. A survey shows high public acceptance of the Project.<sup>30</sup> The Project improved the air quality, benefiting all residents in the Qitaihe area. QEPGC strengthened the social infrastructure by establishing new educational, medical, and recreational facilities to support the increased economic activity. About 3,000 local residents—16% were women—were temporarily employed during project construction. Furthermore, operation of the power plant created permanent employment for 450 people, 29% of whom are female. The additional coal used to operate the plant also provides long-term employment for

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<sup>28</sup> At appraisal, the coal to be used had design value for sulfur content of 0.24% and average ash content of 35.4%.

<sup>29</sup> The actual collection efficiency has been measured as 99.8% during environmental test conducted by the provincial environment protection bureau in March 2004.

<sup>30</sup> ADB-financed consultants confirmed that the survey was conducted in a manner acceptable to ADB.

miners in the coal mines in Xinxing district, a state-level poverty district. The district heating component has provided direct benefits to about 25,000 households in the Taoshan and Qiezihe districts of Qitaihe city.

56. **Capacity building.** The EA regularly provides domestic and international training to its staff on technical and management issues. During project implementation, HEPC sent 25 of its staff abroad for 2–4 weeks each for training in plant operation and maintenance, and coal management. About 100 employees were trained in improved maintenance skills in similar power plants in China. A number of staff underwent training every year on aspects of financial management and planning, accounting, budgeting, and computer systems. Training under ADB TAs also enhanced HEPC capacity in procurement, project management, organization design, system planning, and modern management information systems. These training programs enhanced the operational and institutional capability of the company and eventually will provide the required competence to face demands of the restructured power industry.

57. **Enterprise reforms.** HEPC recently went through the initial stages of restructuring in the power sector. This is expected to lay the foundation for the introduction of a market mechanism designed to boost competition and deregulate the generation sector, with market forces dictating the electricity price. The organizational structures of HEPC and QEPGC are being realigned in preparation for the restructured scenario.

#### IV. OVERALL ASSESSMENT AND RECOMMENDATIONS

##### A. Overall Assessment

58. The Government's strategic priority, and ADB's operational strategy for the power sector in the PRC, were foremost considerations in formulating and designing the Project. The objectives of providing additional generating capacity to address power shortages in Heilongjiang Province, and improving the generation reserve margin to ensure security and reliability of the power system, were fully achieved. Construction of a 700-MW coal-fired power plant provided a big boost to the deficient power supply in the grid. Project execution was smooth, even though the commissioning was delayed. The power plant is equipped with state-of-the-art technology, with a high level of plant automation. The environmental and energy efficiency concerns associated with the Project were addressed properly, increasing environmental awareness in Qitaihe city. The financial performance of the project company was not robust, but is expected to improve with increased utilization of the plant as system-wide demand rises. QTPP's advantageous position as an efficient, base-load facility in the emerging competitive power market should ensure the power plant's long-term viability.

59. The Project is rated<sup>31</sup> successful, based on relevance, efficacy, efficiency, sustainability, institutional development, and other impacts. A project performance audit may be fielded to review the Project's financial performance after 2 more years of operation.

##### B. Lessons Learned

60. Project implementation delays, especially the delay in launching, emphasized the urgent need to harmonize ADB's and the PRC's internal approval processes. PRC Resident Mission has already initiated this harmonization process; its recommendations are being considered for implementation.

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<sup>31</sup> This PCR is a part of a sample of the PCRs that have been independently reviewed by the Operations Evaluation Department. The review has validated the methodology used and the rating given.

61. A strong commitment by the project proponents, and efficient management and execution of experienced and well-trained project implementation staff, consistently have been the primary success factors in most projects in the PRC. Selection and recruitment of competent international as well as domestic consultants have ensured observance of the quality standards required for projects with high investment costs.

62. **Timely fund availability.** Timely availability of the required funds is essential for smooth project implementation. In this project, availability of counterpart funds was a key issue, because they could not be secured until project launching. ADB staff must carefully scrutinize counterpart fund arrangements and availability during project appraisal.

63. Properly administered bidding processes were key to obtaining advantageous bid offers. Deviations between the final project costs and appraisal estimates were small. But the contingencies in foreign currency cost items, at almost 20% of the base cost, were too high. Consultants and ADB staff must carefully review the status of project feasibility studies to arrive at reasonable contingencies in project costs.

64. TA that is suitably designed, properly targeted, and appropriately timed can provide synergies to a loan project and enhance its overall impact. Both TAs associated with the Project were directly relevant and well timed, which enabled smooth unbundling of HEPC and transition of plant's ownership to CDT.

## **C. Recommendations**

### **1. Project-Related**

#### **a. Future Monitoring**

65. Occasional monitoring by ADB, through the Resident Mission, of QEPGC's monitoring system and CDT's reports, would help ensure that the environmental safeguard measures designed for the Project are continuously observed.

#### **b. Timing of Preparation of the Project Performance Audit Report**

66. The project performance audit for the Project can be in 2006. By then, the power reform program, which calls for competitive market-based electricity pricing, will have operated long enough to produce sufficient data to reassess the project's financial performance.

### **2. General**

67. The favorable experience with the Project demonstrates that a coal-fired power plant can support sustainable development. ADB may consider supporting power generation projects that are designed to minimize adverse environmental and social impacts, and maximize efficiency.

**CHRONOLOGY OF MAJOR EVENTS**

8 March 1994	Fact-Finding Mission fielded
25 May 1994	Management Review Meeting held
14 June 1994	Report of the Summary Environmental Impact Assessment (SEIA) circulated to the Board
11 July 1994	Appraisal Mission fielded
5 August 1994	Approved request of the Heilongjiang Electric Power Co., Ltd (HEPC) to initiate process for direct appointment of PowerGen (the power consultant for implementation supervision consulting services under the loan)
12 September 1994	Staff Review Committee meeting held
14 September 1994	HEPC invited PowerGen to submit technical and financial proposals for implementation supervision consulting services
26 September 1994	Loan negotiations held
27 October 1994	The Asian Development Bank (ADB) approved a loan of \$165 million from ADB's ordinary capital resources to the People's Republic of China (PRC) for the Qitaihe Thermal Energy and Environmental Improvement Project (Loan 1328-PRC). Two technical assistance (TA) grants for the Institutional and Management Strengthening of Heilongjiang Electric Power Company (TA 2191), and for the Energy Efficiency and Environmental Improvement Study (TA 2192), for \$600,000 and \$150,000, respectively, were approved, along with the loan.
29 October 1994	HEPC requested that Pulverized Coal Preparation System be financed from the ADB loan rather than cofinancing, because procurement of this package was on the critical path.
3 December 1994	Special Loan Administration Mission fielded
7 March 1995	Special Consultation mission fielded
21 April 1995	Loan was signed
10 May 1995	The consultant for the TA 2191 commenced services
17 July 1995	First tripartite field meeting under TA 2191 held in Beijing
21 July 1995	Loan became effective
16 August 1995	Disbursement mission fielded
15 September 1995	First disbursement made

6 November 1995	Contract awarded for turbine generators, for \$74.2 million equivalent
20 November 1995	Seminar held in Harbin as part of training under Phase III of TA 2191
22 November 1995	Review Mission fielded
2 April 1996	The Borrower requested a reallocation of foreign exchange from cofinancing to an ADB loan to utilize savings in the turbine generator package.
15 June 1996	ADB agreed to change the financing arrangement, to cofinance \$33.5 million for financing part of the local currency cost under part A of the Project.
12 July 1996	Final report under TA 2191 submitted by the consultant
3 September 1996	Review Mission fielded
10 December 1996	Review Mission fielded
22 May 1997	The Borrower requested to use loan savings to procure additional auxiliary items, using international shopping procedures
25 June 1997	ADB approved HEPC's request to use loan savings to procure auxiliary items
31 August 1997	The Project was formally launched
31 October 1998	The small-scale TA for Energy Efficiency and Environmental Improvement Study (TA 2192) was financially closed
14 December 1998	Review Mission fielded
30 May 1999	Canceled \$28.00 million of cofinancing
November 1999	Commencement of delivery equipment under the turbine-generator package
27 April 2000	Requested extension of loan closing date to 31 December 2001
9 May 2000	HEPC requested cancellation of loan surplus amounting to \$34.9 million
30 June 2000	Original loan closing date
10 July 2000	ADB approved extension of loan closing date to 31 December 2001, and cancellation of \$33.05 million loan surplus
31 August 2000	Delivery of equipment for Unit 1 completed
September 2000	Delivery of equipment for Unit 2 commenced

6 November 2000	Review mission fielded
22 November 2000	Long-term capital Investment plan submitted
December 2000	Delivery of equipment for Unit 2 completed
5 September 2001	Procurement review mission fielded
29 November 2001	Review mission fielded
14 December 2001	Unit 1 was commissioned
14 January 2002	2nd partial cancellation, amounting to \$3 million
16 January 2002	Approved extension of loan closing date by 6 months, from 31 December 2001 to 30 June 2002
4 April 2002	Borrower requested for extension of loan closing date from 30 June 2002 to 31 December 2003
19 April 2002	ADB approved extension of loan closing date from 30 June 2002 to 31 March 2003
17 May 2002	Unit 2 commissioned
7 June 2002	Approved supplementary agreement under turbine generator contract for technical services
15 June 2002	Unit 1 started commercial operation
11 January 2003	Unit 2 started commercial operation
13 March 2003	Final disbursement
6 June 2003	Cancellation of the loan surplus of \$6,807,037, retroactive to 18 March 2003
29 September 2003	Cancellation of the undisbursed loan balance of \$1,177,438, and official closure of the loan account retroactive to 13 May 2003
15 December 2003	The Borrower prepaid the full amount of the loan, including the loan prepayment premium
29 March 2004	Project Completion Review mission fielded

**PROJECT COST AND FINANCING PLAN**  
(\$ million)

Item	Appraisal Estimate			Actual		
	Foreign	Local	Total	Foreign	Local	Total
<b>A. Project Cost</b>						
1. Part A: Thermal Power Plant	166.43	201.44	367.87	115.22	289.90	405.12
a. Land	0.00	2.32	2.32	0.00	4.10	4.10
b. Equipment	164.59	109.38	273.98	114.87	185.66	300.53
c. Civil Works	0.00	47.98	47.98	0.00	75.70	75.70
d. Consulting Services	0.81	4.78	5.60	0.35	5.48	5.83
e. Project Administration	1.02	7.70	8.72	0.00	8.20	8.20
f. Taxes and Duties	0.00	29.27	29.27	0.00	10.76	10.76
2. Part B: Heating, Stage 1	0.20	1.34	1.54	0.00	2.68	2.68
a. Equipment	0.20	1.09	1.29	0.00	1.96	1.96
b. Civil Works	0.00	0.05	0.05	0.00	0.56	0.56
c. Taxes and Duties	0.00	0.20	0.20	0.00	0.16	0.16
3. Part C: Heating, Stage 2	0.00	2.99	2.99	0.00	9.65	9.65
a. Equipment	0.00	2.56	2.56	0.00	9.65	9.65
b. Taxes and Duties	0.00	0.43	0.43	0.00	0.00	0.00
<b>Total Base Cost</b>	<b>166.63</b>	<b>205.77</b>	<b>372.40</b>	<b>115.22</b>	<b>302.23</b>	<b>417.45</b>
4 Contingencies	33.02	72.39	105.41	0.00	0.00	0.00
Physical	18.63	12.35	30.98	0.00	0.00	0.00
Price	14.39	60.06	74.43	0.00	0.00	0.00
5 Total Before IDC	199.65	278.16	477.81	115.22	302.23	417.45
6 IDC	20.35	41.84	62.19	32.64	37.00	63.18
<b>Total Project Cost</b>	<b>220.00</b>	<b>320.00</b>	<b>540.00</b>	<b>147.86</b>	<b>339.23</b>	<b>487.09</b>
<b>B. Financing Plan</b>						
1. Foreign Financing						
a. ADB Loan	165.00	0.00	165.00	120.96	0.00	120.96
b. Cofinancing Loan	55.00	0.00	55.00	26.90	0.00	26.90
2. Domestic Financing						
a. HEPC Local Borrowing	0.00	261.14	261.14	0.00	200.88	200.88
b. HEPC Equity	0.00	54.82	54.82	0.00	128.70	128.70
c. QHC Loan and Own Funds	0.00	4.04	4.04	0.00	9.65	9.65
<b>Total</b>	<b>220.00</b>	<b>320.00</b>	<b>540.00</b>	<b>147.86</b>	<b>339.23</b>	<b>487.09</b>

ADB = Asian Development Bank, HEPC = Heilongjiang Electric Power Co., Ltd, IDC = interest during construction.

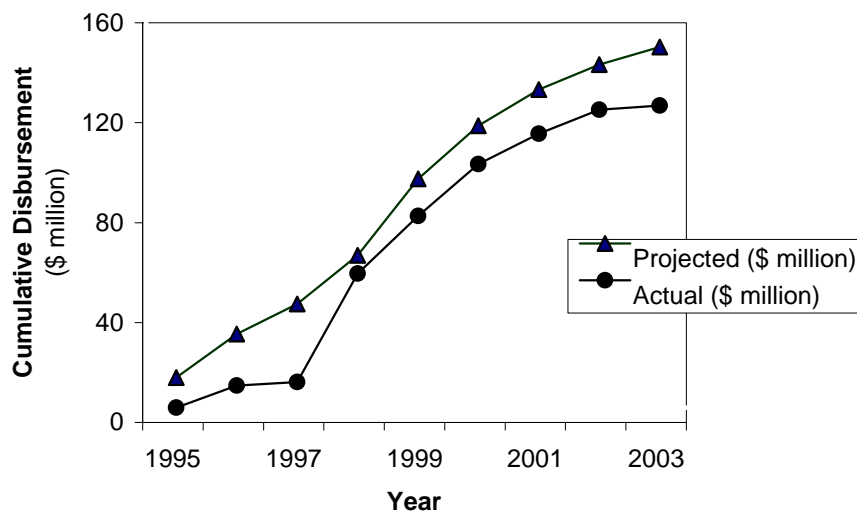
Source: Heilongjiang Electric Power Company.

## PROJECTED AND ACTUAL LOAN DISBURSEMENTS (1995–2003)

Table A3.1: Disbursement Schedule

Year	For the Year (\$ million)		Cumulative (\$ million)		
	Projected	Actual	Projected	Actual	% of Loan
1995	12.10	0.04	12.10	0.04	0.0
1996	17.40	8.83	29.50	8.88	7.3
1997	12.00	1.32	41.50	10.20	8.4
1998	19.50	43.45	61.00	53.65	44.4
1999	30.60	23.05	91.60	76.70	63.4
2000	21.20	20.82	112.80	97.52	80.6
2001	14.56	12.13	127.36	109.64	90.6
2002	10.00	9.65	137.36	119.29	98.6
2003	7.00	1.67	144.36	120.96	100.0

Figure A3.1: Cumulative Disbursements



# PROJECT IMPLEMENTATION SCHEDULE

**Figure A4.1: Project Implementation Schedule**

Item	1994				1995				1996				1997				1998				1999				2000				2001				2002				2003			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
<b>Part A: Thermal Power</b>																																								
Tendering and Evaluation																																								
Contract Awarding																																								
Rail Diversion																																								
Power Plant Building																																								
Boiler 1																																								
Boiler 2																																								
Turbine 1																																								
Turbine 2																																								
Instrumentation, Unit 1																																								
Instrumentation, Unit 2																																								
Electrical Equipment																																								
Stacks																																								
Central Control Building																																								
Coal Conveying System																																								
Hydraulic Building and Equipment																																								

Legend:  At Appraisal       Actual

Item	1994				1995				1996				1997				1998				1999				2000				2001				2002				2003			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Chemical Water Treatment																																								
Ash Yard and Pipelines																																								
500/220kV Switchyard																																								
<b>Part B: Heating</b>																																								
<b>Stage 1</b>																																								
Equipment																																								
Pipeline																																								
<b>Part C: Heating</b>																																								
<b>Stage 2</b>																																								
Main Pipeline																																								
Consumer Pipeline																																								

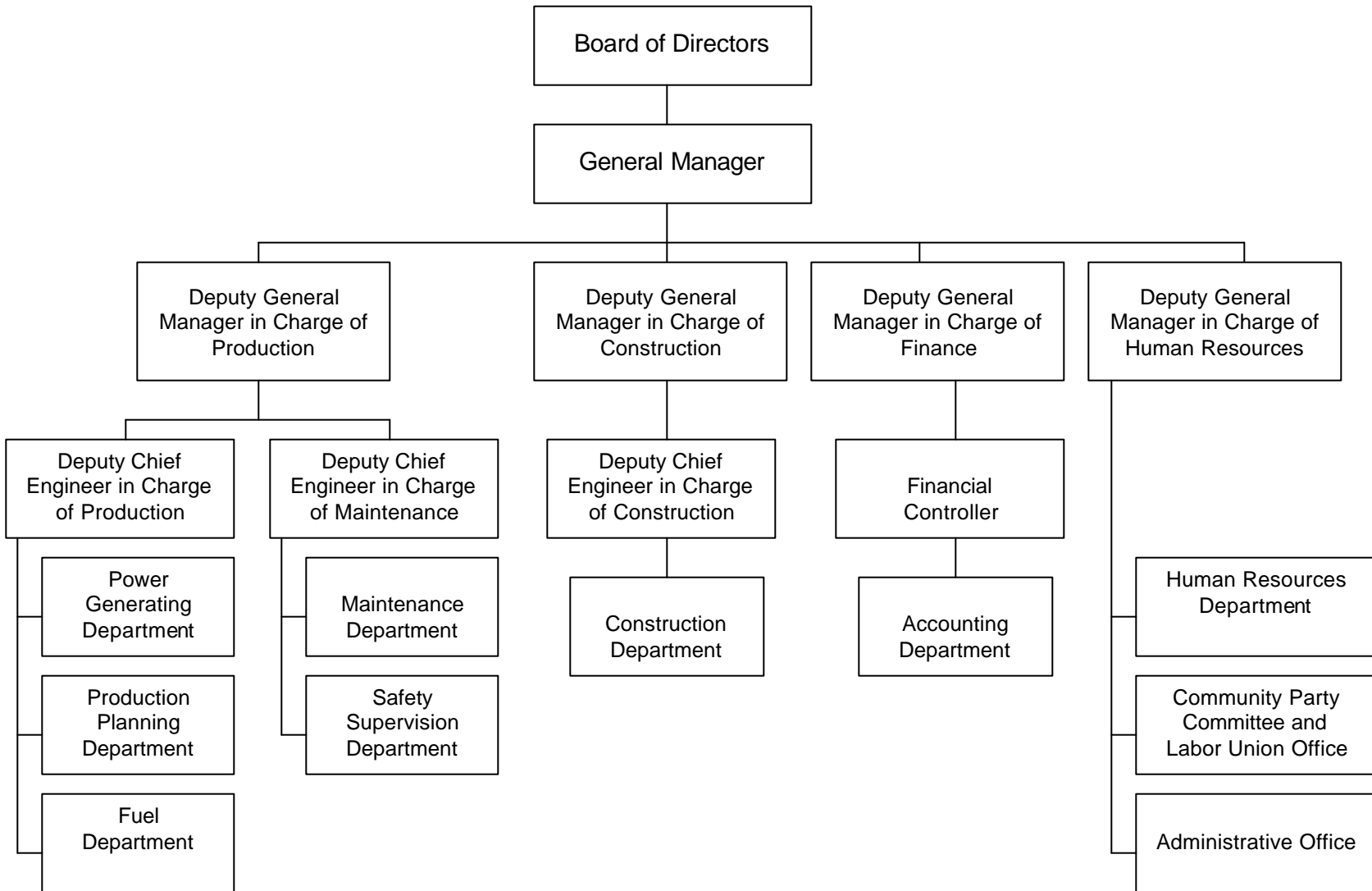
kW = kilowatt.

Legend:  At Appraisal  Actual



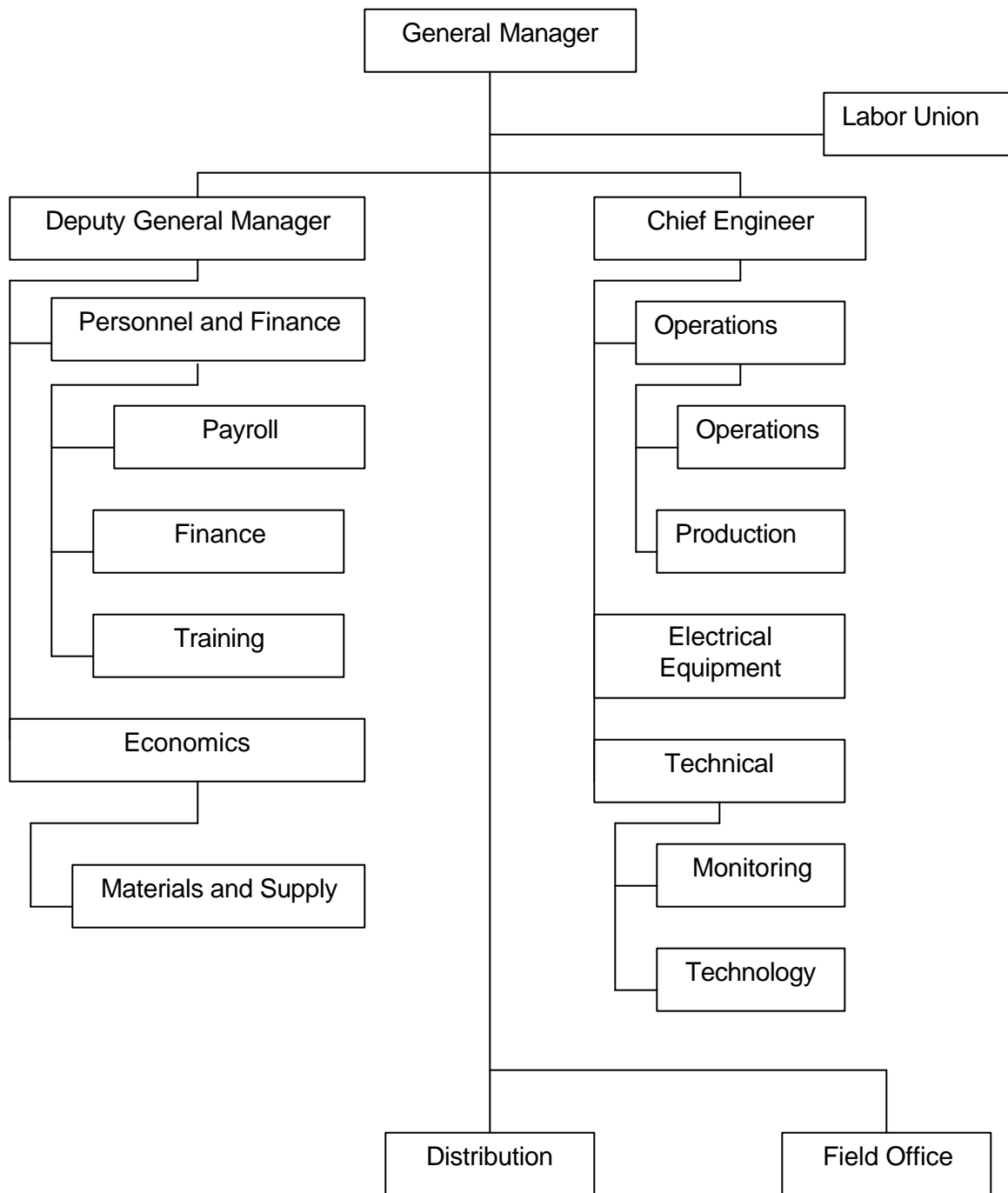
# ORGANIZATION CHARTS OF QEPGC AND QHC

Figure A5.1: Organization Chart of QEPGC



QEPGC = Qitaihe No. 1 Electric Power Generating Company.

**Figure A5.2: Organization Chart of QHC**



QHC = Qitaihe Heating Company.

## COMPLIANCE WITH LOAN COVENANTS

Covenant	Reference	Remarks
<b>Loan Effectiveness</b>		
1. The following are additional conditions to the effectiveness of the Loan Agreement for the purposes of Section 9.01(f) of the loan regulations:	Loan Agreement (LA), Section 6.01	
The Loan Agreement shall have been approved by the state council of the Borrower; and		Complied with
(i) the subsidiary loan agreement, in form and substance satisfactory to the Asian Development Bank (ADB), shall have been duly executed and delivered on behalf of the concerned parties, and shall have become fully effective and binding on those parties in accordance with its terms, subject only to the effectiveness of this Loan Agreement.		Complied with
<b>Execution of the Project:</b>		
<b>Parts A and B</b>		
(ii) The Heilongjiang Electric Power Co., Ltd. (HEPC), as Executing Agency (EA) for parts A and B of the Project, compile and submit all reports required to be provided to ADB. HEPC shall, throughout implementation of part A, maintain an office at the site of the cogeneration plant to be built. The office shall be adequately staffed with engineers and administrative personnel.	LA, Schedule 6, para. 1	Complied with
(iii) Unless ADB agrees otherwise, HEPC shall ensure that major technical recommendations resulting from the ADB-financed project preparatory technical assistance (TA 1919-PRC) are incorporated in the detailed design of parts A and B.	LA, Schedule 6, para. 2	Complied with
(iv) HEPC shall maintain detailed and comprehensive records of the plant's operation, for accurate monitoring and evaluation of the benefits of part A. HEPC shall also monitor progress of part B of the Project and, as lead EA, of part C, and shall collect data on replacement of coal-burning stoves, heaters, and industrial boilers for future benefit evaluation. Results of such monitoring and data collection shall be reported to ADB in project progress reports at regular intervals, or as ADB requests.	LA, Schedule 6, para. 3	Complied with

Covenant	Reference	Remarks
(v) Unless ADB agrees otherwise, the Borrower and HEPC shall, no later than 7 months from the effective date, execute the necessary arrangements for cofinancing or shall make, in a timely manner to ensure expeditious project implementation, other arrangements, satisfactory to ADB, to commit the foreign currency funds intended to be provided under the cofinancing.	LA, Schedule 6, para. 7	Complied with
<b>Part C of the Project</b>		
(vi) The Qitaihe City Municipal Government (QMG) shall be the EA for part C of the Project, and the Qitaihe Heating Company (QHC) shall be the Implementing Agency (IA) for part C. QMG shall maintain, throughout implementation of part C of the Project, a project coordination office (PCO), directly supervised by the Qitaihe vice mayor. The main functions of the PCO shall be to help QHC fulfill its responsibilities under part C, to coordinate activities of QHC and the concerned departments and agencies of QMG and the Borrower, and to liaise between QHC and QMG on the one part and HEPC on all matters relating to part C. QHC shall be responsible for the technical, financial, and administrative control of part C, and for its proper execution.	LA, Schedule 6, para. 8 (a)	Complied with
(vii) HEPC shall be responsible for liaising between the PCO and ADB on all matters relating to part C of the Project.	LA, Schedule 6, para. 8(b)	Complied with
(viii) QMG and QHC shall ensure that, before 31 December 1999, at least 1.5 million square meters (m <sup>2</sup> ) of hot water bulk supply pipework and industrial and domestic heating networks will be provided under part C of the Project. QMG and QHC shall further ensure that the expansion of the Qitaihe city district heating network shall continue under the QHC Capital Expansion Program.	LA Schedule 6, para. 9	Complied with
(ix) QMG shall ensure that, before completion of part C of the Project, the four district heating stations previously operated by QHC shall have been closed, with QHC receiving its heat in bulk from the plant. QMG and QHC shall make their best efforts to find suitable employment in their other operations for workers that such plant closures have made redundant.	LA, Schedule 6, para. 10	Complied with

Covenant	Reference	Remarks
<b>Environment</b>		
(x) HEPC shall ensure that an adequately staffed environmental protection unit (EPU) is established within the plant's organization. The unit shall be responsible for the day-to-day monitoring of effluents, noise, and health and safety conditions to ensure and demonstrate compliance with applicable environmental regulations. The EPU will submit quarterly reports to the Heilongjiang EPU.	LA, Schedule 6, para. 4	Complied with
(xi) HEPC shall place the highest priority on the proper installation, operation, and maintenance of the pollution control and monitoring equipment included in the plant's design, to ensure that its environmental standards, as initially designed, are met and enforced at all times.	LA, Schedule 6, para. 11	Complied with
(xii) HEPC shall ensure inclusion in the design of part A of the Project, and in the plant's operating procedures, of appropriate mitigating measures for environmental impact. Such measures, which must be satisfactory to ADB, include:	LA, Schedule 6, para. 12	Complied with
<b>Air Quality</b>		
(a) low nitrogen oxide burner technology in the boiler design;		Complied with
(b) installation of electrostatic precipitators with a guaranteed efficiency of no less than 99.5%;		Complied with
(c) a single stack with a height of at least 210 meters;		Complied with
(d) use in the plant of coal with a sulfur content of no more than 0.24% (400 mg/m <sup>3</sup> ) and an ash content of no more than 36%;		Complied with
(e) use of appropriate dust suppression techniques to minimize the dispersion of airborne coal dust during off-loading, stockpiling, and handling of coal at the plant site; and minimization of the dispersion of fugitive coal dust around the plant site by the planting and maintenance of trees as a greenbelt around the perimeter;		Complied with
(f) facilities to treat wastewater before it and other effluents are discharged or recycled;		Complied with
(g) use of the entire discharge from the cooling water circuit to transport ash to the ash disposal facility;		Complied with
(h) facilities and measures for water conservation, with provision for the recycling of treated effluents and ash disposal water;		Complied with
(i) facilities and procedures to ensure that rainwater from the coal yard passes through a sedimentation tank before its disposal into the production wastewater system;		Complied with

Covenant	Reference	Remarks
<b>Noise Mitigation</b>		
(j) adoption of noise mitigation measures to ensure compliance with all applicable noise standards;	LA, Schedule 6, para. 12	Complied with
<b>Coal Handling</b>		
(k) use of good stockyard management to minimize the risk of spontaneous combustion of coal in the plant stockyard, including <ul style="list-style-type: none"> <li>• careful monitoring to ensure that coal stocks are used and replaced regularly, and that no stocks remain for more than 2 months;</li> <li>• careful stacking of coal to ensure consolidation of the heap, with compaction if necessary; and</li> <li>• installation of a temperature monitoring system for coal stockpiles at 3- and 7-meter intervals at all coal bays;</li> </ul>	LA, Schedule 6, para. 12	Complied with
<b>Environmental Monitoring</b>		
(l) monitoring of the environmental impact by the EPU. Such site-specific long-term monitoring should include monitoring of the wastewater discharge points to the Woken River, and of the groundwater under the ash disposal yard;	LA, Schedule 6, para. 12	Complied with
(m) on line stack emission monitoring equipment to measure nitrogen oxides and sulfur dioxide, and stack cross-duct optical density equipment to measure particulate concentrations;		Complied with
(n) Installation in appropriate areas of Qitaihe city of air quality monitoring stations to measure concentrations of sulfur oxides, nitrous oxides, and particulates at ground level; and		Complied with
<b>Ash Dam</b>		
(o) Minimization of the risk of failure of the ash dam by adoption of suitable design and construction procedures, adequate sealing of the bed of the ash disposal area, use of a suitable impermeable membrane in the dam, and recirculation of at least 60% of the water used for ash transport.	LA, Schedule 6, para. 12	Complied with
(p) EPC shall ensure that appropriate measures for environmental impact mitigation are adopted and followed during plant construction. Such measures shall include minimizing soil erosion by establishing a stepped site layout; utilizing rubble mounds and water barriers, and providing suitably-designed drainage ditches.	LA, Schedule 6, para. 13	Complied with

Covenant	Reference	Remarks
(q) QMG shall make its best efforts to encourage residents of Qitaihe city to cease use of coal-burning stoves and heaters in favor of the district heating system provided under part C of the Project. Such efforts shall include:	LA, Schedule 6, para. 14	Complied with
a. maintaining Qitaihe City Ordinance No. 5 (1991), which prohibits the construction of chimneys in new buildings in the central districts of Qitaihe city; and		Complied with
b. providing price incentives to consumers, through cooperation with the Borrower and its relevant authorities to establish market pricing of coal within Qitaihe city, and establishment of the retail heat tariff at a level relative to the local price of coal. QMG and HEPC shall negotiate the bulk heat supply tariff to ensure that retail district heating tariffs may be set at levels to make the use of the district heating system, provided under part C, attractive to consumers in price, compared with coal heating.		Complied with
(r) QMG shall, before project completion, ensure that the portion of Qitaihe city that is covered with trees or other vegetation is increased from 30 to 40%.	LA, Schedule 6, para. 18	Complied with
(s) The Borrower shall cause the Heilongjiang Provincial Government to ensure that QMG, in cooperation with the Heilongjiang Environmental Protection Bureau and with the municipal and county governments in the Qitaihe region, continues through 1999 its implementation of the district environmental management plan prepared in conjunction with QMG's surrounding municipalities and counties. Information on the progress in plan implementation shall be provided to ADB in HEPC's project progress reports at regular intervals, or as ADB requests.	LA, Schedule 6, para. 19	Complied with

Covenant	Reference	Remarks
<b>Social Dimensions</b>		
(t) HEPC shall ensure that the construction of dedicated transmission lines is completed before commissioning of the plant, and that the transmission equipment associated with such transmission lines and switchyards does not utilize polychlorinated biphenyl (PCB). HEPC shall further ensure that the routes of the dedicated transmission lines are chosen following due consideration of environmental impact and, without limiting the generality of the foregoing, ensuring that such dedicated transmission lines do not encroach upon any nature reserves, or important cultural and historic sites, etc.	LA, Schedule 6, para. 16	Complied with
(u) HEPC and QMG shall take the necessary measures to mitigate possible adverse social impacts associated with the Project. Such measures shall include ensuring that all land required for the plant, the ash disposal dam, and the dedicated transmission lines are free from settlement or, if settled, that payments are made to property owners or users whose land is expropriated or whose use of the land is disrupted by the Project. Such payments will be made promptly and in accordance with local laws and regulations, and on the basis of current market prices.	LA, Schedule 6, para. 17	Complied with
<b>Financial</b>		
(v) Unless ADB agrees otherwise, HEPC shall take all necessary measures, including tariff adjustments, to enable it to generate funds from internal sources sufficient to finance, commencing with the fiscal year beginning in 1997 and in each fiscal year thereafter, no less than 30% of its 3-year average capital expenditures.	LA, Schedule 6, para. 21	Not complied
(w) Unless ADB agrees otherwise, HEPC shall take all necessary measures, including tariff adjustments, to maintain its net revenues at a level which, for each fiscal year, will produce internally generated funds equal to at least 1.3 times the debt-service requirements for the fiscal year.	LA, Schedule 6, para. 22	Complied with

Covenant	Reference	Remarks
<b>Reports</b>		
(x) QMG shall furnish to ADB, through HEPC for inclusion in its quarterly project reports, information on execution, operation, and management of the Project and its facilities. Such information will include, in such detail as ADB reasonably requests, progress and problems during the quarter under review, steps taken or proposed to remedy the problems, and the proposed activities and expected progress during the next quarter.	PA, Section 2.08(b)	Complied with
(y) Promptly after project completion, QMG shall prepare and furnish to ADB, through HEPC for inclusion in its project completion report, information on the execution and initial operation of the Project, including its costs, and QMG and QHC's performance of obligations under the project agreement.	PA, Section 2.08(c)	Complied with
<b>Accounts</b>		
(z) QHC shall (i) maintain separate accounts for the Project; (ii) have such accounts and related financial statements (balance sheets, statements of income and expenses, and related statements) audited annually by auditors whose qualifications, experience, and terms of reference are acceptable to ADB; and (iii) furnish ADB, through HEPC, certified copies of such audited accounts and financial statements, in English. QHC shall furnish to ADB further information concerning such accounts and financial statements, and their audits, if ADB requests the information.	PA, Section 2.09	Complied with

### LIST OF CONTRACT PACKAGES

PCSS No.	Item	Mode of Procurement	Country of Contractor	Date of Contract	Contract Amount (\$)
0001	Implementation Consulting Services	DP	United Kingdom	5 Dec 94	351,817
0002	2x352.75 MW Steam Turbine Generator Units	ICB	Japan	14 Mar 96	61,411,296
0003	Pulverized Coal Preparation System	ICB	France	1 Apr 96	13,546,929
0004	Fans Equipment	ICB	PRC	24 Oct 97	1,514,830
0005	Cranes in the Main Building	IS	PRC	3 Nov 97	256,023
0006	Hydrogen Generation	IS	PRC	2 Nov 97	401,226
0007	Telecommunication Exchange	IS	PRC	2 Nov 97	110,843
0008	Air Compressor	IS	PRC	2 Nov 97	326,137
0009	Instrumentation and Control System	ICB	Hong Kong	24 Jan 98	9,343,612
0010	Boiler Make-up Water Pre-treatment Equipment	IS	PRC	3 Sep 98	118,865
0011	Pumps of Boiler Make-up Water	IS	PRC	3 Sep 98	92,835
0012	Acid and Caustic Storage Equipment	IS	PRC	3 Sep 98	67,493
0013	Oil Treatment Equipment	IS	PRC	3 Sep 98	67,524
0014	Chemical Water Treatment Control System	IS	PRC	3 Sep 98	238,128
0015	Raw Water Heater	IS	PRC	3 Sep 98	117,630
0016	Dead Tank Circuit Breaker	ICB	PRC	31 Oct 98	2,642,025
0017	Circulating Water Pump and Screen Cleaner	ICB	PRC	30 Jun 99	755,033
0018	Boiler Make-up Water Treatment Equipment	ICB	PRC	30 Jun 99	193,595
0019	Transformers and Auxiliaries	ICB	Japan	25 Jun 99	6,897,023
0020	Fire Fighting and Fire Alarm System	ICB	PRC	27 Aug 99	249,909
0021	Ash Supply Pump	ICB	PRC	13 Aug 99	496,825

DP = direct purchase, ICB = international competitive bidding, IS = international shopping, MW = megawatt, PCSS = procurement contract summary sheet, PRC = People's Republic of China.

Source: Asian Development Bank.

## FINANCIAL PERFORMANCE OF PROJECT ENTERPRISES

1. The financial performance of the Heilongjiang Electric Power Company (HEPC) during 1998–2002 was satisfactory. HEPC's profitability was moderate and the company maintained its high cash position. The financial covenants in the Loan Agreement were partially fulfilled, and the debt service coverage ratios were met, except in 1999 and 2000. But the covenant on the self-financing ratio was not satisfied. HEPC's 2003 financial statements, and the long-term projections, were not available. HEPC's financial profile is expected to differ because of changes in its mandate as a pure network company and the transfer of ownership of its generating facilities, including Qitaihe No. 1 Electric Power Generating Company (QEPGC) to the China Datang Corporation (CDT) and other power-generating groups. The power sector restructuring in the People's Republic of China (PRC) is still ongoing, and being in transition, HEPC could not provide the financial projections to evaluate its financial prospects.

2. Also, QEPGC did not provide financial statements. But HEPC's 2001 audit report showed that QEPGC had difficulty meeting its debt service payments, and was expected to report a loss in 2002. QEPGC's low capacity utilization is the primary factor for its current non-robust financial status. Its current plant factor of 55% is expected to substantially improve and the power plant is expected to reach full capacity by summer 2005, subject to appropriate load dispatching schedules. The cogeneration power plant has already achieved its designed heat supply capacity, and has secure heat supply arrangements with the district heating company. The long-term financial projections, prepared on the basis of existing tariff levels and full capacity dispatch, show that QEPGC will maintain a reasonably sound financial position that will enable the company to meet its financial obligations and improve the plant's profitability. The prepayment of the ADB loan through its refinancing from local banks has eliminated any financial risk for ADB. The company's long-term prospects remain positive due to the plant's efficiency and advantageous position as a base-load facility. This should enable the power plant to remain successful in the emerging competitive power market, and should ensure its long-term financial viability.

3. The financial statements of Qitaihe Heating Company were not made available. The company reported that its financial position continues to be marginal, because of the low regulated heat tariffs approved by the price bureau. But implementation of the ongoing heating tariff reforms in the PRC is expected to improve the company's financial position.

**Heilongjiang Electric Power Company**  
**Table A8.1 : Income Statements**  
(CNY million)

Year Ending December 31	1998	1999	2000	2001	2002
<b>Revenues and Expenses</b>					
<b>Revenues</b>					
Sales Revenue	8,311	8,645	10,378	12,059	12,620
Sales Tax and Surcharge	35	41	43	70	64
<b>Net Operating Revenues</b>	<b>8,276</b>	<b>8,604</b>	<b>10,335</b>	<b>11,989</b>	<b>12,556</b>
<b>Operating Costs</b>					
Fuel		812	717	684	718
Purchased Power		5,623	7,097	7,966	8,413
Materials and Water		139	102	172	171
Wages and Welfare		426	485	588	680
Depreciation		784	735	1,051	1,152
Operation and Maintenance		314	855	972	989
<b>Total Operating Costs</b>	<b>8,183</b>	<b>8,098</b>	<b>9,992</b>	<b>11,433</b>	<b>12,122</b>
<b>Operating Income</b>	<b>92</b>	<b>506</b>	<b>343</b>	<b>557</b>	<b>433</b>
Financial Expenses	359	181	189	278	353
Non-operating Income	327	(388)	(14)	(15)	221
Prior Year's Adjustment	0	106	(37)	16	0
<b>Net Income Before Tax</b>	<b>61</b>	<b>43</b>	<b>102</b>	<b>280</b>	<b>302</b>
Income Tax	20	22	50	82	93
<b>Net Income</b>	<b>41</b>	<b>21</b>	<b>52</b>	<b>198</b>	<b>209</b>
<b>Ratios</b>					
Rate Base <sup>a</sup> (CNY million)	0	11,064	9,891	11,418	13,003
Operating Ratio <sup>b</sup> (%)	98.9	94.1	96.7	95.4	96.5
Return on Rate Base <sup>c</sup> (%)	0	4.4	3.0	4.2	2.6

CNY = yuan.

<sup>a</sup> Average of beginning and ending net fixed assets.

<sup>b</sup> Total operating expenses as a percentage of total revenues.

<sup>c</sup> Net operating income after taxes as a percentage of rate base.

Source: Heilongjiang Electric Power Company.

**Heilongjiang Electric Power Company**  
**Table A8.2: Balance Sheets**  
(CNY million)

Year Ending December 31	1998	1999	2000	2001	2002
<b>Assets</b>					
<b>Fixed Assets</b>					
Gross Fixed Assets	19,215	16,101	17,757	20,286	22,516
Accumulated Depreciation	6,422	6,766	7,309	7,897	8,900
<b>Net Fixed Assets in Service</b>	<b>12,793</b>	<b>9,335</b>	<b>10,448</b>	<b>12,389</b>	<b>13,616</b>
Work in Progress	542	2,236	4,378	1,195	907
Other Fixed Assets	6	1	1	104	73
<b>Net Fixed Assets</b>	<b>13,341</b>	<b>11,572</b>	<b>14,827</b>	<b>13,687</b>	<b>14,596</b>
<b>Other Assets</b>					
Long-Term Investments	3,376	4,516	4,551	5,602	5,495
<b>Total Other Assets</b>	<b>3,376</b>	<b>4,516</b>	<b>4,551</b>	<b>5,602</b>	<b>5,495</b>
<b>Current Assets</b>					
Cash	2,684	2,428	3,008	3,107	2,590
Short-Term Investment	0	480	598	626	502
Accounts Receivable	1,494	990	1,026	933	919
Other Receivables	2,557	2,852	1,976	4,976	4,732
Inventories	210	122	82	104	76
Advances/Other Current Assets	15	123	102	114	198
<b>Total Current Assets</b>	<b>6,959</b>	<b>6,995</b>	<b>6,792</b>	<b>9,859</b>	<b>9,018</b>
<b>Total Assets</b>	<b>23,677</b>	<b>23,083</b>	<b>26,169</b>	<b>29,149</b>	<b>29,108</b>
<b>Equity and Liabilities</b>					
<b>Equity</b>					
Capital	6,542	6,688	6,688	6,688	6,688
Capital Surplus	3,730	4,495	4,882	5,474	5,625
Reserves and Retained Earnings	822	748	44	218	424
<b>Total Equity</b>	<b>11,093</b>	<b>11,931</b>	<b>11,614</b>	<b>12,380</b>	<b>12,737</b>
Long-Term Debt	7,157	6,106	8,604	10,000	10,287
Other Long-Term Liabilities	124	(153)	341	212	163
<b>Total Long-Term Liabilities</b>	<b>7,281</b>	<b>5,953</b>	<b>8,945</b>	<b>10,212</b>	<b>10,449</b>
<b>Current Liabilities</b>					
Short-Term Loan	260	150	128	205	43
Long-Term Loans Due in One Year	0	0	0	818	937
Accounts Payable	1,414	1,592	2,373	1,926	1,928
Taxes Payable	49	251	296	268	232
Wages and Welfare Payable	356	289	278	360	385
Other Payables	3,154	2,728	2,295	2,844	2,270
Other Current Liabilities	69	188	240	135	127
<b>Total Current Liabilities</b>	<b>5,302</b>	<b>5,199</b>	<b>5,609</b>	<b>6,556</b>	<b>5,922</b>
<b>Total Equity and Liabilities</b>	<b>23,676</b>	<b>23,083</b>	<b>26,169</b>	<b>29,149</b>	<b>29,108</b>
<b>Ratios</b>					
Current Ratio <sup>a</sup>	1.3	1.3	1.2	1.5	1.5
Debt/(Debt + Equity) Ratio <sup>b</sup> (%)	39.6	33.3	43.5	45.2	45.1

CNY = yuan.

<sup>a</sup> Ratio of current assets to current liabilities.

<sup>b</sup> Ratio of long-term debt to long-term debt plus equity.

Source: Heilongjiang Electric Power Company.

## Heilongjiang Electric Power Company

Table A8.3: Cash Flow Statements

(CNY million)

Year Ending December 31	1998	1999	2000	2001	2002
<b>Sources</b>					
Net Income After Tax	41	21	52	198	209
Add: Non-Cash Charges					
Depreciation	231	550	800	1,140	1,834
Other Non-Cash Charges		55	131	115	485
Interest Expense	359	131	193	279	355
Internal Cash Generation	631	757	1,176	1,732	2,883
Borrowings	146	3,817	3,980	3,362	2,093
Equity Contribution	17				
Receipts from Investments/Assets Disposal	27	131	520	1,278	1,062
<b>Total Sources</b>	<b>821</b>	<b>4,705</b>	<b>5,676</b>	<b>6,372</b>	<b>6,038</b>
<b>Applications</b>					
Capital Expenditures	181	3,253	3,104	3,674	2,597
Debt Service	405	837	1,218	1,340	2,287
Principal	46	706	1,025	1,061	1,932
Interest	359	131	193	279	355
Long-Term Investment	65	150	531	538	948
Dividends	0	20	15	562	0
Others					
Change in Working Capital/Others		700	228	159	724
<b>Total Applications</b>	<b>651</b>	<b>4,960</b>	<b>5,096</b>	<b>6,273</b>	<b>6,555</b>
<b>Net Cash Flow</b>	<b>170</b>	<b>(255)</b>	<b>580</b>	<b>99</b>	<b>(517)</b>
Check	170	(255)	580	99	(517)
Cash, Beginning	2,514	2,684	2,428	3,008	3,107
Cash, End	2,684	2,428	3,008	3,107	2,590
<b>Ratios</b>					
Debt Service Ratio <sup>a</sup>	1.6	0.9	1.0	1.3	1.3
Self-Financing Ratio <sup>b</sup> (%)	19.7	(35.8)	(8.1)	7.5	(6.1)

CNY = yuan.

<sup>a</sup> Ratio of internal cash generation to debt service requirement.<sup>b</sup> Internal cash generation net of changes in working capital and debt service as a percentage of the three-year moving average of capital expenditures.

Source: Heilongjiang Electric Power Company. Some accounts were estimated based on available information.

## FINANCIAL EVALUATION

### A. General

1. As at appraisal, the financial internal rate of return (FIRR) for the Qitaihe Thermal Energy and Improvement Project (Project) was calculated jointly for all parts—A, B, and C of the Project. The FIRR was reevaluated on the basis of financial and operational information provided by Qitaihe No. 1 Electric Power Generating Company (QEPGC) and Qitaihe Heating Company (QHC). Investments made for the Project were considered. The economic life of the Project, assumed at appraisal to be 25 years, was maintained, with zero residual value. All revenues and expenditures are in constant 2003 prices and exclude depreciation and interest.

### B. Revenues and Operating Costs

2. Incremental revenues were calculated based on the energy output from the QEPGC and heat revenues realized by QHC. Expected annual operation of QEPGC is at 5,400 hours with net annual energy generation of 3,570 gigawatt-hours (GWh), after a 5.5% station use. Actual revenues from the start of operations were considered. The current tariff level of CNY0.234 per kilowatt-hour (kWh), excluding the value-added tax, was used in the projections and was assumed to be constant during the projection period. The internal consumption of heat is 0.3 million m<sup>2</sup>. Present heating area served by QHC was maintained. Heating tariffs were assumed to increase by 5% in 2005 and in 2010 in consideration of the proposed tariff reforms in the People's Republic of China (PRC). Current levels of operating and maintenance costs were assumed. Income, value added, and other taxes were based on actual rates.

### C. Financial Internal Rate of Return

3. The reevaluated FIRR of the Project was 8.7%, which is lower than the 10.6% estimated at appraisal but higher than the weighted average cost of capital (WACC) of 4.9%. The lower FIRR is due to the differences in revenue and cost assumptions and the deduction of income tax from the cash flows.

### D. Weighted Average Cost of Capital

4. The estimated WACC for the Project—in real terms, after taxes—was derived following the methodology in the Asian Development Bank's *Guidelines for the Financial Governance and Management of Investment Projects Financed by the Asian Development Bank* using actual capital mix and costs of funds. The real interest costs of loan funds were considered, while the cost of equity was assumed to be 10%. Actual income tax rate was used. The standard income tax rate in the PRC is 33%, although preferential rates are given in some inland provinces. Domestic inflation is assumed at 3% per year.

5. The recalculated WACC is 4.9%, compared to 3.0% estimated at appraisal. The WACC calculated at appraisal adopted a different methodology and assumed different levels and costs of debt and equity, and a higher inflation rate.

**Table A9.1 : Financial Internal Rate of Return**  
(CNY million )

Year	Electricity Sales (GWh)	Heat Sales (1,000 m <sup>2</sup> )	Capital Costs	Revenues	Operating Costs		Income Tax	Net Cash Flow After Tax
					Fuel	O&M		
1997			139.46					(139.46)
1998			127.66					(127.66)
1999			1,141.89					(1,141.89)
2000			515.07					(515.07)
2001			1,128.14					(1,128.14)
2002	1,273	1,400	330.51	362.31	127.07	63.32	0.0	(158.59)
2003	2,352	1,800	217.84	595.96	186.33	79.41	0.0	112.38
2004	2,499	1,800		599.27	193.80	79.36	5.97	320.15
2005	3,213	1,800		802.89	229.79	82.20	63.37	427.54
2006	3,570	1,800		886.43	247.78	83.32	86.88	468.45
2007	3,570	1,800		886.43	247.78	83.32	89.14	466.19
2008	3,570	1,800		886.43	247.78	83.32	91.40	463.94
2009	3,570	1,800		886.43	247.78	83.32	93.66	461.68
2010	3,570	1,800		888.07	247.78	83.32	96.71	460.26
2011	3,570	1,800		888.07	247.78	83.32	99.25	457.73
2012	3,570	1,800		888.07	247.78	83.32	101.59	455.38
2013	3,570	1,800		888.07	247.78	83.32	103.93	453.04
2014	3,570	1,800		888.07	247.78	83.32	106.27	450.70
2015	3,570	1,800		888.07	247.78	83.32	108.61	448.36
2016	3,570	1,800		888.07	247.78	83.32	110.95	446.02
2017	3,570	1,800		888.07	247.78	83.32	113.29	443.68
2018	3,570	1,800		888.07	247.78	83.32	114.84	442.13
2019	3,570	1,800		888.07	247.78	83.32	114.84	442.13
2020	3,570	1,800		888.07	247.78	83.32	114.84	442.13
2021	3,570	1,800		888.07	247.78	83.32	114.84	442.13
2022	3,570	1,800		888.07	247.78	83.32	114.84	442.13
2023	3,570	1,800		888.07	247.78	83.32	182.47	374.50
<b>Total</b>			<b>3,600.6</b>	<b>18,339.1</b>	<b>5,197.0</b>	<b>1,804.0</b>	<b>2,027.7</b>	<b>5,709.9</b>
							<b>FIRR =</b>	<b>8.7%</b>

FIRR = financial internal rate of return, GWh = gigawatt-hour, O&M = operation and maintenance.

Source: Qitaihe No 1 Electric Power Generating Company and Asian Development Bank Estimates.

## ECONOMIC EVALUATION

### A. General

1. The economic evaluation of the Qitaihe Thermal Energy and Environmental Improvement Project (Project) followed the methodology used at appraisal. Incremental costs and benefits for the Project were determined. The economic life of the Project, assumed at appraisal to be 25 years, was maintained. The residual value at the end of the economic life was assumed to be zero. All costs and benefits were expressed in 2003 constant prices.

### B. Capital Costs, Incremental Benefits, and Operating Costs

2. Imported equipment was valued at its actual cost. Other tradable and non-tradable costs were valued by applying the standard conversion factor.<sup>1</sup> Taxes, import duties, and all financial charges, including interest during construction, have been excluded.

3. The economic benefits were derived from incremental energy supplied to consumers and from resource cost savings from the displacement of inefficient generation by small coal-fired boilers. As at appraisal, the bulk of the power generation was assumed to supply new customers and was measured in terms of consumers' willingness to pay<sup>2</sup> (WTP). The WTP was estimated based on the cost of alternative electricity supplies and an assumed 35% consumer surplus adopted from appraisal. Although a survey was not undertaken at the time of project completion to establish an updated consumer demand curve, updated assumptions on the cost of alternative electricity supplies, customer profile in Heilongjiang Province, and consumer tariffs by consumer category were used to determine the WTP. Coal cost savings due to displacement of small coal-fired boilers for heating were also quantified.

4. Other benefits identified at appraisal, which remain valid at project completion, include: (i) improved district heating efficiency, (ii) improved air quality thereby reducing health care expenses and maintenance costs for public structures affected by acid rain, (iii) additional jobs created by businesses using steam, and (iv) increased recreational activities from new greenbelt areas. The other benefits were not quantified both at appraisal and at project completion.

5. The economic price of coal was calculated using its border price, adjusted by the transportation and handling costs in Heilongjiang Province. Other operating costs, including water, salary, welfare, and maintenance, were converted to their economic costs using the standard conversion factor. Transmission and distribution costs were assumed.

### C. Economic Internal Rate of Return

6. The economic internal rate of return (EIRR) for the Project is recalculated at 19.1%, lower than the 21.5% estimated at appraisal but higher than ADB's 12% hurdle rate for the economic opportunity cost of capital. The lower EIRR is due to the reduced benefits as a result of the low capacity utilization in the initial years of operation and lower values used in the valuation of benefits.

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<sup>1</sup> The standard conversion factor used in this evaluation is 0.99.

<sup>2</sup> The WTP used in this evaluation is equivalent to 60%, which represents the proportionate share of generation cost in the long-range marginal cost of electricity for the People's Republic of China.

**Table A10.1: Economic Internal Rate of Return**  
(CNY million)

Year	Power Sale (GWh)	Heat Sale (1,000 m <sup>2</sup> )	Capital Costs	Economic Benefits			Operating Costs		Net Economic Benefits
				Incremental Sales	Coal Saving	Total	Fuel	O&M	
1997			138.85						(138.85)
1998			145.01						(145.01)
1999			1,129.40						(1,129.40)
2000			502.47						(502.47)
2001			1,122.60						(1,122.60)
2002	1,273	1,400	324.14	472.95	20.81	493.76	87.52	52.21	29.89
2003	2,352	1,800	216.87	870.89	29.05	899.94	159.01	63.64	460.42
2004	2,499	1,800		925.15	29.06	954.21	168.95	63.65	721.61
2005	3,213	1,800		1,188.74	30.10	1,218.84	217.22	63.65	937.97
2006	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2007	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2008	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2009	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2010	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2011	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2012	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2013	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2014	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2015	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2016	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2017	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2018	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2019	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2020	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2021	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2022	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
2023	3,570	1,800		1,320.46	30.10	1,350.56	241.36	63.65	1,045.55
<b>Total</b>			<b>3,579.33</b>	<b>27,226.04</b>	<b>650.78</b>	<b>27,876.82</b>	<b>4,977.10</b>	<b>1,388.86</b>	<b>17,931.53</b>
								<b>EIRR =</b>	<b>19.1%</b>

EIRR = economic internal rate of return, GWh = gigawatt-hour, O&M = operation and maintenance.  
Source: Qitaihe No 1 Electric Power Generating Company and Asian Development Bank Estimates.

### INVESTMENTS FOR ENVIRONMENTAL IMPROVEMENT FACILITIES AND WORKS

No.	Item	Actual Cost \$ million
<b>A. Mitigating Measures</b>		
1.	Electrostatic Precipitator	3.47
2.	Wastewater Treatment System	2.96
3.	Air Quality Monitoring Stations	1.42
4.	Stack	1.80
5.	Hydraulic Return Pipeline from Ash Gully, Pumps, and Filters	13.19
6.	Compensation for Two Farm Structures	0.22
	<b>Subtotal A</b>	<b>23.04</b>
<b>B. Environmental Protection Improvement</b>		
1.	District Heating Facilities	2.13
2.	Reforestation: Greenbelt Around the Power Plant	0.56
3.	Low Nitrogen Oxides Burner	0.49
	<b>Subtotal B</b>	<b>3.18</b>
	<b>Total</b>	<b>26.22</b>

Source: Heilongjiang Electric Power Company.

## ENVIRONMENTAL MONITORING INDEXES

Table A12.1: Emissions from Power Plant Stack

Parameter	Unit	PRC Standard <sup>a</sup>	Actual Values <sup>b</sup>
SO <sub>2</sub>	mg/m <sup>3</sup>	2,100	340
PM	mg/m <sup>3</sup>	200	60
NO <sub>x</sub>	mg/m <sup>3</sup>	1,100	630

mg = milligram(s), m<sup>3</sup> = cubic meter(s), NO<sub>x</sub> = nitrogen oxides, PM = particulate matter, SO<sub>2</sub> = sulfur oxide.

<sup>a</sup> PRC standard GB 13223-2003 : Emission Standard of Air Pollutants for Thermal Power Plants .

<sup>b</sup> Recorded during environmental tests conducted by State, Provincial and Municipal Environment Bureau in March 2004.

Source: Heilongjiang Electric Power Company.

Table A12.2: Power Plant Wastewater Pollution Indexes

Parameter	Unit	PRC Standard <sup>a</sup>	Actual Values <sup>b</sup>
pH		6~9	6.7
SS	mg/l	≤70	29
CODCr	mg/l	≤100	87

CODCr = chemical oxygen demand, l = liter, mg = milligram(s), pH = potential hydrogen, SS = suspended substance.

<sup>a</sup> PRC standard-GBJ4-73: Industrial Waste Emission Standard for Power Plants.

<sup>b</sup> Recorded during environmental tests conducted by Municipal Environment Bureau in August 2003.

Source: Heilongjiang Electric Power Company.

Table A12.3: Power Plant Boundary Noise Levels

Item	Unit	PRC Standard <sup>a</sup>	Actual Values <sup>b</sup>
Daytime	decibels	≤60	
Highest	decibels		52
Lowest	decibels		49
Night time	decibels	≤50	
Highest	decibels		46
Lowest	decibels		42

<sup>a</sup> PRC standard-GB12348-90: Standard of Plant Boundary Noise Levels.

<sup>b</sup> Recorded during environmental tests conducted by State, Provincial and Municipal Environment Bureau in March 2004.

Source: Heilongjiang Electric Power Company.