

**REPORT AND RECOMMENDATION  
OF THE  
PRESIDENT  
TO THE  
BOARD OF DIRECTORS  
ON A  
PROPOSED LOAN  
AND TECHNICAL ASSISTANCE GRANTS  
TO THE  
PEOPLE'S REPUBLIC OF CHINA  
FOR THE  
HUNAN LINGJINTAN HYDROPOWER PROJECT**

**August 1994**

## CURRENCY EQUIVALENTS

(As of 1 September 1994)

Currency Unit	—	Yuan (Y)
Y 1.00	=	\$ 0.115
\$ 1.00	=	Y 8.70

On 1 January 1994, the PRC's dual exchange rate system was unified. The exchange rate of the Yuan is now determined under a managed floating exchange rate system. For the purposes of this Report, an exchange rate of Y 8.70 to \$1.00 is used.

## ABBREVIATIONS

BOO	-	Build-Own-Operate
BOT	-	Build-Operate-Transfer
DSM	-	Demand Side Management
ECC	-	Energy Conservation Company
FGD	-	Flue Gas Desulfurization
HEPC	-	Hunan Electric Power Company
HIPDC	-	Huaneng International Power Development Corporation
HPG	-	Hunan Provincial Government
HPEPB	-	Hunan Province Electric Power Bureau
LRMC	-	Long-Run Marginal Cost
MOEP	-	Ministry of Electric Power
MSDI	-	Mid-South Design and Research Institute for Hydroelectric Projects
NEPA	-	National Environmental Protection Agency
OECF	-	Overseas Economic Cooperation Fund
PCBC	-	People's Construction Bank of China
SDB	-	State Development Bank
SEIC	-	State Energy Investment Corporation
SETC	-	State Economic and Trade Commission
SMEPC	-	Shanghai Municipal Electric Power Co.
SOEs	-	State-Owned Enterprises
SPC	-	State Planning Commission

## WEIGHTS AND MEASURES

kV	(kilovolt)	-	1,000 V
kW	(kilowatt)	-	1,000 W
MW	(megawatt)	-	1,000 kW
GW	(gigawatt)	-	1,000 MW
kWh	(kilowatt-hour)	-	1,000 Wh
GWh	(gigawatt-hour)	-	1,000,000 kWh
TWh	(terawatt-hour)	-	1,000 GWh
kVA	(kilovolt-ampere)	-	1,000 VA
MVA	(megavolt-ampere)	-	1,000 kVA
toe		-	ton of oil equivalent = 10,000 kilocalories or 39,680,000 British thermal units
kgoe		-	kilogram of oil equivalent

## NOTES

- (i) The fiscal year (FY) of the Government, HEPC and HPEPB coincide with the calendar year.
- (ii) In this Report, "\$" refers to US dollars.

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(ii)

**PEOPLE'S REPUBLIC OF CHINA  
HUNAN LINGJINTAN HYDROPOWER PROJECT**

**LOAN AND PROJECT SUMMARY**

<b>Borrower</b>	:	The People's Republic of China (PRC)
<b>The Project</b>	:	The Project includes the construction of a 240 megawatt (MW) run-of-river hydropower scheme on the Yuanshui River in the Hunan Province, which will also serve as a reregulating station for the 1,200 MW Wuqiangxi hydropower scheme located upstream, and strengthening of energy conservation activities of the Hunan Electric Power Company (HEPC).
<b>Classification</b>	:	Economic growth
<b>Rationale</b>	:	The Project supports the Government's subsector policy of accelerating the development of hydropower resources and intensifying energy conservation activities. Furthermore, the Project supports the Government's policy of promoting balanced regional development through the addition of power generating capacity needed to facilitate the development of an inland province.
<b>Objectives and Scope</b>	:	The principal objective of the Project is to accelerate the development of hydropower resources in Hunan Province through the provision of an additional power generating capacity of 240 MW and a reregulating station for a 1,200 MW hydropower scheme. The Project objectives also include institutional development of HEPC as well as tariff policy and energy conservation reforms in Hunan Province.

The Project consists of the following:

- (i) construction of the 240 MW Hunan Lingjintan hydropower scheme; and
- (ii) consulting services and training for strengthening energy conservation activities of HEPC.

**Cost Estimates**

(\$ million equivalent)

	Foreign Exchange	Local Currency	Total
Base Cost	89.7	149.2	238.9
Contingencies	16.4	30.2	46.6
Interest During Construction	<u>23.4</u>	<u>57.9</u>	<u>81.3</u>
Total	<u>129.5</u>	<u>237.3</u>	<u>366.8</u>
	(35.3%)	(64.7%)	(100.0%)

(iii)

**Financing Plan**

:

(\$ million equivalent)

Source	Foreign Exchange	Local Currency	Total	Percentage
Bank	116.0	-	116.0	31.6%
State Development Bank	6.8	118.7	125.4	34.2%
Hunan Provincial Government	<u>6.8</u>	<u>118.7</u>	<u>125.4</u>	<u>34.2%</u>
Total	<u>129.5</u>	<u>237.3</u>	<u>366.8</u>	<u>100.0%</u>

**Loan Amount and Terms**

:

The proposed Bank loan of \$116.0 million will be from the Bank's ordinary capital resources. The repayment period will be 25 years including a grace period of 6 years, at an interest rate determined in accordance with the Bank's pool-based variable lending rate system for US dollar loans.

**Relending Terms**

:

The Borrower will relend, under a Subsidiary Loan Agreement, the proceeds of the Bank loan to HEPC on the same terms and conditions prevailing on the Bank's loan to the Borrower. HEPC will bear the foreign exchange and interest variation risks.

**Period Utilization**

:

Until 30 April 2001

**Executing Agency**

:

Hunan Electric Power Company (HEPC)

**Implementation Arrangements**

:

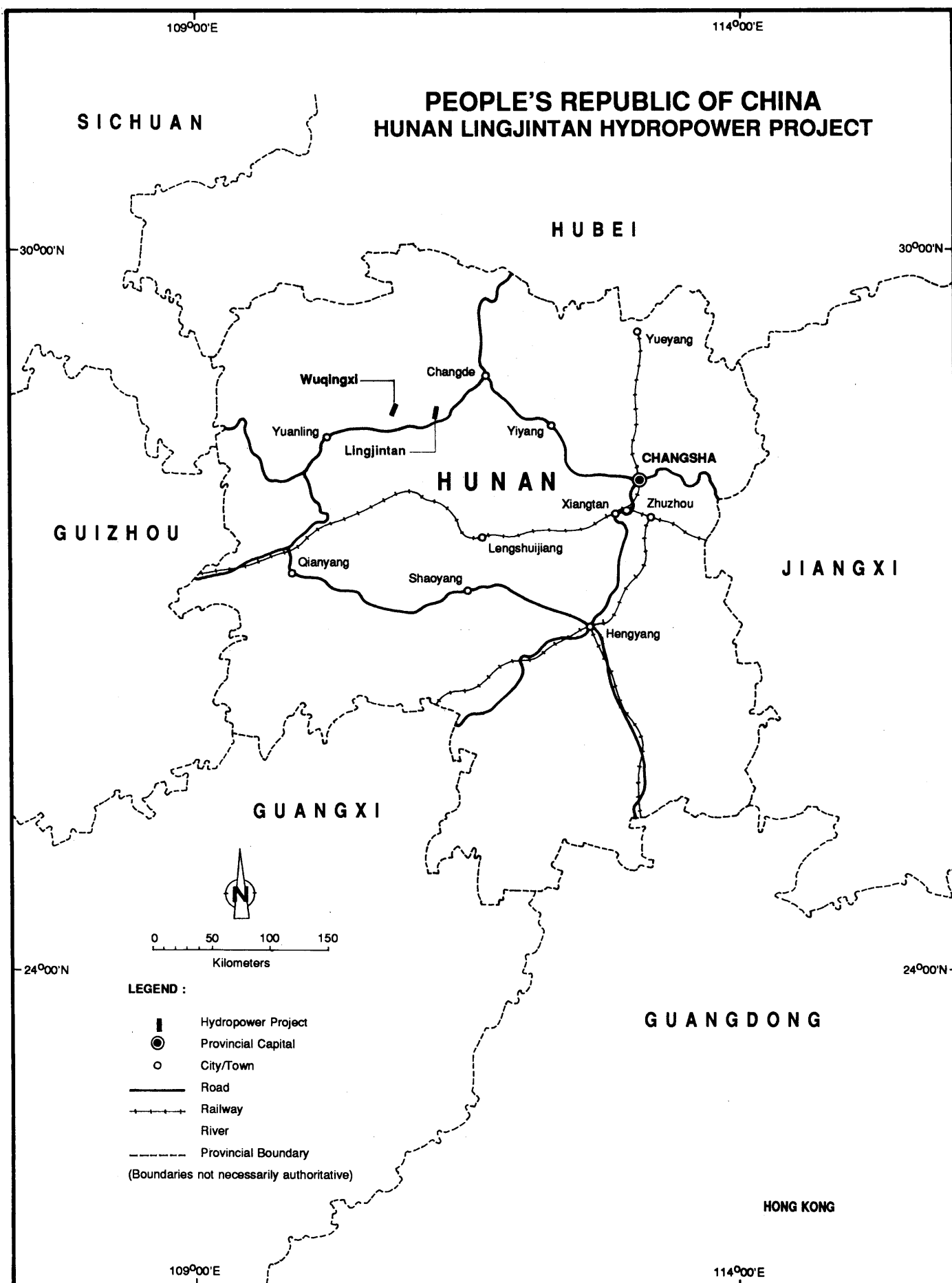
HEPC will form a Lingjintan Project Construction Unit with a sufficient number of qualified staff and headed by a senior HEPC staff with experience and qualifications satisfactory to the Bank. The Mid-South Design and Research Institute for Hydroelectric Projects will assist HEPC in the engineering design. The construction of civil works and installation of equipment will be carried out by local contractors, while the supply and installation supervision of the electromechanical equipment and instrumentation will be carried out by international manufacturers.

**Procurement**

:

The procurement of goods and services to be financed under the Bank loan will be carried out in accordance with the Bank's *Guidelines for Procurement*.

<b>Consulting Services</b>	:	The international consultants financed under the Bank loan to assist the construction supervision of the Lingjintan hydropower scheme and to strengthen HEPC's energy conservation activities will be recruited in accordance with the Bank's <i>Guidelines on the Use of Consultants</i> .
<b>Estimated Project Completion Date</b>	:	31 October 2000
<b>Project Benefits and Beneficiaries</b>	:	The Project benefits will consist of an improved power supply in an environment friendly manner and, indirectly, improved and geographically balanced economic growth supported by the power supply. The Project will also promote environment friendly, energy efficient installations, both on the supply and demand sides. Further, the Project will improve the navigation conditions in the Yuanshui River downstream of the Wuqiangxi hydropower scheme. The beneficiaries of the Project will be existing and future industrial, commercial, and residential electricity consumers in Hunan Province, and the population using the Yuanshui River for navigation.
<b>Technical Assistance</b>	:	A technical assistance (TA) grant for \$400,000 will assist HEPC in improving its organization structure and management, accounting and financial management systems, and tariff levels and structure. A second TA grant for \$600,000 will assist the Government and the Shanghai Municipal Electric Power Company in introducing the BOO/BOT concept for the Shanghai Waigaoqiao Stage II Project.



## **I. THE PROPOSAL**

1. I submit for your approval the following Report and Recommendation on a proposed loan to the People's Republic of China (PRC) for the Hunan Lingjintan Hydropower Project. The Report also describes proposed technical assistance (TA) grants for: (i) institutional strengthening of the Hunan Electric Power Company (HEPC); and (ii) introducing the concepts of build-own-operate (BOO) and build-operate-transfer (BOT) for the Shanghai Waigaoqiao Stage II Project. If the proposed loan is approved by the Board, I, acting under the authority delegated to me by the Board, shall approve the TA grants.

## **II. INTRODUCTION**

2. The Government requested assistance from the Bank for the Hunan Lingjintan Hydropower Project during the 1992 Country Programming Mission to the PRC. Subsequently, two small-scale TA grants have been provided for the preparation of the Project.<sup>1</sup> Bank Reconnaissance and Fact-Finding Missions visited the country in July and November 1993, respectively. During the 1994 Country Programming Mission, the Government reconfirmed its request for Bank financing of this Project. An Appraisal Mission visited the PRC from April to May 1994,<sup>2</sup> and confirmed that the Project was feasible and suitable for Bank financing. Loan negotiations were held in Manila from 22 to 24 August 1994 with authorized representatives of the Government and HEPC. This Report is based on the findings of the TA consultants and the Bank's Missions, and discussions with representatives of the Government and HEPC.

## **III. BACKGROUND**

### **A. The Energy Sector**

3. The PRC is the third largest energy consumer in the world after the United States and Russia. In 1992, the PRC's annual primary commercial energy consumption totalled 769 million tons of oil equivalent (toe).<sup>3</sup> Coal is the most important source of commercial energy (76 per cent), followed by oil (17 per cent), hydroelectric power (5 per cent), and natural gas (2 per cent). The industry sector accounts for the largest share of consumption (67 per cent), followed by households (14 per cent), services (10 per cent), and agriculture (5 per cent). Energy resources are large, with estimated 900 billion tons of coal resources, 1,900 terawatt hours (TWh) per annum of hydroelectric potential, 80 billion tons of crude oil, 33 trillion cubic feet of natural gas, and uranium sufficient to sustain 15,000 megawatts (MW) of nuclear power for 30 years. Geothermal energy plays only a minor role in energy supply, although it is found in many regions of the country. Noncommercial biomass energy accounts for about one quarter of total energy consumption. The PRC's overall energy balance in 1992 is shown in Appendix 1.

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<sup>1</sup> TA Nos. 1734-PRC and 1950-PRC: Hunan Lingjintan Hydropower approved in July 1992 and September 1993, respectively.

<sup>2</sup> The Appraisal Mission consisted of K. Sakai (Senior Project Economist/Mission Chief), E. M. Baardsen (Project Engineer); K. Sridhar (Financial Analyst); J. Boyd (Senior Counsel); E. A. Cua (Senior Programs Officer); A. Akanda (Project Economist for resettlement issues); X. Xia (Investment Officer); and M. Gatti (Young Professional).

<sup>3</sup> Compared with 1,961 million toe in the United States and 815 million toe in Russia.

4. The PRC's annual per capita energy consumption (656 kilograms of oil equivalent [kgoe] in 1992) is low, at about one third of the world average. Energy shortages are endemic, particularly in the coastal growth corridor, and are a serious constraint to the PRC's reform and modernization programs. The Government is giving high priority to investments in the energy sector to ease this bottleneck. In 1992, Y 80.4 billion (\$14.6 billion)<sup>1</sup> was invested for capital construction in the energy sector. Of this, Y 49.0 billion (\$8.9 billion)<sup>1</sup>, or 61 per cent, was for power generation.

5. Although the PRC's energy consumption per capita is low, the consumption per unit of gross domestic product (GDP) is considered to be high, estimated at 1,561 kgoe per \$1,000 of GDP in 1990.<sup>2</sup> This reflects the high share in GDP of industrial output, the structure of industry, the use of inefficient technologies, and the inadequate energy management practices.<sup>3</sup> However, there have been considerable improvements in these areas. During 1980-1990, the PRC's energy intensity per unit of GDP fell by about 30 per cent. Nevertheless, further efforts to improve energy efficiency are crucial to sustain economic growth and the Government is making energy efficiency improvement the main focus of its energy sector strategy. Energy supply targets for the 1990s imply that about half of required incremental energy services will come from the additional energy supplies, while the other half will come from energy efficiency improvements.

6. Another focus of the Government's energy sector strategies is energy price reform, aimed at pricing energy at the economic cost of supply and providing market-based incentives to encourage the efficient use of energy. The price reform has been proceeding steadily, resulting in substantial increase in real energy prices. In the mid-1980s, a dual-track energy pricing system was introduced, in which energy supplies outside the national plan were charged at market prices, which were substantially higher than the administered prices. Over the years, the proportion of energy priced at market prices has increased, and at the same time, the administered prices have also been raised substantially. The Government intends to abolish the administered prices for the main forms of energy by the end of 1995, with the exception of a few consumer categories. Prices of coal and oil have already been liberalized in line with this policy.

## **B. The Power Subsector**

### **1. Overview**

7. The PRC is the fourth largest electricity producer in the world. Its installed capacity and annual electricity generation amounted to 180.9 gigawatts (GW) and 815.9 TWh in 1993, respectively, more than a half of the total of Bank DMCs. However, the PRC's per capita annual electricity consumption, 688 kilowatt-hours (kWh) in 1993, places it in the mid-range of Bank DMCs.<sup>4</sup> Electricity consumption in the PRC is dominated by industrial consumers. Heavy industry consumers accounted for 61.2 per cent of the electricity consumption in 1992, followed by light industry (15.9 per cent), residential (8.5 per cent), agricultural (6.8 per cent),

<sup>1</sup> At the average official exchange rate in 1992 of \$1.00 = Y 5.51.

<sup>2</sup> In constant 1985 US dollars.

<sup>3</sup> Although the PRC's energy intensity per unit of production is considered to be high, it is difficult to make accurate comparison with other developing member countries (DMCs) because of statistical distortions including those related to the exchange rate and the purchasing power and the estimates of the size of the service sector in PRC's national accounts. In 1985 constant US dollars, energy intensities in other DMCs in 1990 ranged from 106 kgoe to 517 kgoe per \$1,000 of GDP.

<sup>4</sup> Taipei, China - 4,433 kWh, Republic of Korea - 2,637 kWh, Malaysia - 1,384 kWh, Thailand - 853 kWh, Philippines - 337 kWh, India - 285 kWh, Pakistan - 284 kWh, Sri Lanka - 165 kWh (1992 figures).

public and commercial (5.8 per cent), and transportation and telecommunication (1.8 per cent). The relative importance of the industrial and agricultural consumers has been gradually declining, while that of residential consumers has increased. In 1992, 68 per cent of the population in the PRC had access to electricity.<sup>1</sup>

8. The dramatic growth of the PRC's installed capacity and annual electricity generation is shown in Table 1. From 1981 to 1993, the installed capacity grew at average annual rate of 8.1 per cent. Every year since 1988, 11,000 MW to 15,000 MW of generating capacity has been added. Despite this, the electricity supply has not been able to keep pace with the fast growing demand and the PRC is facing an acute power shortage, currently estimated at about 20 per cent of the demand.

**Table 1: Growth of Installed Capacity and Generation in PRC's Power Subsector**

Year	Installed Capacity			Electricity Generation				Annual Growth	
	Total (MW)	Hydro (%)	Thermal (%)	Total (TWh)	Hydro (%)	Coal (%)	Oil/Gas (%)	Electricity Generation (%)	GNP (%)
1980	65,869	30.7	69.2	300.6	19.4	59.3	21.3		
1981	69,133	31.7	68.3	309.3	21.2	58.7	20.1	3.0	5.0
1982	72,360	31.7	68.3	327.7	22.7	59.1	18.2	5.8	8.6
1983	76,445	31.6	68.4	351.4	24.6	59.1	16.3	7.3	9.6
1984	80,117	31.9	68.1	377.0	23.0	62.7	14.3	6.8	20.0
1985	87,053	30.3	69.7	410.7	22.5	64.6	12.9	9.6	8.0
1986	93,819	29.4	70.6	449.6	21.0	68.6	10.4	9.5	8.6
1987	102,897	29.3	70.7	497.3	20.2	70.4	9.4	10.0	10.2
1988	115,497	28.3	71.7	545.1	20.0	69.9	10.1	9.7	12.4
1989	126,639	27.0	73.0	584.7	20.3	70.4	9.3	5.4	2.8
1990	137,890	26.1	73.9	621.3	20.3	71.0	8.7	6.2	5.4
1991	151,473	25.0	75.0	677.5	18.4		81.6	8.7	7.2
1992	166,532	24.4	75.6	754.2	17.4		82.6	11.6	12.6
1993	180,915	24.0	76.0	815.9	17.0		83.0	8.4	13.3
Average Annual Growth	8.1%			8.0%				8.0%	9.4%

Source: Ministry of Electric Power

9. The generation mix of the installed capacity is 24 per cent hydropower and 76 per cent thermal power. In terms of annual electricity generation, the mix is 17 per cent hydropower and 83 per cent thermal. Reflecting the rich coal resources in the country and the Government's policy of saving oil for export, the share of coal-fired power has been increasing steadily. Coal-fired plants account for about 90 per cent of the installed thermal power capacity and electricity generation.

10. The PRC has adopted 500/220/110/35/10 kilovolt (kV) voltage levels for its transmission and distribution line systems. At the end of 1993, the PRC had 100,617 kilometer (km) circuit length of transmission lines above 220 kV, and 137,887 megavolt-ampere (MVA)

<sup>1</sup> Compared with Malaysia (84 per cent), Thailand (80 per cent), Philippines (62 per cent), Pakistan (38 per cent), Indonesia (35 per cent), and Sri Lanka (31 per cent).

of transformer capacity above 220 kV. The average transmission line losses were estimated at 8.3 per cent in 1993.<sup>1</sup>

## 2. Power Subsector Institutions

11. Within the Government, the Ministry of Electric Power (MOEP) is responsible for the power subsector. MOEP was created in March 1993 when the Ministry of Energy was reorganized into MOEP and the Ministry of Coal Industries.<sup>2</sup> The power system in the PRC comprises five regional networks, covering the northern, northeastern, eastern, northwestern, and central part of the country. Each regional network consists of two to four provincial grids. There are also ten independent provincial grids<sup>3</sup> (see Appendix 2). The five regional networks are placed under the regional network administrations, while the provincial grids are under provincial electric power bureaus. Consistent with the Government's economic and enterprise reform policies, regional electric power group corporations and provincial electric power companies have recently been established to manage and operate regional power networks and provincial power grids. These regional and provincial enterprises operate under MOEP, with the exception of three provincial power companies.<sup>4</sup> The Huaneng International Power Development Corporation (HIPDC) is also placed under MOEP and constructs power stations by mobilizing foreign funds through loans and joint venture arrangements. Electricity output from HIPDC power stations is sold to provincial power companies under contractual agreements. In addition, MOEP has a number of affiliated enterprises and research institutes which carry out work related to the power subsector. An organization chart of MOEP and its affiliated institutions is in Appendix 3.

12. Financial institutions providing funds for power development include the State Energy Investment Corporation (SEIC), which was created in 1988 to serve as a conduit for the allocation of Government's funds to energy projects. In April 1994, the debt financing function of SEIC was absorbed by the newly established State Development Bank (SDB) together with five similar investment corporations for other sectors. The role of SDB is to provide debt financing for the Government's priority development projects such as hydropower projects and projects located in inland provinces.<sup>5</sup> The People's Construction Bank of China (PCBC) also provides loans for power projects on commercial terms. It is expected that a State Investment Corporation will be established soon to undertake equity investments. In 1988, the Energy Conservation Company (ECC) was established under SEIC as a conduit of State funds for energy conservation projects. In April 1994, with the integration of SEIC into SDB, ECC was detached from SEIC and placed directly under SPC. ECC finances energy efficiency improvement projects for industries, including those related to electricity use.

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<sup>1</sup> This is the figure given in PRC statistics as the "average line loss rate" in 1993. The figure represents losses within those parts of power system which are under direct management of State power companies and could be interpreted more or less as transmission losses. Reliable data for distribution losses, inclusive of losses in the systems operated by local distribution entities, are not available. The World Bank estimates that the transmission and distribution line losses in PRC amount to 16 to 20 per cent. Line losses in other DMCs are: 4.5 per cent in Taipei, China, 5.4 per cent in the Republic of Korea, 10.2 per cent in Thailand, 10.3 per cent in Malaysia, 12.4 per cent in Indonesia, 12.5 per cent in the Philippines, 21.2 per cent in India, 22.2 per cent in Pakistan, and 28.8 per cent in Bangladesh (1992 figures).

<sup>2</sup> The petroleum and natural gas subsector is administered by the China National Oil and Natural Gas Corporation and the China National Offshore Oil Corporation, which have a status similar to that of a ministry.

<sup>3</sup> Including two grids belonging to autonomous regions.

<sup>4</sup> Guangdong Power Company, Hainan Power Company, and Xizang Industry and Power Administration.

<sup>5</sup> The current lending rate of SDB is 11.16 per cent per annum with repayment periods of 12 to 15 years. SDB is expected to have a soft loan window, for which lending terms have not yet been decided.

### C. Government Policies and Strategies

13. The Government's main objective in the power subsector is to develop adequate power facilities to support the country's economic growth and to increase people's access to the electricity in the rural area. During 1981 to 1993 electricity generation in the PRC grew at average annual rate of 8.0 per cent, while gross national product (GNP) grew at average annual rate of 9.4 per cent in real terms (see Table 1). During the rest of the 1990's, the Government aims to increase the electricity generation at the same rate as expected GNP growth (about 8 to 9 per cent). The Government also intends to improve the ratio of people having access to the electricity from 68 per cent in 1992 to 95 per cent in the year 2000. The total installed capacity in the year 2000 is expected to reach 300,000 MW and annual generation 1,400 TWh. To achieve this target, an average annual capacity addition of about 16,700 MW is necessary. To meet these objectives, the Government is implementing several strategic initiatives such as: (i) institutional reform; (ii) financing reform; (iii) tariff reform; (iv) network integration; (v) environment protection; and (vi) energy conservation.

14. **Institutional Reform.** The implementation of policy measures to restructure State-owned enterprises (SOEs), including those in the power subsector, accelerated in 1992 with the issuance of several provisional regulations in support of the 1988 State Industrial Enterprise Law. Among these were the Regulations on Enterprises' Shareholding System Experiment, Standards for Limited Share Companies, and Standards for Limited Liability Companies. In December 1993, the Company Law was enacted. The development of such a regulatory framework is indicative of the Government's ultimate objective of transforming the State enterprise system into a full-fledged independent corporate structure. The main thrusts of the reforms in the power subsector are to (i) give more autonomy to regional and provincial power utilities; (ii) gradually corporatize power utilities and transform the role of the Government from that of direct administration to indirect control through legal and regulatory mechanisms; and (iii) gradually commercialize power utility operations. The Government has been establishing regional electric power group corporations and provincial electric power companies and transferring the task of managing and operating power facilities from regional network administrations and provincial electric power bureaus to these regional electric power group corporations and provincial electric power companies. By 1993, provincial electric power companies were established in all provinces and autonomous regions, except for the Xizang Autonomous Region. At present, however, the provincial electric power bureaus and provincial electric power companies are run by the same management and staff. The situation is the same for regional network administrations and regional electric power group corporations. Therefore, the intended separation of subsector regulation from utility management has not been achieved yet. Plans to separate the company from the bureau, including management and staff, have been developed for Jiangsu Province and Zhejiang Province on an experimental basis and are expected to be implemented by 1995. The recent adoption of internationally accepted accounting principles is also expected to contribute to the institutional strengthening of SOEs, including power companies.

15. **Financing Reform and Private Sector Participation.** In the mid-1980s, the Government changed the funding method for power projects from State grants to loans from such institutions as SEIC and PCBC. In addition, the Government began to seek foreign investments in the subsector. In 1985, HIPDC was established to mobilize foreign funds, and provincial utilities were allowed to finance projects through the creation of joint venture companies with foreign investors. To encourage these new types of financing, the Government adopted a "new plant, new price" policy. This policy allowed electricity from power stations constructed with non-State funds to be sold at prices that would cover costs, including debt service requirements, and provide a reasonable profit.

16. Until 1992, private sector participation or foreign investment in power plants in the PRC was limited and confined mainly to Guangdong Province. Examples were the Shajiao B Power Plant, completed in 1987 by the Hopewell Holdings Ltd. of Hong Kong under the BOT scheme, and the Daya Bay Nuclear Power Plant, in which the Hong Kong-based China Light and Power has an equity participation. The low level of foreign investment in the past reflected the low State-fixed electricity pricing, foreign exchange restrictions, Government-controlled management of power bureaus, and lack of a regulatory framework.

17. The recent moves to corporatize the power subsector have encouraged the formation of joint ventures with foreign investors. One such joint venture is the Guangzhou Pearl River Power Company, for which the Bank has provided assistance.<sup>1</sup> Another example is the Shajiao C Power Station of Hopewell Holdings Ltd., for which the financing arrangements involved a number of international banks. A clear policy towards encouraging foreign investments in the power subsector was adopted by the Government in March 1993. The policy not only encouraged the formation of joint ventures, but also allowed 100 per cent foreign ownership of power plants anywhere in the PRC. Several joint-venture projects are reportedly under preparation and more than 30 projects have recently been earmarked for BOO/BOT. The Government's strategy also includes listing of power companies' shares in overseas stock exchanges. Shares of the Shandong Huaneng Power Generation Company have recently been listed in the New York Stock Exchange and three more companies are expected to be listed soon, one<sup>2</sup> in New York and two<sup>3</sup> in Hong Kong. The Government is also preparing to establish a new off-shore financial institution to mobilize foreign funds for investment in the development of the power subsector.

18. For foreign investments and internally generated funds of power corporations to become major sources of investment financing, additional policy measures in support of enterprise reforms need to be pursued in the areas of power pricing, foreign exchange management, and legal and regulatory framework. The introduction of a simplified and more rational tariff structure in Hubei and Hunan on an experimental basis, effective 1 April 1993, was a step in this direction. The Ministry of Finance issued instructions to SOEs to adopt financial accounting methods that are more in line with internationally accepted accounting principles, effective 1 July 1993. The use of these new accounting rules will enable potential foreign investors to understand clearly the financial status of the power companies and thus facilitate their investment decisions.

19. **Tariff Reform.** Electricity tariffs in the PRC are set on a province by province basis. The annual tariff proposals are prepared jointly by provincial power companies and provincial governments (provincial price administration bureaus) and submitted to the Government for joint review and approval by MOEP and SPC. The tariff system generally consists of three components: (i) State base prices, (ii) a price differential for non-State financed power, and (iii) a schedule of additional fees and surcharges. Part of the power outputs are sold directly from provincial power companies to consumers; the rest is sold through local distribution entities. Two types of tariff schedules are applied by provincial power companies: retail tariff schedules for the consumers, and wholesale tariff schedules for local distribution entities.

20. The State base prices, often referred to as the "listed prices", are the base prices issued in 1976 and charged for electricity generated by capacity financed by the State and

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<sup>1</sup> Investment 7087/1177-PRC, for which a loan of \$50.0 million was approved on 22 September 1992.

<sup>2</sup> HIPDC

<sup>3</sup> Shandong International Power Source Development Company and Datong Power Plant in Shanxi Province.

managed by provincial power companies. This capacity includes: (i) power plants constructed before 1985 with State grant financing; and (ii) plants constructed with loan funds from the State since 1985.

21. The price differential for non-State financed power is to cover the cost of power supply from the capacity not financed with funds allocated by the State. This includes power from capacity financed by provincial and local governments, including plants constructed under joint venture arrangements, power from independent plants such as those owned by HIPDC, power provided by various power plants above their contracted production quotas, and power supplied to the grid from captive industrial plants. Prices for the first two categories are based on costs including debt service requirements and reasonable profit ("new plant, new price" policy), while the prices for the latter two categories are set on a negotiated basis. The costs of these sources of power supply are added together and averaged into a price differential. The tariffs levied by provincial power companies are the summation of the State base prices and the price differential for non-State financed power. The price differential varies from locality to locality, depending on the configuration of plants supplying power to the area. As a result, different consumer tariffs are levied by the same provincial power company depending on the locality.

22. The actual prices paid by consumers include a variety of additional fees and surcharges. With the exception of 0.4 fen per kWh levy on all consumers throughout the country to help finance the Three Gorges Hydropower Project, these surcharges are levied by provincial and local governments for various purposes. They normally include surcharges for provincial power construction funds and local power construction funds as well as fees to cover local distribution costs and street lighting. The magnitude of surcharges varies depending on consumers, generally low for agricultural consumers, and high for industrial and commercial consumers. The surcharges account for 10 to 20 per cent of the prices paid by residential, commercial, and industrial consumers.

23. During the 1970s, electricity prices in the PRC remained practically unchanged, averaging about 7 fen per kWh. Since 1985, however, power tariffs have been adjusted upward in response to the increases in the price of fuel sources and in line with pricing reforms. A fuel surcharge was introduced to absorb increases in fuel prices and a "new plant, new price" policy was implemented. In 1993, a substantial increase in electricity tariff was effected through the reform of the State base prices. The main thrusts of the reform were:

- (i) The new State base price allows for power from all capacities financed with debt, including those financed with State-allocated funds, to be priced based on "new plant, new price" policy.
- (ii) The fuel surcharge introduced in 1985 was added only to the energy charge, while the capacity charge was kept unchanged. This resulted in the imbalance between the energy charge and the capacity charge, and did not provide incentives for consumers to improve load factors. In 1993, the accumulated fuel surcharges since 1985 were incorporated in the State base price and at the same time the imbalance between the energy charge and the capacity charge was corrected.

24. As a result of these reforms, the national average of the State base price was increased by about 33 per cent in 1993, from about 14.2 fen per kWh to about 19.5 fen per kWh. The average State base price varied from province to province, ranging from 25.3 fen per kWh in Jiangsu Province to 10.2 fen per kWh in Qinghai Province. Given the price differential and the surcharges added to the State base prices, the average electricity prices

actually paid at the consumer level have been much higher. In an urban area in Jiangsu Province, the average consumer price of electricity in 1993 was estimated to be about 37 fen per kWh (US¢4.3 per kWh at the present exchange rate).<sup>1</sup> In Hunan Province, where the proposed Project is located, the average consumer price of electricity is presently estimated to be about 29 fen per kWh (US¢3.3 per kWh). While the consumer price in Jiangsu is close to the long-run marginal cost (LRMC) of power supply,<sup>2</sup> that in Hunan appears inadequate to cover the LRMC (see para. 94).

25. The current tariff system is fairly complicated. The inclusion of various surcharges makes the cost of supply opaque and does not provide the right price signals to consumers. The diversity in the consumer tariffs from locality to locality makes it difficult for power utilities to administer tariffs. Furthermore, even in the same consumer category, consumption within the allocated quota is priced only at State base prices plus various surcharges, while consumption above the quota is priced with a price differential for non-State financed power. The Government intends to simplify tariffs gradually. As an experiment, a uniform and simplified tariff system was introduced in Hunan and Hubei provinces in 1993. Under this unified tariff scheme, the State base prices and the price differential for non-State financed power were integrated into uniform tariff schedules, and applied to all consumers in a given consumer category throughout the province regardless of consumption within the quota or above the quota<sup>3</sup> (see para. 92). After an evaluation of results, the scheme is expected to be gradually expanded to other provinces.

26. **Network Integration.** Coal, found mostly in the north, and hydropower resources, located mostly in the west, are the main sources of power generation in the PRC. While the railway system continues to play a critical role in transporting coal to the energy-deficient but industrialized eastern region, the power networks were not developed in an integrated manner. The existing network system includes five regional power networks and ten provincial power grids. The interconnection of these networks will reduce the need to transport coal long distances and will provide benefits to the various power systems in the form of compensation and regulation of peak-loads.

27. To enhance the efficiency of the power subsector and to alleviate the power shortages in the major load centers, the Government is actively pursuing interconnection among the various networks and grids. In 1990, the first 500 kV direct current link, which connects the Central China Network with the East China Network, was commissioned. Other 500 kV transmission projects are planned to link the coal-producing areas in the north to major urban centers, and the hydropower sites in the southwest to Guangdong. However, substantial investments will be required to construct the long-distance transmission lines required to achieve greater interconnection among the various networks and provincial grids.

28. **Environment Protection.** About three quarters of the PRC's primary commercial energy supply is from coal. Power generation is the largest consumer of coal in the PRC, accounting for more than a quarter of total annual coal consumption. This heavy dependence on coal is causing serious environmental problems at every stage of coal chain (mining, transport, combustion, and ash disposal). Air pollution in the PRC is largely related to the burning of coal. A survey conducted as part of the Global Environment Monitoring System found that five cities in the PRC -- Beijing, Guangzhou, Shanghai, Shenyang, and Xian -- were

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<sup>1</sup> Compared with Philippines (MERALCO) - US¢8.2 per kWh; Singapore (PUB) - US¢7.8 per kWh; Indonesia (PLN) - US¢7.2 per kWh; Malaysia (TNB) - US¢7.0 per kWh; and Thailand (MEA) - US¢6.5 per kWh (information compiled by the Bank in November 1993).

<sup>2</sup> Estimated by the World Bank at 35 to 40 fen per kWh.

<sup>3</sup> In some localities in Hubei, there still exist additional energy charges for the power from locally owned plants.

among the 20 most polluted cities in the world in terms of suspended particles and sulfur dioxide. Efforts are being made to reduce the power subsector's contribution to the problem. Apart from the mandatory environmental impact assessment for new power plants that has to be approved by the National Environmental Protection Agency (NEPA), the Government strategy in addressing coal-related environmental issues includes: (i) accelerating development of hydropower and other more environment friendly sources of power; (ii) constructing more thermal power plants with larger unit capacities that consume less coal per unit of power generated, particularly at the pitheads of large coal mines and at the ports and railway hubs; (iii) retrofitting smaller thermal units or replacing them with larger, less polluting, and more efficient plants; (iv) introducing advanced mining technology to improve the output and coal quality; and (v) incorporating advanced technology and equipment such as flue gas desulfurization (FGD) systems and electrostatic precipitators in power plants to reduce the emission of sulfur dioxide and other particulates. With regard to the use of FGD systems, several pilot projects such as those in Luohang, Sichuan Province, and Qingdao, are to be carried out in the next few years, particularly in areas where the sulphur content of coal is relatively high. These pilot projects should facilitate the development and wider utilization of FGD technology. Environmental protection is also being pursued through pricing reforms aimed at increasing cost-consciousness and strengthening the institutional capabilities of provincial bureaus tasked with environmental protection responsibilities.

29. **Energy Conservation.** Despite the 10 per cent reduction achieved during the 1980s, the electricity intensity in the PRC is still high<sup>1</sup> and there is a room for further reduction. Faced with an acute electricity shortage, the Government is placing an equal emphasis on energy conservation and on the addition of new supply capacity. Of the 140 TWh of electricity demand-supply gap projected in the year 2000, the Government plans to meet 70 TWh (about 4.5 per cent of the total demand) through energy conservation.

30. The institutions for energy conservation at the central level include the State Council, which sets basic policy directions; SPC, which is responsible for planning of conservation work and the allocation of funds for capital construction energy conservation projects; and the State Economic and Trade Commission (SETC), which is responsible for energy conservation management activities such as the promotion of energy initiatives through energy supply quota management and the allocation of funds for technical renovation energy conservation projects. The ECC under SPC, acts as a conduit for state funds for energy conservation projects. In the MOEP, the Department of Safety and Production Coordination is responsible for energy conservation. At the provincial level, provincial governments have offices for electricity allocation, conservation, and safety ("three electricity offices"), which operate under the guidance of provincial economic commissions in close cooperation with provincial electric power bureaus. These offices are responsible for administering power supply quota systems and overseeing electricity conservation work, including the efforts to monitor the adherence to unit electricity consumption standards and to promote the use of electricity efficient equipment.

31. Energy conservation efforts on the supply side of electricity have been concentrated on the reduction of unit coal consumption for thermal power generation. In 1992, the national average coal consumption decreased from the 1991 level of 424 grams (g) per kWh to 419 g per kWh, an improvement of 1.2 per cent. By contrast, the station use of electricity and line losses have not shown much improvement recently. Station use of electricity in 1992 was estimated at 6.7 per cent, about the same level as in 1988.

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<sup>1</sup> In 1990, the electricity intensity in the PRC was 1,575 kWh per \$1,000 of GDP in 1985 constant US dollars, while figures for other DMCs ranged from 185 kWh to 829 kWh per \$1,000 of GDP. However, as mentioned in footnote 3 to para 5, it is difficult to make accurate comparisons with other DMCs.

Improvements in line losses have been marginal, from 8.6 per cent in 1982 to 8.3 per cent in 1993. Because the majority of power facilities in the PRC use local equipment, efficiency improvements in the locally manufactured equipment is crucial and efforts are being made in this area.<sup>1</sup>

32. The PRC's energy conservation efforts on the demand side are carried out through administrative measures such as energy supply quotas, unit energy consumption standards, and the system of fines and subsidies. Each enterprise receives an allocation of annual power supply under the economic plan, commonly referred to as the quota for "in-plan" supply. Enterprises can consume more power than the quota by having access to "out-plan" power supply. However, the prices of "out-plan" supply are substantially higher than "in-plan" supply. Also, the "in-plan" supply is more secure in times of power shortages. Thus, through the energy quota system, the Government exercises pressure on enterprises to save electricity. In addition, the Government sets power consumption standards per unit of production, which are determined on an enterprise-by-enterprise basis. Fines are charged on enterprises that exceed the standards and the funds accumulated through these fines are used to subsidize enterprises carrying out electricity saving technical renovation projects. The PRC's energy conservation efforts from these direct administrative measures have been successful. However, the Government is now reviewing this approach in the light of ongoing reforms toward a more market-oriented structure of the power subsector. The substantial tariff increases in the 1990s have provided market-based incentives for energy conservation.

33. Demand side energy conservation is also pursued by manufacturing energy efficient appliances and equipment. The PRC now produces compact fluorescent lamps, although their quality still needs improvement and their use is limited because of the high prices (typically ten times higher than those of incandescent lamps). Given the recent rapid growth in electricity use for home appliances such as refrigerators, TVs, and air conditioners, efforts are being made to improve their efficiency. A high proportion of electricity use by industrial consumers is for electric motors. The stock of electric motors currently in use in the PRC is quite inefficient by world standards. However, recent models conform with international standards and have electricity efficiency ratings close to standards in the United States.

34. **Legal and Regulatory Reform.** The power subsector is governed by a number of laws, administrative rules and regulations, and policy circulars, which are not well coordinated. Many of these laws and regulations were enacted before the acceleration of subsector reforms and are not consistent with, or supportive of, the reforms. To address this problem MOEP has drafted a new Electricity Law, which is currently under review by the State Council and is expected to be enacted by 1995. The draft law reflects the Government's new strategies and is designed to: (i) separate Government administration and subsector regulation from power company management and operation; (ii) define the functions, rights, and obligations of power companies; (iii) specify general pricing principles; (iv) specify the project approval process; and (v) require a franchise license to engage in distribution services. The Company Law, and SOE-related regulations will also help define better the structure and regulation of power companies through amendments to the existing charters of these power companies.

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<sup>1</sup> For example, losses in recent models of transformer are about 1.2 per cent compared with 1.7 per cent for models produced before 1986.

#### **D. External Assistance**

35. Because of its importance in the national economy, the PRC's energy sector has been one of the largest recipients of capital and advanced technology financed through multilateral and bilateral sources. Most of this assistance has been used by the Government to expand and modernize the power subsector. The PRC is expected to continue to rely on external funding sources, including the Bank, during the 1990s when more large-scale power projects will be constructed.

36. The Bank has so far provided four loans totalling \$348.3 million for power projects in the PRC, seven project preparatory TAs totaling \$1.5 million and eight advisory TAs totaling \$3.5 million (see Appendix 4). The Bank's involvement began in 1987 with a fuel conversion project in Jilin Province (Loan No. 880-PRC). The project, which supported the PRC's policy of reducing dependence on oil for power generation by using domestically available coal, was completed in 1992, within the time schedule and below the cost estimate. The United Nations Development Programme (UNDP) financed a TA (TA No. 938-PRC) to the executing agency, the Huaneng Power Generation Corporation, an affiliate of HIPDC specialized in fuel conversion, to strengthen its capability in key areas such as technical and economic evaluation of thermal power projects, project management, and utility management. The Bank's second power subsector loan was for the Liulin Thermal Power Project in Shanxi Province (Loan No. 1091-PRC). The project included the construction of a 2 x 100 MW coal-fired power station to be operated by a newly established power company. Implementation of this project is well underway and no significant problems have been encountered. TAs were also provided to develop the institutional capability of this company (TA No. 1453-PRC) and to help Shanxi Province formulate a long-term power development plan (TA No. 1544-PRC).

37. The Bank's third loan in the power subsector was to the Guangzhou Pearl River Power Company, a Sino-foreign joint venture that was set up to construct a 2 x 300 MW coal-fired power station to alleviate power shortages in the booming Pearl River Delta (Investment No. 7087/1177-PRC). Through this private sector loan, the Bank played a catalytic role in promoting private sector investment in the power subsector. The project was successfully completed and has an excellent operational record. The fourth loan was for Guangzhou Pumped Storage Stage II Project, which was approved in August 1993 (Loan No. 1242-PRC). The project includes the construction of a 1,200 MW pumped storage hydropower scheme to provide a peak power capacity for Guangdong Province. The executing agency for the project is a joint venture company established with investments from the provincial power utility of Guangdong, which has been transformed into a shareholding company. The Bank also assisted the Government in arranging \$63 million of commercial co-financing for the project. Together with the loan, three TAs were provided to assist the executing agency and the Government in such areas as utility financial management information system (TA No. 1921-PRC), power sector tariff and financing reforms (TA No. 1922-PRC), and electricity end use efficiency (TA No. 1920-PRC). The Bank is also assisting the Government in a comprehensive review of the power subsector energy conservation activities in Jiangsu Province with the view to facilitating the adoption of improved demand-side management measures (TA No. 1867-PRC).<sup>1</sup>

38. In the energy sector, the Bank has provided TAs and loans to help the Government develop and implement an energy conservation program for the industry sector

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<sup>1</sup> In addition, up to 40 per cent of the Asian Infrastructure Fund, which is being established with Bank participation with the expected fund size of \$1 billion, can be allocated for infrastructure development in the PRC including power (Investments No. 7101: Asian Infrastructure Fund and No. 7102: Asian Infrastructure Fund Management Company approved in April 1994).

and an urban environmental improvement program directly related to energy use. The Bank has also provided TAs to assist the Government in carrying out integrated planning and policy analysis of the long-term development of the energy sector and in developing an energy utilization strategy for the rural areas based on renewable energy sources (see Appendix 4).

39. As of 30 June 1994, the World Bank had provided \$2.7 billion for 14 power projects comprising 13 large generation projects (seven hydro and six thermal) and one transmission line project. Besides contributing to capacity addition and network integration, the World Bank is helping executing agencies introduce modern technologies in project construction and management, improve the efficiency of pollution control, improve operational efficiency, and introduce modern financial management practices and marginal cost pricing principles. The World Bank's sector work and policy dialogue are focused on power pricing, enterprise reform, and energy conservation.

40. Other major sources of external assistance include Japan, which through the Overseas Economic Cooperation Fund (OECF) has provided Yen 159.7 billion (\$1.6 billion) for five projects (four hydropower projects and one thermal power project).<sup>1</sup> France and the United Kingdom are actively providing assistance to the PRC's power subsector, including the Daya Bay Nuclear Power Station in Guangdong. Canada, Italy and Spain, and the United States have also provided assistance to the power subsector.

41. The Bank coordinates its operations in the power subsector with other aid agencies, particularly in the policy areas with the World Bank. Both the Bank and the World Bank have emphasized the importance of improved management of power utilities, tariff reforms, efficiency improvement, environment protection, and greater role for the private sector. The proposed Project is complementary to a hydropower project financed by OECF, for which it will provide a reregulating station.

## **E. Lessons Learned**

42. Of the four loans and fifteen TAs provided by the Bank in the PRC, two loans and five TAs have been completed. A Project Completion Report (PCR) and a Project Performance Audit Report (PPAR) have been prepared for one loan (Loan No. 880-PRC: Fuel Conversion Project).<sup>2</sup> The PCR found that physical implementation was smooth and efficient, but there was a need to improve financial reporting and attention to environmental matters. This has been confirmed by the PPAR, which also indicated that the Project was generally successful, achieved the objective of substituting exportable domestic oil with local coal for power generation, and was economically viable. Of the five completed TAs, three were project preparatory TAs. Two of them led to the successful processing of loan projects and the other one was for the proposed Project. Two advisory TAs have successfully contributed to the human resource development by providing training for the staff of the power utility and design institute in such areas as project engineering, project management, and economic and financial analysis.

43. The World Bank has also found that most of the power projects in the PRC that it has financed have been implemented in a satisfactory manner, on schedule, and within budget. The lessons learned by the World Bank include the need to: (i) improve procurement and contractual arrangements; and (ii) enhance the role of project management and of consultants.

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<sup>1</sup> In addition, OECF provided \$186 million for one multipurpose dam project involving power supply.  
<sup>2</sup> PCR dated 25 October 1993 and PPAR dated 24 August 1994.

44. While physical implementation of the projects has been smooth, the Bank has found that the financial management of power utilities is generally weak including data collection and management reporting. This indicates the need to increase Bank staff time or staff consultant inputs during Bank project processing for discussions about the financial aspects of the projects. There is also a need for institutional strengthening focused on strengthening of financial management, including assistance to introduce internationally accepted accounting practices.

## **F. Bank Sectoral Objectives and Strategy**

45. The central theme of the Bank's operational strategy in the PRC is to assist the country to achieve economic growth in an efficient, equitable, and sustainable manner. Accordingly, three strategic objectives - efficiency improvement, environment protection, and poverty reduction - provide the focus for Bank operations in the PRC. The strategy supports the PRC's ongoing program of market-oriented reforms to raise productivity and efficiency and address the critical issues associated with economic growth such as the growing disparities in regional income and degradation of the environment.<sup>1</sup> Improvements in efficiency will be pursued by alleviating the institutional, policy and physical constraints in key infrastructure sectors (e.g., energy, transport, and communications) that are impeding efficient and sustained growth.

46. In the energy sector, the Bank's operational strategy seeks to support the Government's two-pronged energy development program aimed at expanding energy supplies and promoting energy conservation. The Bank is paying special attention to the power subsector because it is in urgent need of: (i) further expansion to overcome the prevailing power shortages, and (ii) modernization to enhance sector-wide efficiency. Energy conservation in the power subsector and the industrial sector, the two largest consumers of energy and the major sources of environmental pollution, is also a primary thrust of Bank operational strategy. In addressing environment-related issues associated with the coal-dominated energy structure in the PRC, the Bank is helping the Government to develop more environment-friendly energy sources, including the country's hydropower resources, and facilitating the transfer of more advanced and appropriate pollution abatement equipment in the design of thermal power plants. The need to develop the power supply to support the growth of less developed inland provinces in the PRC is given due recognition in the Bank's operational strategy. The Bank is also helping promote private sector participation in the energy sector, especially in the power subsector, which has recently been opened up to foreign investors.

47. The Bank is also supporting the ongoing policy reforms including the adoption of a more rational pricing structure for energy products. In addition, the capabilities of concerned Government agencies involved in system planning, project design, and demand management need to be strengthened. The institutional development of power utilities, which have recently been corporatized in line with enterprise reforms, will remain an integral part of the Bank's operations in the power subsector. In particular, the introduction of modern

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<sup>1</sup> The Bank, through TA No. 1436-PRC: Environmental Impact Assessment and Training has played a leading role in strengthening the PRC's environmental impact assessment (EIA) procedures and in formulating and reviewing draft legislation on EIAs. The Bank is also addressing the problem of air pollution through urban environment improvement and industrial modernization projects (Loan No. 1178-PRC: Industrial Energy Conservation and Environmental Improvement, Loan No. 1205-PRC: Qingdao Environmental Improvement; Loan No. 1270-PRC: Tangshan and Chengde Environmental Improvement; and Loan No. 1162-PRC: Lai-Wu Iron and Steel Mill Modernization and Expansion).

concepts of utility management will enable power companies to operate and manage power plants in a more efficient and commercially-viable manner.

## **G. Policy Dialogue**

48. Within the framework of the Bank's operations in the energy sector, the policy dialogue has been designed to support and reinforce the Government's reform program described earlier. The Bank's agenda for policy dialogue includes: (i) pricing and tariff reforms; (ii) power subsector institutional reforms; (iii) mobilizing private sector resources for the power subsector development; and (iv) energy conservation and environmental protection.

49. The rationalization of energy prices has been discussed in conjunction with recent Bank loans in the energy sector and the power subsector. In connection with the Industrial Energy Conservation and Environment Improvement Project (Loan No. 1178-PRC), the Government agreed to abolish State-administered prices for energy sources including coal, petroleum, and electricity by the end of 1995 for all major energy intensive enterprises. Under the Qingdao Environmental Improvement Project (Loan No. 1205-PRC) and the Tangshan and Chengde Environment Improvement Project (Loan No. 1270-PRC), consumer subsidies for coal were eliminated in the project areas and town gas prices were adjusted to ensure full cost recovery of the projects. Under the power subsector projects, the Government adopted the principle of full cost recovery in pricing the electricity output from the projects. Under the 1993 tariff reforms, this policy was expanded to all power plants and a simplified, uniform tariff system was introduced in Hunan and Hubei provinces on an experimental basis. During the processing of Guangdong Pumped Storage Stage II Project, the Government indicated that further reforms would be implemented including the extension of the simplified tariff system to other provinces. In support of this initiative of the Government, the Bank provided a TA for Support for Power Sector Tariff and Financing Reforms, to enable MOEP and provincial power companies to assess the adequacy of tariff levels in relation to LRMC of power supply and financial requirements for sound utility management. During the processing of the proposed Project, the Government indicated that the tariff setting based on LRMC would be experimented in Shandong Province, which had been selected as a sample for detailed study under the TA.

50. The policy dialogue related to institutional reform has been complemented by loans that supported the executing agencies established under the Government's reform initiatives. During the processing of the proposed Project, discussions were held about the measures necessary to implement the autonomous status recently granted to provincial power companies. The discussions identified two areas that need improvement: a clearer separation of power companies from the power bureaus, and strengthening the financial management of power companies. Financial planning was not adequate, as demonstrated by the current practice of setting the tariffs based on the previous years' operational results rather than on financial projections for the future. Following the discussions, the Government requested a TA for institutional strengthening of the executing agency including the preparation of a program for separating the functions, responsibilities, and work force of the executing agency from the provincial power bureau. The TA will also focus on the strengthening of financial management of the executing agency (see para. 98).

51. The policy dialogue about the financial reforms and utilization of private sector resources has been complemented by loans and TAs. The Bank has provided one loan under its private sector operations and the executing agency for another Bank loan was a joint venture company (see para 37). Under the TA for Support for Power Sector Tariff and Financing Reforms, the Bank provided assistance to MOEP for organizing seminars on foreign

investment, and corporatization and shareholding options.<sup>1</sup> The discussions during the processing of the proposed Project focused on the need to develop an appropriate regulatory framework for BOO/BOT projects in the power subsector, and to introduce competitive procedures for the selection of project sponsors. Following these discussions, the Government agreed to test these concepts for the Shanghai Waigaoqiao Thermal Power Stage II Project and requested a Bank TA for this purpose (see para. 99).

52. In the area of energy conservation, the Bank has been emphasizing improvements in end-use efficiency through demand side management (DSM). The dialogue has been complemented by two ongoing TAs.<sup>2</sup> Although these TAs are for specific provinces, the findings of the studies will provide useful inputs in the formulation of energy conservation strategies at the central level and energy conservation programs in other provinces. The discussions during the processing of the proposed Project also focused on the need to strengthen energy conservation activities of the executing agency and a component for that purpose has been included in the scope of the Project.

#### IV. THE PROJECT

##### A. Concept

53. The Project is the most downstream development of a series of 17 hydropower schemes to be constructed on the main stream and tributaries of the Yuanshui River. Of these, the Fengtan hydropower plant (400 MW) is in operation and the Wuqiangxi hydropower plant (1,200 MW) is under construction. The Project will provide a run-of-river type hydropower generating plant. The plant will also serve as a reregulating station for the Wuqiangxi hydropower plant located immediately upstream and will improve river navigation downstream of Wuqiangxi. The Project will also strengthen the energy conservation activities of the Executing Agency, Hunan Electric Power Company (HEPC).

##### B. Rationale

54. The PRC is facing severe shortages in electricity. The main problem is insufficient capacity to meet the rapidly growing demand. The inability to meet the peak demand is necessitating load shedding and causing serious loss to the economy. These problems are common in the power system in Hunan Province. Its daily load curve for the day with the maximum load in 1993 shows that the minimum load was about 60 per cent of the maximum load, much higher than the more usual ratio of 40 to 50 per cent. This indicates a high degree of load shedding and the existence of suppressed demand in the system. The situation is expected to be aggravated because of the rapid growth in demand in the system, in particular by residential consumers, as a result of sustained economic growth.

55. The Government has placed a high priority on developing the power system and on improving the efficiency in the supply and use of electricity. Given the environmental

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<sup>1</sup> A seminar on foreign investment, focused on BOO/BOT schemes, is scheduled for early September 1994 and one on corporatization and shareholding options in early 1995. In addition, under TA No. 1850-PRC: Conference on the Roles of Planning and the Market in Economic Management, the Bank provided support to SPC in organizing an international conference on BOT investment program for infrastructure development including power.

<sup>2</sup> TA No. 1867-PRC: Power Subsector Energy Conservation Study in Jiangsu Province, which focused on identification of barriers preventing the successful introduction of DSM, and TA No. 1920-PRC: Electricity Efficiency Study (for Guangdong Province), which focused on a survey of demand behavior and load patterns.

problems caused by the reliance on coal, the Government has been placing particular importance on the accelerated development of hydropower. These priorities will be supported by the proposed Project, which will provide the Hunan power system with the needed dependable peak supply capacity through a least-cost and environmentally sound solution. The Project will also strengthen electricity conservation activities to control the growth in demand. Together with the TA provided in conjunction with the loan, the Project will help the newly-established HEPC develop into an autonomous, commercially-oriented power company and improve its tariff structure, in line with the Government's economic reforms.

### **C. Objectives**

56. The principal objective of the Project is to accelerate the development of hydropower resources in Hunan Province through the provision of an additional power generating capacity of 240 MW and a reregulating station for a 1,200 MW hydropower scheme. The Project objectives also include institutional development of HEPC as well as tariff policy and energy conservation reforms in Hunan Province.

### **D. Scope**

57. The components of the Project consist of the following: (i) civil works associated with the hydropower plant and reregulating station consisting primarily of a structure about 1,006 meters (m) long and 53.5 m high across the Yuanshui River plus ancillary components, including concrete and earth-fill dams, flood sluice, a shiplock, docking facilities, and power house, together with access road, switchyard, and ancillary structures; (ii) supply and installation of eight 30 MW bulb turbine units; (iii) supply and installation of associated generator sets and ancillary equipment; (iv) supply and installation of auxiliary equipment including switchgear, communications, and power plant control systems; (v) supply and installation of metal structures including sluice gates, gates at the shiplock, cranes, steel trash racks and rakes; and (vi) land acquisition, resettlement of affected people, and improvement of adjacent infrastructure and ancillary facilities.<sup>1</sup> The Project also includes consulting services and training.

### **E. Project Area**

#### **1. Background**

58. The proposed Project is located in the northern part of the inland province of Hunan, the PRC's seventh largest province. Hunan has an estimated population of 62.1 million, 84.1 per cent of whom live in rural areas. Although it has abundant nonferrous mineral resources and is the PRC's biggest rice producer, Hunan remains one of the PRC's poorest provinces. Despite the 8.4 per cent average annual growth of provincial GDP recorded during the past ten years (1983-1992), the average income per capita, Y 1,240, is 26 per cent less than the national average. The provincial Government has classified 30 counties as poverty-stricken, including eight counties that receive financial assistance directly from the central Government. The net rural income per capita in these eight counties is far below the national average. It ranges from Y 391 in Xinhua to Y 862 in Liuyang in 1992. In line with its strategy to promote more balanced regional development, the central Government has been increasing its investment allocation for infrastructure development, including transport, communications, and

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<sup>1</sup> The associated transmission lines, consisting of two single circuit 220 kV lines with a total length of about 185 km, will be constructed with funding from the Government.

power in the poorer inland provinces such as Hunan.<sup>1</sup> While agriculture still employs the largest segment of the labor force in the province (68 per cent), its share in the provincial GDP has been decreasing; in 1992, the share of the industrial sector (38 per cent) surpassed that of the agriculture sector (35 per cent). Improvements in infrastructure facilities are essential to help create the conditions necessary to support further development of the industrial sector. To help attract foreign investments to the province, in 1992, the central Government made Changsha, the provincial capital, an open city with privileges similar to those granted to the fourteen coastal cities in the early 1980s. This will help accelerate economic reforms and economic growth in Hunan Province.

## 2. Hunan Power System

59. The power system in Hunan Province forms part of the Central China Power Network. Other provinces belonging to the network are Hubei, Henan, and Jiangxi. The total installed capacity in Hunan Province in 1993 was 6,658 MW, of which half (3,296 MW) was hydropower and the other half (3,362 MW) thermal power. The annual electricity generation in 1993 was 27,271 GWh, of which 12,672 GWh (46 per cent) was by hydropower and 14,599 GWh (54 per cent) was by thermal power. The provincial network includes 24,839 km of transmission lines, including 301 km of 500 kV line, and 13,390 MVA of transformer capacity. About 54 per cent of generating capacity, 71 per cent of transmission lines, and 91 per cent of transformer capacity are owned by HEPC. Most of the remaining facilities belong to and are operated by county governments.<sup>2</sup> Electricity sales in 1992 were 28,001 GWh (including the electricity imported from other provinces), or 450 kWh per capita. Transmission line losses in 1992 were estimated at 9.9 per cent. The major consumer groups are industrial (77 per cent), residential (10 per cent) and agricultural (8 per cent). The province is facing power shortages, especially for peaking power, and power shedding is frequent.

60. Energy generation and energy imports/exports of the Hunan power system in the past 10 years are shown in Table 2. The net energy supply in the system (generation plus imports minus exports) increased from 14,429 GWh in 1984 to 28,812 GWh in 1993, or at the average annual growth rate of 8.0 per cent. The annual growth rate has exceeded 9.0 per cent during the last two years. During the same period, the total installed capacity in the system increased from 3,823 MW to 6,657 MW, or at an average annual growth rate of 6.4 per cent. The average annual growth rate of energy supply during 1984-1992 (7.8 per cent) was slightly lower than that of provincial GDP.

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<sup>1</sup> Hunan is the beneficiary of Loan No. 1261-PRC: Hunan Expressway and is one of the inland provinces covered under Loan No. 1243-PRC: Telecommunications Project.

<sup>2</sup> There is also a 700-MW coal-fired plant owned and operated by HIPDC.

**Table 2: Energy Generation, Imports/Exports of the Hunan Power System (In GWh)**

Year	(A) Energy Generation	(B) Energy Imports	(C) Energy Exports	(D) Net Energy Supply (A) + (B) - (C)	Annual Growth	
					Electricity Generation (%)	Provincial GDP (%)
1984	13,847	614	32	14,429		
1985	14,717	979	106	15,590	8.1	12.0
1986	15,195	1,436	23	16,608	6.5	8.1
1987	16,140	2,234	8	18,366	10.6	9.3
1988	17,312	2,758	27	20,043	9.1	8.2
1989	18,334	3,072	127	21,279	6.2	3.6
1990	20,140	2,573	85	22,628	6.3	4.0
1991	22,125	2,185	202	24,108	6.5	7.8
1992	24,478	2,018	189	26,307	9.1	12.3
1993	27,271	1,894	353	28,812	9.5	*
Average Annual Growth					8.0	8.1

\* Provincial GDP in 1993 not yet published.

### 3. Load Forecast and Capacity Expansion Plan

61. The requirements for power system expansion prepared by Hunan Province Electric Power Bureau (HPEPB) and Mid-South Design and Research Institute for Hydroelectric Projects (MSDI)<sup>1</sup> were reviewed by the Mission. The analysis carried out by HEPC and MSDI took into account past load growth, planned provincial GDP growth, and power demand projections for each consumer category based on sectoral plans prepared by the Provincial Planning Commission. The results of the analysis are summarized in Table 3. Annual energy demand in the Hunan system is forecast to reach 69.5 TWh in the year 2003, equivalent to an average annual growth rate of 9.2 per cent from the 1993 level. This compares with the projected provincial GDP growth of 10.0 per cent per annum. The share of industrial consumers is projected to decrease from the present level of 77 per cent to 66 per cent, while that of residential consumers will increase from 10 per cent to 16 per cent. The share of commercial and other service sector consumers is expected to increase from 6 per cent to about 10 per cent. The share of agricultural consumers will remain at about 8 per cent. The system peak load is projected to grow from about 5,500 MW in 1993 to 12,640 MW in the year 2003.<sup>2</sup>

<sup>1</sup> MSDI is an affiliate institution of the Ministry of Electric Power and the Ministry of Water Resources.

<sup>2</sup> It has been assumed that, despite the increasing share of residential consumers, the system load factor will remain at about 63 per cent because of DSM.

**Table 3: Load Forecast for Hunan Power System**

Year	Annual Energy Demand (TWh)	Peak Load (MW)
1993	28.8 <sup>a</sup>	5,500 <sup>b</sup>
1996	38.6	7,020
1997	42.1	7,660
1998	46.0	8,360
1999	50.3	9,150
2000	55.0	10,000
2001	59.5	10,820
2002	64.3	11,690
2003	69.5	12,640
Average Annual Growth	9.2%	8.7%

<sup>a</sup> Actual<sup>b</sup> Estimate

62. HEPC's expansion plan in Appendix 5 is based on these forecasts. The plan shows capacity additions of 7,390 MW during 1994-2003, consisting of 1,440 MW of hydropower and 5,950 MW of thermal power. Despite the capacity addition, the reserve margin will decrease from the current level of 20 per cent to about 10 per cent in 2003. To some extent, this decrease in the reserve margin reflects the changes in the capacity mix with a higher share of thermal units. However, the 10 per cent reserve margin is very low and implies that the capacity in 2003 would still be inadequate, even without taking into account suppressed demand. In view of this, and given the current acute power shortages and expected rapid economic growth, the risk of overcapacity is marginal. The plan includes only two hydropower projects, the Wuqiangxi project, which is now under construction, and the proposed Project. Thus the Project is one of the core projects of the expansion plan and would be justified even in the case of slower demand growth than projected. The Project is also needed to strengthen the peaking capability of the Hunan system.

63. The plan is quite ambitious in comparison with the present capacity level and in terms of its financing requirements. The installed capacity in 2003 is expected to more than double from the 6,657 MW in 1993 to 14,047 MW and the investment requirements are estimated at Y 32.6 billion (about \$3.7 billion), excluding those to reinforce the network (transmission and distribution).<sup>1</sup> The implementation of the plan requires strengthening of HEPC's institutional capability, including financial management and enhancing its funding resources. The institutional strengthening TA (see para. 98) and proposed loan covenants (see para. 90) will help HEPC to address these requirements.

<sup>1</sup>

This amount includes only the investments required for the plants to be commissioned by 2003. Investments for the plants to be commissioned after 2003 are not included. The total capital expenditures by HEPC during 1994-2003, including those for plants to be commissioned after 2003 and to reinforce the network, are estimated at Y 54.2 billion.

#### 4. Energy Conservation

64. The Hunan Provincial Government and HEPC are actively pursuing energy conservation measures. HEPC's Energy Conservation Office prepares annual plans for both supply and demand side energy conservation. The supply side plan focuses on reduction in unit coal consumption, station use of electricity, and line losses. HEPC's unit coal consumption for thermal generation decreased from 533 g/kWh in 1989 to 487 g/kWh in 1993. During the same period, station use of electricity decreased from 5.7 per cent to 5.6 per cent<sup>1</sup> and line losses from 9.8 per cent to 9.4 per cent. On the demand side, HEPC closely coordinates with the "three electricity offices" (see para. 30) at provincial, prefecture, and county levels. Activities for demand side energy conservation include information campaigns, energy audits, the promotion of energy efficient equipment, and a mechanism of penalties and subsidies to encourage energy conservation. HEPC publishes a monthly magazine entitled "Modern Energy Conservation", which provides information regarding the Government's policies and programs for energy conservation as well as technical discussions and advice on energy conservation measures. The magazine is widely disseminated throughout the country. The Project includes an energy conservation component to strengthen HEPC's energy conservation activities by improving energy conservation planning and exposing HEPC staff to modern demand side management and integrated resource planning concepts and techniques.

#### F. Technical Justification

65. The Linjintan hydropower plant is designed as a low head run-of-river type plant having a reservoir for daily pondage with an active storage capacity of 55 million cubic meters (m<sup>3</sup>). The installed capacity will be 240 MW and the average annual energy output will be 1,173 GWh, of which 462 GWh will be firm. The power plant will have eight 30-MW bulb turbine units. Bulb turbines are commonly used in low head run-of-river plants in large rivers such as the Yuanshui and the technology is well proven. Turbine suppliers in the PRC have manufactured several smaller units. However, the design head of the Lingjintan plant is quite low (8.5 m) requiring a large runner diameter (6.9 m). Because no firm in PRC has experience in manufacturing such large units, foreign suppliers will be invited. The suppliers will be encouraged to cooperate with local manufacturers to transfer technology.

66. The main dam will be 1,006 m long across the Yuanshui River and consist of a concrete gravity dam, flood sluices, and a river-type power house. To allow navigation to continue after the dam has been built, there will be a 1000-ton capacity shiplock on the right bank. It will have an annual cargo capacity of 2.5 million tons per year. Each lift will be able to handle two fleets of 500-ton barges. The thick overburden on the left bank requires an earth dam to be constructed there as a continuation of the concrete gravity dam/sluices/power house structure. The concrete structures, gates, and the earth dam are of conventional design and within the PRC's contractors' capabilities.

67. The reservoir to be created under the Project will reach the Wuqiangxi plant located 47.5 km upstream. The Wuqiangxi plant has been designed as a 1,200 MW installed capacity peaking plant. Without the Lingjintan reservoir, the Wuqiangxi power plant would have to release 380 cubic meters/second (m<sup>3</sup>/s) of water through the turbines (generating about 150 MW) continuously throughout the day for base load supply (1,248 GWh a year). This is necessary to guarantee a minimum water depth for downstream navigation. The maximum capacity and the dependable peaking capacity would then be 1,050 MW and 650 MW

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<sup>1</sup> Station use of thermal power stations improved from 10.1 per cent to 9.6 per cent, while that of hydropower stations went up from the low level of 0.18 per cent to a more usual level of 0.32 per cent.

respectively.<sup>1</sup> The Lingjintan reservoir will improve navigation because it will submerge the rapids located between Wuqiangxi and Lingjintan, even at its lowest regulated level, while releasing 380 m<sup>3</sup>/s of water (equivalent to 40 MW) for downstream navigation purposes. As a result, the maximum capacity of Wuqiangxi will be increased from 1,050 MW to 1,200 MW and the dependable peaking capacity from 650 MW to 800 MW, enabling Wuqiangxi to annually supply 1,248 GWh of firm energy during peak hours. Thus, the Project will avoid the need to construct expensive and more environmentally adverse thermal peaking power.

## G. Cost Estimates

68. The cost estimates for the Project are summarized in Table 4 and detailed in Appendix 6. The total cost of the Project is estimated at \$366.8 million equivalent, of which \$129.5 million (35.3 per cent) is the foreign exchange cost and \$237.3 million equivalent (64.7 per cent) is the local cost.

**Table 4: Summary of Project Costs**  
(\$ million)

Item	Foreign Exchange Cost	Local Currency Cost <sup>b</sup>	Total
<b>A. Base Cost <sup>a</sup></b>	89.7	149.2	<u>238.9</u>
<b>B. Contingencies</b>			
1. Physical Contingencies	4.4	11.6	16.0
2. Price Contingencies	<u>12.0</u>	<u>18.6</u>	<u>30.6</u>
Base Cost + Contingencies	106.1	179.4	285.5
<b>C. Interest During Construction</b>	<u>23.4</u>	<u>57.9</u>	<u>81.3</u>
<b>TOTAL PROJECT COST</b>	<u>129.5</u>	<u>237.3</u>	<u>366.8</u>

<sup>a</sup> Base cost is based on October 1993 prices.

<sup>b</sup> Dollar equivalent of local cost is based on the exchange rate of \$1 = ¥ 8.70

## H. Financing Plan

69. The proposed financing plan for the Project is shown in Table 5. The \$116 million Bank loan would finance 89.6 per cent of the foreign exchange costs and 31.6 per cent of the total costs of the Project. All the local costs would be financed by loans from the Hunan Provincial Government (HPG) and the State Development Bank (SDB). The loans from the HPG and SDB are expected to have a repayment period of 12 years, including a grace period until the first generating unit under the Project is commissioned, with an interest rate of 3.6 per cent for HPG and 11.16 per cent for SDB.

<sup>1</sup> The Wuqiangxi power plant can generate 1,200 MW during the rainy season when the reservoir water level is high. Without Lingjintan, however, 150 MW would be used for base load supply, and the maximum peaking capacity would be 1,050 MW. As the water level drops in the dry season, the maximum output would also drop. Dependable capacity is the output that can be guaranteed at least 95 per cent of the time. For Wuqiangxi, this is 1,020 MW. Because 220 MW needs to be kept as a spinning reserve, the dependable peaking capacity would be 800 MW with Lingjintan and 650 MW without Lingjintan.

**Table 5: Financing Plan**  
(\$ million)

Source	Foreign Exchange Cost	Local Currency Cost	Total	%
Bank	116.0	-	116.0	31.6
SDB	6.8	118.7	125.4	34.2
HPG	<u>6.8</u>	<u>118.7</u>	<u>125.4</u>	34.2
Total	<u>129.5</u>	<u>237.3</u>	<u>366.8</u>	<u>100.0</u>

70. The Borrower of the Bank loan will be the PRC. The loan will be denominated in US dollars and will carry an interest rate to be determined in accordance with the Bank's pool based variable lending rate system for US dollar loans and a commitment charge of 0.75 per cent per annum in accordance with current Bank policy. The loan will have a repayment period of 25 years including a grace period of six years.

71. The Bank will enter into a Loan Agreement with the Borrower and a Project Agreement with HEPC. The Borrower will relend the proceeds of the Bank loan to HEPC under a subsidiary loan agreement with terms and conditions satisfactory to the Bank, and with a guarantee from the HPG. The HEPC will bear the foreign exchange and interest variation risks.

## **I. Project Implementation**

### **1. Implementation Arrangements**

72. HEPC will be the Executing Agency for the Project. HEPC has formed a Lingjintan Project Construction Office within the Wuqiangxi Project Construction Unit, and the Assistant General Manager of the Wuqiangxi Project Construction Unit has been appointed as the head of this office. Before the start of the main construction work, this office will be upgraded to an independent construction unit under HEPC. A senior staff member of HEPC, with experience and qualifications acceptable to the Bank, will be appointed as the head of Lingjintan Construction Unit. A sufficient number of qualified staff will be provided by transferring staff from the Wuqiangxi Construction Unit whose activities are to be wound down. This process will ensure the transfer to this Project of experience and skills gained during construction of the Wuqiangxi plant. The MSDI, which is well experienced in the design of hydropower plants, carried out the feasibility study for the Project and will continue to be responsible for the engineering design of the Project. The civil works and installation of equipment will be carried out by local contractors, while the supply and installation supervision of the electro-mechanical equipment and instrumentation will be carried out by international manufacturers. Because the PRC lacks experience in handling bulb turbines of this size, a firm of international consultants will be engaged to assist HEPC in implementation supervision.

### **2. Implementation Schedule**

73. The Project implementation schedule is in Appendix 7. The first generation unit of the Project will be commissioned in 1998. The last unit will be commissioned by 31 October 2000.

### 3. Procurement

74. A list of indicative contract packages for the Project is in Appendix 8. For the Bank-financed electromechanical and auxiliary equipment, procurement will be undertaken through international competitive bidding (ICB) and international shopping (IS) in accordance with the *Bank's Guidelines for Procurement*.<sup>1</sup> In response to Government requests, fixed price contracts will be used for all procurement. For the purpose of technology transfer, suppliers will be encouraged to associate closely with local manufacturers through joint operation or subcontracting arrangements. The equipment to be financed by HPG and SDB will be procured under international and local competitive procedures acceptable to the Bank. Civil works and erection will be carried out by local contractors to be selected by HEPC under local competitive procedures acceptable to the Bank.

75. For the procurement of Bank-financed equipment, HEPC has engaged experienced procurement agents in accordance with the PRC's regulations for import of foreign goods.<sup>2</sup> The procurement agents will carry out procurement on behalf of HEPC and sign and execute the procurement contracts.

### 4. Consulting Services

76. International consultants will be engaged to assist HEPC with implementation supervision, in particular tender evaluation, engineering design, supervision of installation, and testing and commissioning of equipment. International consultants will also be engaged to assist HEPC's Energy Conservation Office in reviewing its current energy conservation activities, prepare a framework medium-term energy conservation plan, conduct a seminar on demand side management and integrated resource planning, and organize overseas training. The outline terms of reference for the implementation supervision consultants are in Appendix 9 and for the energy conservation consultants are in Appendix 10. The consultants will be recruited in accordance with the *Bank's Guidelines on the Use of Consultants*.

77. Local consultants will be engaged by HEPC to assist in Project implementation for (i) supervising the civil works, (ii) supervising the erection of metal structures, and (iii) supervising the installation of electrical and mechanical engineering works. These locally-recruited consultants will be selected following procedures acceptable to the Bank.

### 5. Advance Procurement and Recruitment Action and Retroactive Financing

78. To facilitate timely implementation of the Project, the Bank approved advance procurement action for the electromechanical equipment and advance recruitment action for the Project implementation supervision consultants. Subject to the approval of the Board, the Bank has provided retroactive financing of \$500,000 for the foreign exchange costs incurred on or after 11 May 1994 for the services of the implementation supervision consultants.<sup>3</sup>

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<sup>1</sup> This has been standard procedure under PRC projects including those financed by the Bank and the World Bank and has not caused any implementation problems.

<sup>2</sup> The procurement agents are China National Machinery Import and Export Corporation in association with China Electric Power Technology and Trade Corporation for turbo generator units and auxiliaries, and China National Instrument Import and Export Corporation in association with China Electric Power Technology and Trade Corporation for other Bank-financed equipment.

<sup>3</sup> The approval of the advance procurement action was reported in the May 1994 issue of *ADB Business Opportunities*.

## **J. The Executing Agency**

### **1. Organization and Staff**

79. HEPC is a state-owned utility responsible for generation, transmission, and distribution of the electric power in Hunan Province. HEPC belongs to the Central China Electric Power Group, which covers Henan, Hubei, Hunan and Jiangxi provinces, with the interconnected grids. HEPC owns and operates seven hydropower stations with a combined installed capacity of 1,523 MW and six thermal power stations with 1,454 MW. HEPC also owns and operates 16,813 km of transmission lines, including 301 km of 500 kV lines and 4,103 km of 220 kV lines, with 11,502 MVA of associated transformer capacities. HEPC's annual energy production in 1993 amounted to 14,700 GWh. In addition, HEPC purchased more than 5,000 GWh of power from power plants owned by HIPDC and other entities. HEPC's energy sales in 1993 amounted to 19,985 GWh, or about 71 per cent of the total energy sales in Hunan Province.<sup>1</sup>

80. HEPC was established as a company in October 1993, taking over utility functions from the provincial power bureau, HPEPB.<sup>2</sup> The separation of HEPC from HPEPB was in line with the Government's policy of making State-owned organizations more autonomous and commercial. However, the intention has not been fully achieved yet. At present, HEPC and HPEPB are run by the same management and staff. The Bank will assist HEPC in developing an organizational structure and systems suitable for commercially-oriented management, including preparation of a program for separating functions, responsibilities and work force of HEPC from HPEPB (see para. 98).

81. The organization chart of HEPC is shown in Appendix 11. HEPC's management consists of a General Manager and five Deputy General Managers, who are assisted by the Chief Engineer, Chief Economist and Chief Accountant. The General Manager of HEPC is appointed by the Central China Electric Power Group with the concurrence of HPG. The responsibility of each Deputy General Manager (construction, operation, finance, administration, etc.) is not permanently fixed, but depends on the background of the incumbent Deputy General Managers and the prevailing business conditions. HEPC's organization consists of the headquarters, power plants, power supply boards, and groups of peripheral companies and institutions such as construction companies, research institutes, and equipment factories. HEPC has about 46,900 employees, of which about 230 work at the headquarters, about 12,800 at power plants, about 17,500 at power supply boards, and the rest in peripheral companies and institutions.

82. The Finance Department at the headquarters oversees the company's financial functions. It is headed by the Finance Manager, who is assisted by two Deputy Finance Managers. There are five sections in the department dealing with production, construction, power pricing, administration, and costing and information systems. Each project under construction and each operating station has a separate finance section. In addition, there is an internal audit department reporting to the management. The accounts maintained at the project/operating station level are consolidated for the company as a whole. The operating budgets are prepared annually and are reviewed every quarter. HEPC prepares medium term (5 years) and long-term (10 years) capital budgets. A modest beginning has been made in the computerization of accounting and finance functions. The focus of HEPC's financial

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<sup>1</sup> The rest of the provincial sales were from isolated small systems.

<sup>2</sup> HPEPB continues to exist as an arm of the provincial government responsible for regulatory functions (see para. 14).

management so far has been on budgets based on historic costs rather than on cost control and contribution to internal resources. With greater financial autonomy for power utilities, the key to HEPC's sound financial management will be the availability of accurate financial data and appropriate accounting and financial systems for financial analyses. During processing of the project, it was agreed that the Bank would provide assistance to help strengthen HEPC's financial management by introducing computer-based accounting, cost information, financial planning, and management control systems.

83. HEPC has been preparing its annual accounts regularly and on time. The company's accounts are audited by the Provincial Audit Bureau as well as by the State Audit Administration. The present auditing arrangements appear satisfactory.

84. The old accounting system in the PRC did not employ the concept of asset revaluation. However, with recent high inflation levels and with more foreign investment being considered under joint venture arrangements, there is now a need to revalue assets. In line with the guidelines for revaluation issued by the State Council in 1993, all power entities in the PRC have revalued their fixed assets. In the case of HEPC, the revaluation of the assets was carried out in 1993 which resulted in a 32.4 per cent increase in the value of assets. But the revaluation was done as a one time measure because the guidelines do not cover revaluation of assets on a continuing basis. During Project processing, it was agreed that the issue of revaluation of assets would be studied in greater detail and the Bank would assist HEPC in preparing an appropriate revaluation methodology.

## 2. Financial Performance

85. The financial performance of HEPC is summarized in Table 6 (for details, see Appendix 12).<sup>1</sup>

**Table 6: Summary of HEPC's Past Financial Performance**

Indicator	1989	1990	1991	1992	1993
Energy Sales (GWh)	14,842	15,837	16,811	18,351	19,985
Average Revenue (fen/kWh)	10.8	12.1	13.4	16.1	20.4
Increase in Average Revenue (%)	10.4	12.2	11.2	19.8	26.6
Net Income After Tax (Y million)	61	152	71	106	136
Net Fixed Assets [Historical] (Y million) <sup>a</sup>	3,498	4,025	4,166	4,506	6,255
Annual Capital Expenditure (Y million)	1,237	987	626	1,309	1,915
Construction in Progress (Y million)	373	580	766	1,433	2,595
Operating Ratio (%)	92.3	89.0	92.9	94.2	93.4
Rate of Return on					
Historically Valued Net Assets (%) <sup>a</sup>	2.1	4.3	2.5	2.7	4.0
Debt Service Ratio (times)	2.6	2.1	2.1	1.8	1.3
Self-Financing Ratio					
3-Year Moving Average (%)	-	9.2	25.3	7.1	11.9
Current Ratio (times)	2.1	2.4	2.2	2.1	1.6
Debt as % of Debt and Equity	47.0	49.8	50.7	52.0	47.3

<sup>a</sup> Except in 1993 when assets were revalued.

<sup>1</sup> The analysis of HEPC's past financial performance involved some difficulties because HEPC's historical financial statements were prepared in accordance with the earlier accounting system of the PRC, which was different from internationally accepted procedures and practices. Adjustments were made in presenting the financial statements in Bank format, particularly in relation to the treatment of items such as contributions to special funds. Such difficulties are not expected to continue in the future since, effective 1 July 1993, the State Council has adopted new business accounting standards, which are based on internationally accepted accounting procedures.

86. During 1989 to 1993, HEPC maintained a satisfactory financial position, considering the unique aspects of the PRC's accounting and financial systems. Sales grew at 6.3 per cent per annum. HEPC's tariffs were adjusted in line with the rising costs of inputs. The average revenue per kWh increased at an average rate of 17.2 per cent per annum between 1989 and 1993 and a substantial increase has been budgeted in 1994. During the past five years, the company has generated surplus funds, although these have been largely used for contribution to special funds in line with the PRC's practices for State-owned power utilities. However, a high operating ratio coupled with steep increases in operating costs, at an average rate of about 27.2 per cent per annum during the last five years, have resulted in low rate of return (ROR) on net fixed assets.<sup>1</sup> Another reason for the low ROR has been the high income taxes. The liquidity position of the company is favorable. The debt service ratio has averaged around 2 times except in 1993 when it was 1.3 times. The self-financing ratio has averaged 12.3 per cent during this period. However, such performance indicators based on past data have limited significance since so far the power utilities did not have full financial autonomy and portions of internal resources generated by the company were transferred to the government under various special fund provisions.

87. A summary of HEPC's projected financial performance is in Table 7 (the details of the projections and the assumptions used are in Appendix 12).

**Table 7: Summary of HEPC's Projected Financial Performance**

Indicator	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Energy Sales (GWh)	21,051	23,768	27,167	29,208	32,936	37,017	40,980	43,977	50,618	55,083
Average Revenue (fen/kWh)	25.0	28.4	30.0	35.2	37.6	40.7	43.7	47.0	48.2	50.2
Increase in Average Revenue (%)	22.8	13.5	5.6	17.3	6.8	8.2	7.4	7.6	2.6	4.1
Net Income After Tax (Y million)	404	679	908	1,233	1,588	2,072	2,397	2,705	2,829	2,690
Net Fixed Assets (Y million)	6,525	8,831	12,697	17,829	21,790	25,225	31,525	34,095	33,205	34,192
Annual Capital Expenditure (Y million)	3,978	3,566	3,887	4,713	6,068	6,563	6,259	6,431	6,668	6,977
Construction in Progress (Y million)	5,767	6,268	5,272	3,466	3,785	4,759	2,091	2,851	7,044	9,438
Operating Ratio (%)	85.1	81.8	81.0	77.5	77.7	76.6	76.5	76.7	78.5	81.5
Rate of Return on										
Historically Valued Net Assets (%)	9.2	11.7	10.3	11.2	10.0	10.7	10.7	10.6	11.4	11.3
Notionally Revalued Net Assets (%)	8.7	9.8	7.9	8.3	6.9	6.9	6.5	6.1	5.9	4.9
Debt Service Ratio (times)	2.9	2.5	2.0	1.8	2.0	1.8	1.6	1.6	1.4	1.6
Self-Financing Ratio										
3-Year Moving Average (%)	22.7	25.4	25.4	25.3	30.4	30.7	30.8	30.6	30.1	30.6
Current Ratio (times)	1.7	1.8	1.7	1.7	1.8	1.8	1.9	2.1	2.1	2.4
Debt as % of Debt and Equity	58.2	61.3	61.9	62.1	62.3	60.9	58.2	55.3	52.2	50.5

88. During 1994, based on budget figures, HEPC's financial performance is expected to be good. This is due to continued tariff increases (likely to result in an average tariff increase of 23 per cent over 1993) and the projected much lower rate of increase in operating expenses (14 per cent compared with 39 per cent increase in 1993). The ROR on net fixed assets is expected to increase to 9.2 per cent. While debt service ratio will be at 2.9 times, the self-financing ratio is likely to reach a healthy level of 23 per cent, despite the doubling of capital expenditures. This improved financial performance reflects the greater financial autonomy being granted to the power utilities as part of the overall reforms presently taking place in the PRC, whereby the utilities are being allowed to retain the internal resources for debt service and to meet the capital expenditures for capacity expansion programs.

<sup>1</sup> The cost increases are mainly in the cost of purchased power, which forms a major portion of operating expenses (42 per cent in 1993) and in operation and maintenance expenses.

89. During the next decade, HEPC is expected to continue growing rapidly. HEPC's sales are forecast to grow nearly three times and its net fixed assets in operation by more than five times. Assuming that the operating expenses remain within the projected levels and the tariffs are adjusted to meet the financial performance targets described in para. 90, HEPC's financial performance will be satisfactory.

90. The projected financial performance of HEPC is characterized by large requirements for funds for its capacity expansion program, over Y 55 billion or the equivalent of over \$6 billion between 1994 and 2003. While the financial position appears satisfactory at present, considering the growth plan envisaged by HEPC, prudent financial management will be required as well as tariff adjustments and efficiency improvements. HEPC must have an adequate internal cash generation to support its large investment program. The financial covenants for the loan have been formulated to help HEPC achieve satisfactory levels of financial performance. They require that HEPC maintain a self-financing ratio of at least 25 per cent through the year 1997 and 30 per cent thereafter and a debt-service ratio of at least 1.3 times. HEPC's tariffs have been derived so that its revenues are adequate to achieve these financial targets. The projections show that the tariffs will need to be increased by an average of 9.4 per cent per year, above the expected long-term local inflation rate of 7.0 per cent per year.<sup>1</sup> This requirement appears achievable because with these increases HEPC tariffs will be comparable with the projected tariff levels in other provincial utilities. At these tariff levels HEPC should be able to earn adequate return on its assets (about 10.7 per cent on historical values and 7 per cent on a proxy revaluation prepared for analytical purposes) and maintain a comfortable debt-service ratio.

91. However, there are factors that cast a degree of uncertainty on HEPC's finances, in particular those that would be influenced by the economic reforms and consequent policy changes. It is expected that utilities such as HEPC will have greater freedom to retain and utilize surplus funds to manage their expansion plans and therefore less funds will be transferred to the Government by way of taxes and special funds. At the same time, the utilities will be required to obtain domestic loan funds on commercial terms and will be responsible for servicing the debt out of their internally generated funds. Under these changing conditions, HEPC will need to adopt a policy that combines measures aimed at reducing operating costs, improving tariffs and adjusting future investments in accordance with debt service obligations. Bank assistance for strengthening HEPC's financial systems and improving tariff structure and levels would finance a study of these aspects and recommend measures to enable HEPC to identify appropriate financial policies to achieve these objectives. The development and implementation of planning, budgeting, and cost analysis systems will assist HEPC control costs and improve operating efficiencies. To ensure that the package of financial covenants is not limited to an ex-post measure of HEPC's performance, but becomes a tool for the implementation of the company's financial policies, each year HEPC will prepare a rolling ten-year financial projections, showing how the financial covenants are proposed to be met.

### 3. Tariffs

92. The electricity tariff system in Hunan Province consists of HEPC's tariffs and surcharges. HEPC's tariffs consist of retail tariffs applied to the direct sales to consumers and wholesale tariffs applied to the sales to county level distribution entities. Until 1992, HEPC's tariff structure was a complex combination of the "listed prices" issued in 1976 and applied to state-financed plants, fuel surcharges levied since 1985, and a price differential to cover the

<sup>1</sup>

If the budgeted average revenue increase of 23 per cent over the previous year is achieved in 1994, required increases in tariff in the future would be just about at the inflation level.

cost of power from non-State financed plants in accordance with the "new plant, new price" policy. The price differential varied from locality to locality within the province. As a result of the tariff reform in 1993, the "new plant, new price" policy was expanded to the State-financed plants and fuel surcharges were integrated into the "listed prices". In addition, as an experiment, the "listed prices" and the price differential for non-State financed plants were integrated into a single tariff system, based on the concept of "network feeding tariff". Under this system, a network feeding tariff is determined for power output from each power plant. HEPC tariffs are determined based on the aggregate of network feeding tariffs and network costs, such as transmission cost and losses, and the same tariffs are applied throughout the province.

93. The current tariff schedule of HEPC is shown in Appendix 13. The retail tariffs of HEPC consist of: (i) residential; (ii) lighting and commercial; (iii) general industrial; (iv) large-scale industrial; and (v) agricultural. For certain industries and irrigation and drainage in the poorer counties, preferential tariffs are applied. For all consumer categories, the tariff varies depending on the voltage level; lower unit rates (per kWh) are applied to consumers receiving electricity at higher voltages. The tariff for industrial consumers consists of two parts: the base price, which comprises a capacity charge (per kVA) and a demand charge (per kW); and the energy price (per kWh of consumption). Retail tariffs for the other consumers and the wholesale tariffs for all consumer categories consist solely of the energy price.

94. As a result of the tariff reforms and the adjustment in the residential tariff in 1993, HEPC's average revenue per unit of sales in 1993 increased by 26.6 per cent from the 1992 level. Another 22.8 per cent increase is expected in 1994, resulting in the average revenue of 25 fen per kWh (US\$2.9 per kWh). At the consumer level, the average price actually paid is estimated at about 29 fen per kWh (US\$3.3 per kWh) because of the surcharges.<sup>1</sup> The Mission estimated the LRMC of power generation to be about 30 fen per kWh (US\$3.5 per kWh) based on the levelized cost of generating plants to be commissioned during 1994-2003. Thus, the tariff still appears to be inadequate to cover LRMC, including the cost of transmission and distribution. Through a TA, the Bank will assist HEPC in formulating a program of tariff reforms to bring the structure and level of tariff in line with the financial requirements and the costs of supply. -

## **K. Environmental Aspects and Social Dimensions**

95. A comprehensive environmental impact assessment (EIA) report was prepared by HEPC with the assistance of MSDI and approved by the National Environmental Protection Agency (NEPA). The Project does not involve a high dam. The proposed reservoir has a surface area of 25.75 km<sup>2</sup> with an inundation length of 41.1 km along the Yuanshui River. About 928 hectares (ha) will be inundated by the reservoir and an additional 146 ha will be required for the construction area. These areas consist of either cultivated land or barren river bank. No ecologically-sensitive area will be affected by the Project. No precious or rare fish exists in the reaches upstream of the Lingjintan dam. To monitor the environmental impacts during Project implementation, an Environmental Management Office has been set up by HEPC within the Lingjintan Construction Office. In addition, the Environmental Protection Bureau of Yuanling County will establish, by October 1994,<sup>2</sup> an Environmental Monitoring Station at the Wuqiangxi reservoir to monitor the environmental impacts of both the Wuqiangxi and Lingjintan reservoirs during operation.

<sup>1</sup> 2.0 fen per kWh for Provincial Power Development Fund, 0.4 fen per kWh for Three Gorges Project and 30.0 fen per kWh of price adjustment charge for the commercial consumers.

<sup>2</sup> The first unit of the Wuqiangxi plant is scheduled to start operations in October 1994.

96. The Project requires the resettlement of 2,263 people from the areas that will be inundated and 674 people from the construction area. In addition, 475 people will have to change their occupation. A comprehensive resettlement program was prepared by HEPC with the assistance of MSDI and approved by NEPA. The resettlement program was reviewed by the Appraisal Mission and found acceptable. The resettlement program will replace some of the lost crop land by reclaiming land now barren for tree crop and forestry activities for 627 settlers. About 183 people from other families losing land will be trained as aquaculturists to use shallow parts of the reservoir for aquaculture. Most of the people, about 1,770, will be resettled on land now vacant or underused, mostly in the original townships, and will continue as rice or vegetable farmers. About 158 people will be employed by the township enterprises in the area. The compensation for the lost land will be paid to the relocatees according to the PRC's regulations.<sup>1</sup> The relocatees whose occupation will change will receive training and extension assistance. The resettlement program will be coordinated by the resettlement offices to be set up in the two counties concerned. The funds for the resettlement program will be provided by HEPC and managed by the Hunan Province Resettlement Office and the People's Construction Bank of China, Hunan branch. The cost of the environmental mitigation measures and the resettlement program, estimated at Y 65.41 million (\$7.5 million), has been included in the cost estimates for the Project.

97. A summary environmental impact assessment (SEIA) report was prepared by HEPC and circulated to the Bank's Board of Directors on 27 May 1994.

#### **L. Technical Assistance**

98. HEPC was established in October 1993 to take over the role of managing and operating power facilities in Hunan Province from the HPEPB (see para. 80). In the future, the HPEPB will only be responsible for regulation of the subsector. However, it will still take some time to implement fully this major institutional reform. HEPC needs to clearly separate its management and work force from HPEPB to become a genuinely autonomous company. HEPC needs to strengthen its accounting and financial management systems using modern utility management practices. Also, HEPC needs to improve its tariff setting practices to secure adequate revenue to meet its system expansion requirements and to maintain financial soundness as well as to provide right cost signals to consumers. To address these issues, a technical assistance grant for \$400,000 will be provided in conjunction with the loan for institutional strengthening of HEPC. The TA will include recommendations for: (i) improvements in HEPC's organizational structure and management; (ii) improvements in HEPC's accounting, financial planning and management control systems; and (iii) reforms in HEPC's tariff levels and structure. The TA will also finance training for HEPC staff in these areas. The outline terms of reference and cost estimates for the TA are in Appendix 14.

99. To meet the growing demand for power, the PRC needs to develop on average about 16,700 MW of additional power generating capacity per year. The financial requirements for such a capacity addition program are very large, about \$15-20 billion per year. The traditional sources of financing for power development are not sufficient to fund these requirements and innovative financing methods are needed to mobilize the required funds. Because of the limited domestic financing, the PRC has opened the sector for private and foreign investment, through both joint venture and wholly foreign-owned companies. Implementation of the power projects under BOO/BOT scheme is one of the important options being considered by the Government. Thirty-four thermal power projects with a total capacity

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<sup>1</sup> "Regulation on the Compensation of the Land Acquisition and Resettlement of Local Residents during the Construction of Large and Medium Scale Water Conservancy and Hydroelectric Projects" dated 1 May 1991 (the Act No. 74 of the State Council).

of over 30,000 MW have been identified as potential BOO/BOT projects. However, implementation of BOO/BOT power projects under competitive bidding is a new concept in the PRC and requires the preparation of appropriate guidelines and documents for project processing and selection of project sponsors. A technical assistance grant for \$600,000 is proposed to assist the Government in introducing an appropriate framework and arrangements for BOO/BOT scheme through preparation of a specific project. The Government has identified the Waigaoqiao Project Stage II under the Shanghai Municipal Electric Power Company (SMEPC) with a capacity of 2 x 800 to 1000 MW for this purpose. The framework developed and the experience gained under the TA will help establish BOO/BOT option for power development in the PRC. The proposed TA, which is described in more detail in Appendix 15, will:

- (i) identify the scope of the Shanghai Waigaoqiao Stage II Project to be offered for bidding; recommend an appropriate set of guidelines, rules and regulations and incentives for attracting the most favorable responses from bidders;
- (ii) develop bidding procedures and request for proposal (RFP) documents including proforma power purchase agreement, fuel supply agreement, implementation agreement, etc., for the project to be implemented under BOO/BOT scheme; and
- (iii) provide a field study to key officials from the Government and SMEPC involved in the policy making and implementation of BOO/BOT projects on the latest developments in this type of financing.

## **V. PROJECT JUSTIFICATION**

### **A. Economic and Financial Analysis**

#### **1. Least-Cost Analysis**

100. A least cost analysis of the Project has been carried out by HEPC with the assistance of MSDI using a computer model developed by Qinghua University in cooperation with three PRC design institutes including MSDI. The model has been used for the analysis of a number of projects, including those financed by the World Bank. The input data and assumptions used were reviewed by the Bank's TA consultants and found to be appropriate. The analysis showed that the Project was part of the least-cost power development program for the Hunan power system.

101. These findings are supported by the levelized cost analysis carried out by the Mission.<sup>1</sup> The analysis indicates that the unit generation cost of the Lingjintan hydropower plant is US¢3.20/kWh at 10 per cent discount rate, applying an average standard conversion factor of 0.9 to local costs. This is lower than US¢3.52/kWh of coal-fired generation cost based on the use of PRC equipment. Moreover, 26 per cent of the firm energy from the Lingjintan hydropower plant is for peak load supply, for which the likely alternative in the PRC is diesel generation. The cost of diesel generation is estimated at US¢10.8/kwh,<sup>2</sup> also based on the use of PRC equipment. The weighted average cost of the combined base load and peak thermal

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<sup>1</sup> In this analysis, as well as in the subsequent EDR, EIRR and FIRR analyses, costs of environmental mitigation measures, resettlement program, and associated transmission lines have been included in the Project cost estimates.

<sup>2</sup> At the same plant factor as the Lingjintan plant.

generation is estimated at US¢3.52 per kWh, assuming that all secondary energy from Lingjintan will only replace the fuel and the other operation and maintenance costs of coal-fired generation (see Appendix 16).

102. An equalizing discount rate (EDR) analysis has been carried out to compare the Project with a thermal alternative consisting of a coal-fired plant for base load and a diesel power plant for peak load. The EDR analysis shows that the Lingjintan plant is superior to the thermal alternative up to the discount rate of 12.9 per cent. In addition, the Lingjintan plant will serve as reregulating station to the Wuqiangxi plant and will increase Wuqiangxi's dependable peak capacity by 150 MW. This will improve the total operating efficiency of the Hunan power system. The Lingjintan plant will also have the advantage of providing a perpetual supply of renewable and environmentally sound energy (see Appendix 16).

## 2. Economic Internal Rate of Return

103. For the economic internal rate of return (EIRR) calculations, the energy output from the Lingjintan hydropower plant and the increase in the Wuqiangxi hydropower plant's dependable peaking capacity were treated as the benefits of the Project. The firm energy output from the Lingjintan plant was valued at the consumers' willingness to pay (WTP), conservatively estimated at 40 fen per kWh (about US¢4.6 per kWh) based on the costs of alternative electricity supply options. Because of its unreliability, the secondary energy was valued at 18.1 fen per kWh (about US¢2.1 per kWh), equivalent to the fuel and the other operation and maintenance costs saved in coal-fired plants.<sup>1</sup> The 1,248 GWh of the Wuqiangxi plant's annual firm output,<sup>2</sup> which can be used for peaking because of the Lingjintan's reregulating function, was valued at 37.2 fen per kWh (US¢4.3 per kWh), the difference between the cost of alternative thermal power supply for base load (coal-fired power) and that for peak load (diesel power).<sup>3</sup> System losses of 20 per cent and the network cost of 8.7 fen per kWh (US¢1.0 per kWh) were assumed. An average standard conversion factor of 0.9 has been applied to local costs and benefits. The resulting EIRR is 16.6 per cent (for details, see Appendix 16).

## 3. Financial Internal Rate of Return

104. The financial internal rate of return (FIRR) of the Project has been calculated using the network feeding tariff<sup>4</sup> (or transfer price) to be charged for the power output from the Lingjintan Project. The PRC's current tariff policy provides for the network feeding tariff for each plant to be set at an adequate level to recover the construction and operating costs, to meet debt service requirements, and to contribute to the financing of capacity expansion programs. The network feeding tariff for the Lingjintan Project based on this policy works out to 52 fen per kWh during loan repayment period and 38 fen per kWh thereafter.<sup>5</sup> The Government and HEPC have agreed that these levels of tariff will be maintained in real terms by suitable periodic adjustments. On this basis, the FIRR for the Lingjintan Project is estimated at 9.3 per cent,

<sup>1</sup> It was assumed that the secondary energy from the Lingjintan will result in shutdown of existing thermal power plants rather than additional consumption. This assumption is conservative. Under the current power shortage situation, secondary energy is more likely to be used to meet additional consumption rather than to displace energy from existing thermal power plants, and could be valued at WTP.

<sup>2</sup> Corresponding to 380 m<sup>3</sup> per second of water to be constantly discharged in the absence of the reregulating station to be provided by the Lingjintan plant.

<sup>3</sup> At the same peaking plant factor as Wuqiangxi.

<sup>4</sup> See para. 92.

<sup>5</sup> Calculated in nominal terms based on the estimated completion cost of the Project. While computing Project FIRR, these tariffs have been discounted to present levels.

which is higher than the real weighted average cost of capital for the Project, estimated at 1.4 per cent.<sup>1</sup> The FIRR calculations and the assumptions are in Appendix 17. To ensure financial viability of the Project, a loan covenant has been included requiring HPG and HEPC to take all necessary measures to ensure that tariff is separately identified for the electric power supplied from the Project facilities to HEPC and the tariff is adjusted periodically as required.

## B. Project Risks

105. Given the current shortages of power and the ongoing rapid economic growth, there is little risk that the demand for the electricity output from the Project will not materialize. The risk of HEPC failing to charge an adequate tariff to recover the cost of the Project is also limited, in view of the Government's determination to implement tariff reforms ("new plant, new tariff" policy) and the assurances during processing of the Project. The financial projections show that for HEPC to maintain a sound financial position, the required tariff increases are marginal in real terms. There is little if any technical risk associated with the Project. The level of the dam design is well within the capability of entities in the PRC to design and construct. Geological and geotechnical surveys indicated that the site is suitable for the construction of the dam. Bulb turbine generator technology is also well established, but because manufacturers in the PRC have not yet manufactured units of this size, it was agreed that the procurement of the bulb turbine generators will be on the basis of international competitive bidding. As formulated, the Project does not face any unusual risks.

106. Sensitivity analysis has been carried out for the following cases: (i) cost overrun by 10 per cent; (ii) 10 per cent less benefit than expected; (iii) no consumer surplus for EIRR calculation; (iv) one year delay in commissioning; and (v) combination of (i) through (iv). The results of the sensitivity analysis are summarized in Table 8. The analysis shows that in all cases the EIRR is above the usual cut-off rate of 10 per cent and the FIRR is above the real weighted average cost of capital of 1.4 per cent, which indicates the Project is viable.

Table 8: Sensitivity Analysis

Case	Change	EIRR %	SI <sup>a</sup>	FIRR %	SI
(1) Base		16.6	-	9.3	-
(2) Capital Cost	+ 10%	15.2	0.84	8.1	1.29
(3) Benefits	- 10%	14.8	0.08	7.7	1.72
(4) No consumer surplus <sup>b</sup>		14.8	-	-	-
(5) Implementation Delay	1 year	14.3	-	8.3	-
(6) Combination of (2), (3), (4), (5) <sup>c</sup>		10.8	-	6.0	-

<sup>a</sup> Sensitivity Indicator (percentage change in the EIRR/FIRR divided by the percentage change in the given parameter).

<sup>b</sup> Firm output from Lingjintan is valued at the average consumer price of electricity estimated at 29 fen per kWh.

<sup>c</sup> Combination of (2), (3) and (5) for FIRR.

<sup>1</sup> Thirty-two per cent of the Project cost will be financed by the Bank at an interest rate of about 6.5 per cent. The remaining costs are to be financed in local currency half by an SDB loan at an interest rate of 11.16 per cent and half by an HPG loan at an interest rate of 3.6 per cent. This financing pattern and a foreign exchange risk premium of 3.8 per cent (estimated for the Bank loan based on the difference between the projected local and foreign inflation rates) results in a nominal weighted average cost of capital of 8.4 per cent. The real cost is 1.4 per cent after allowing for local inflation rate of 7 per cent.

## VI. ASSURANCES

107. The Borrower and HEPC have given the following assurances, in addition to the standard assurances, which have been incorporated into the legal documents:

- (i) HPG and HEPC will take necessary measures, including making tariff adjustments, to ensure that HEPC's internal cash generation is sufficient to maintain a self-financing ratio of at least 25 per cent on a three-year moving average basis commencing fiscal year 1995 through fiscal year 1997 and 30 per cent thereafter.
- (ii) HEPC will not incur additional debt unless a reasonable forecast of HEPC's revenues and expenditures shows that the estimated net revenues of HEPC for each fiscal year during the term of the debt to be incurred is at least 1.3 times the estimated debt service requirements of HEPC in such year on all HEPC's debt (including the debt to be incurred).
- (iii) HPG and HEPC will take all necessary measures to ensure that a tariff is separately established for the supply of electric power from the Project facilities to HEPC's grid and such tariff is adjusted periodically as required to cover investment costs and operating expenses of the Project as well as provide a financial rate of return consistent with sound electric power utility practices.
- (iv) HEPC will have accounts for the Project and for its overall operations audited annually, by independent auditors acceptable to the Bank, and submit certified copies of such audited accounts to the Bank not later than nine months after the close of the financial year to which they relate.
- (v) HEPC will prepare and submit to the Bank by 1 April of each year rolling ten-year financial projections (including income statement, sources and application of funds statement and balance sheet) commencing with the year in which the projections are submitted showing how the financial covenants are proposed to be complied with.
- (vi) The Borrower, HPG and HEPC will ensure that the persons displaced by the Project will not face reduction in incomes, deterioration in living conditions, or unnecessary social and cultural dislocations owing to losses of social and cultural ties and difficulties in integration with host communities.
- (vii) The Borrower, HPG and HEPC will ensure that adequate and appropriate compensation, training and extension assistance will be provided to persons displaced by the Project in accordance with the resettlement program drawn up by HEPC and accepted by the Bank.
- (viii) The Borrower will ensure that the progress of the resettlement program will be monitored by the HPG. The Resettlement Office of HPG will prepare and furnish HEPC at the beginning of each year during the resettlement period a progress report concerning the resettlement program. By 1 April of each such year, HEPC will furnish the Bank an English translation of each such report. Within a year from the completion of the resettlement program, HEPC will have a program evaluation report prepared by an independent party and furnish the Bank a copy in English.

- (ix) The Borrower and HEPC will ensure that the mitigation and monitoring measures proposed in the SEIA and EIA report will be properly implemented and reported to the Bank by HEPC on an annual basis by 1 April of each year during Project implementation.
- (x) The Borrower and HEPC will ensure that the associated transmission line for the Project will be designed and constructed in time and in an environmentally sound way for the operation of the Lingjintan plant.
- (xi) HEPC will prepare and submit to the Bank by 1 April of each year commencing in fiscal year 1995 an annual program for energy conservation and an annual report concerning past achievements during implementation of the Project.
- (xii) Within six months of receipt of the Bank comments on the final report of the Project energy conservation consultants, HEPC will furnish the Bank a medium-term energy conservation plan, including an action program, taking into account the Bank comments.
- (xiii) Within six months of receipt of the Bank's comments on the final report of the institutional strengthening TA, HEPC will furnish the Bank an action plan including a time-frame to implement recommendations arising under the TA taking into account the Bank's comments.
- (xiv) Within three months of receipt of the consultants' final report on the BOO/BOT TA, the Government and SMEPC will furnish the Bank an action plan including a time-frame to implement the recommendations arising under the TA taking into account the Bank's comments.

## VII. RECOMMENDATION

108. I am satisfied that the proposed loan would comply with the Articles of Agreement of the Bank and recommend that the Board approve the loan of \$116 million to the People's Republic of China for the Hunan Lingjintan Hydropower Project from the Bank's ordinary capital resources, with interest to be determined in accordance with the Bank's pool-based variable lending rate system for US dollar loans and with an amortization of 25 years including a grace period of 6 years and such other terms and conditions as are substantially in accordance with those set forth in the draft Loan and Project Agreements presented to the Board.

MITSUO SATO  
President

30 August 1994

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## ENERGY BALANCE OF THE PRC IN 1992

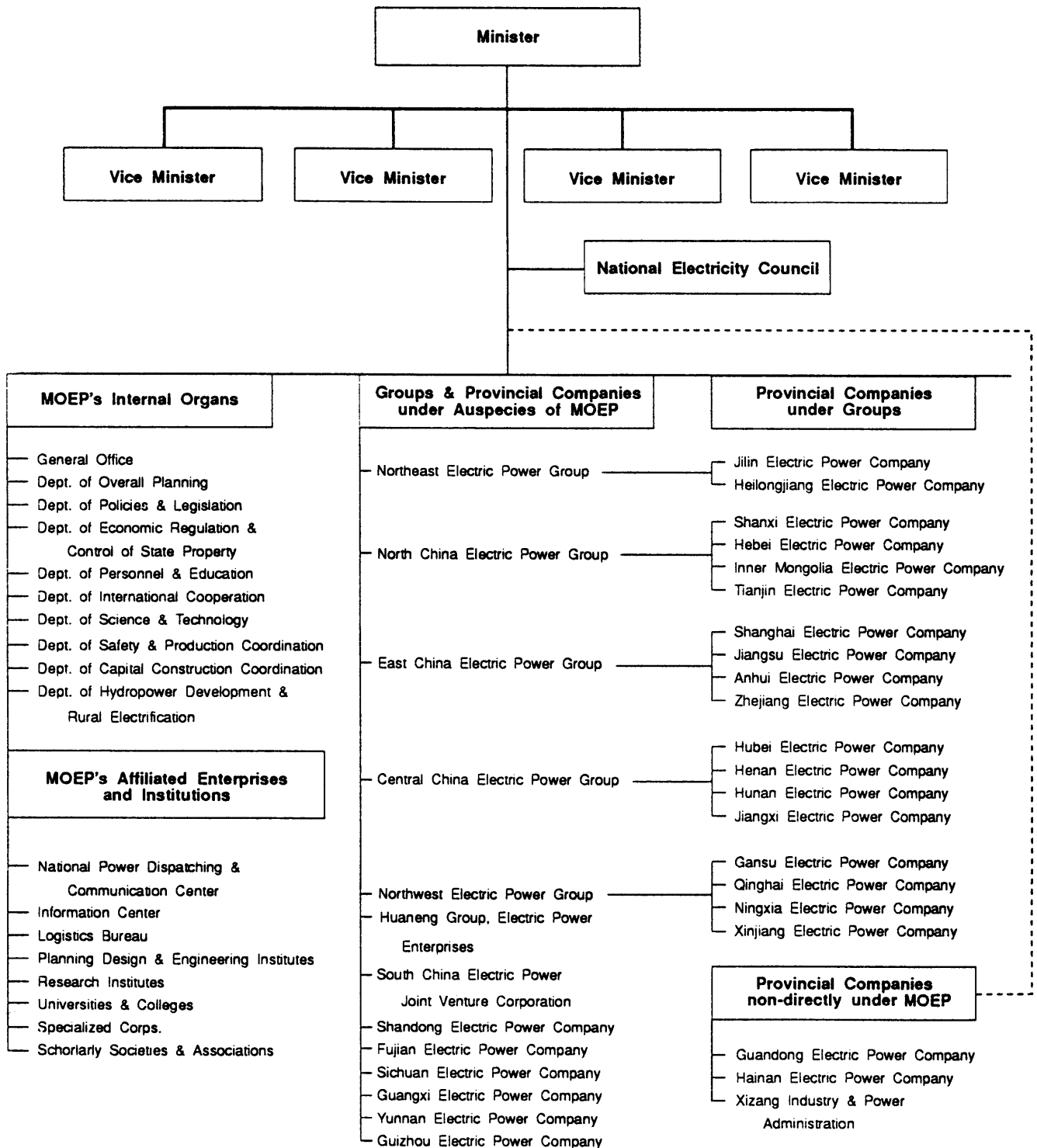
Unit: Thousand TOE

	Coal & Coke	Crude Oil	Petroleum Products	Crude Oil and Petroleum Products	Natural Gas/ City Gas	Hydropwr	Nuclear	Electricity	Heat	Total Commercial Energy
Indigenous Production	587,284	144,098	0	144,098	15,275	41,416	0	0	0	788,073
Imports	999	11,503	7,048	18,551	0	0	0	267	0	19,818
Exports	(11,689)	(21,836)	(7,199)	(29,035)	0	0	0	(22)	0	(40,746)
Bunkers	0	0	0	0	0	0	0	0	0	0
Stock Change	3,514	(1,389)	(497)	(1,886)	0	0	0	0	0	1,629
Primary Energy Requirement	580,109	132,377	(648)	131,729	15,275	41,416	0	245	0	768,774
Statistical Difference	0	0	(10)	(10)	0	0	0	0	0	(10)
Oil Refining	0	(124,821)	119,279	(5,542)	0	0	0	0	0	(5,542)
Gas Manufacture	(2,727)	0	(493)	(493)	6,413	0	0	0	0	3,193
Coke Oven	(13,278)	0	0	0	18,710	0	0	0	0	5,432
Coal Washing	(5,834)	0	0	0	0	0	0	0	0	(5,834)
Combine Heat and Power	(20,029)	(120)	(3,253)	(3,373)	(1,158)	0	0	0	17,301	(7,259)
Power Generation	(162,173)	(1,148)	(11,949)	(13,097)	(2,434)	(41,416)	0	(219,120)	0	(219,120)
Fuel consumed	0	(2,494)	0	(2,494)	0	0	0	64,861	0	64,861
Power generated	0	0	0	0	0	0	0	(4,770)	0	(7,264)
Transmission and Distribution Loss	0	0	0	0	(420)	0	0	(1,229)	(172)	(1,821)
Energy Sector Own Use and Loss	376,067	3,793	102,926	106,720	36,386	0	0	59,108	17,129	595,410
Net Supply Available										
Net Domestic Consumption	376,067	3,793	102,926	106,720	36,386	0	0	59,108	17,129	595,410
Residential	87,461	0	3,846	3,846	5,336	0	0	5,433	2,819	104,897
Commercial	5,060	3	1,023	1,026	270	0	0	968	92	7,417
Industry	248,512	3,652	57,396	61,048	30,345	0	0	45,187	13,813	398,905
Transport	11,040	130	19,344	19,475	48	0	0	1,019	9	31,591
Agriculture	13,015	8	11,103	11,112	0	0	0	4,189	0	28,316
Others/Non - Energy use	10,978	0	10,213	10,213	386	0	0	2,311	395	24,283

**POWER NETWORKS IN THE PRC  
(1992)**

Network & Region	Installed Capacity		Electricity Generation	
	Total (MW)	Share of Hydro (%)	Total (TWh)	Share of Hydro (%)
Northeast Power Network (NEPN)	24,585.4	17.6	112.353	6.8
North China Power Network (NCPN)	21,522.9	5.3	108.078	1.2
East China Power Network (ECPN)	26,703.6	9.6	133.086	5.0
Central China Power Network (CCPN)	23,509.1	36.3	112.111	31.2
Northwest Power Network (NWPN)	11,105.5	43.3	49.533	30.9
Shandong Provincial Grid (SDPG)	9,617.0	0.5	56.329	0.03
Fujian Provincial Grid (FJPG)	3,418.6	51.7	15.997	49.2
Guangdong Provincial Grid (GDPG)	10,093.2	36.3	43.875	17.9
Guangxi Provincial Grid (GXPG)	3,202.6	58.3	13.648	46.9
Sichuan Provincial Grid (SCPG)	7,716.0	33.6	35.064	32.4
Yunnan Provincial Grid (YNPG)	3,084.3	56.1	12.967	52.8
Guizhou Provincial Grid (GZPG)	2,390.3	40.8	11.601	34.5
Hainan Provincial Grid (HNPG)	642.7	31.7	1.718	35.4
Xinjiang Autonomous Region (XJAR)	2,459.3	24.1	8.680	20.3
Xizang Autonomous Region (XZAR)	166.6	72.6	0.357	73.4

## ORGANIZATION CHART OF MINISTRY OF ELECTRIC POWER AND AFFILIATED INSTITUTIONS



# BANK LOANS AND TECHNICAL ASSISTANCE TO THE ENERGY SECTOR IN THE PEOPLE'S REPUBLIC OF CHINA

## 1. Power Subsector

No.	Name of Project	Amount	Date of Approval
		(\$ million)	
<b>A. Loans</b>			
1.	880-PRC Fuel Conversion	33.3	21 December 1987 *
2.	1091-PRC Shanxi Liulin Thermal Power	65.0	25 July 1991
3.	1242-PRC Guangzhou Pumped Storage Stage II	200.0	3 August 1993
	Total	298.3	
<b>B. Investments</b>			
	7087/ 1177-PRC Guangzhou Pearl River Power Company	50.0	22 September 1992*
Total of Loans and Investments (A + B)		348.3	
		(\$ '000)	
		Project Preparatory	Advisory & Operational
<b>C. Technical Assistance</b>			
1.	832-PRC Fuel Substitution	75.0	15 December 1986 *
2.	938-PRC Institutional Development of HNPC		21 December 1987 *
3.	989-PRC Liu-Lin Thermal Power	100.0	22 June 1988 *
4.	1051-PRC Technology Transfer in Hydropower Design		27 October 1988 *
5.	1543-PRC Institutional Development of Liu-Lin Power Company		25 July 1991
6.	1544-PRC Power System Planning	600.0	25 July 1991
7.	1628-PRC Energy-cum-Electricity Demand and Supply Analysis		16 December 1991
8.	1734-PRC Hunan Lingjintan Hydropower	99.7	21 July 1992 *
9.	1867-PRC Power Subsector Energy Conservation Study in Jiangsu Province		14 April 1993
10.	1919-PRC Qitaihe Thermal Power	438.0	02 August 1993
11.	1920-PRC Electricity Efficiency Study		03 August 1993
12.	1921-PRC Financial and Management Information System Study		03 August 1993
13.	1922-PRC Support for Power Sector Tariff and Financing Reforms		03 August 1993
14.	1950-PRC Hunan Lingjintan Hydropower	100.0	10 September 1993
15.	2085-PRC Preliminary Analysis of Fujian and Henan Power Projects	100.0	21 April 1994
TOTAL		1,512.7	3,469.5
		4,982.2	

\* Completed

## 2. Other than the Power Subsector

No.	Name of Project	Amount	Date of Approval
		(\$ million)	
<b>A. Loans</b>			
1. 1178-PRC	Industrial Energy Conservation and Environment Improvement	107.0	24 September 1992
2. 1205-PRC	Qindao Environmental Improvement	103.0	10 December 1992
3. 1270-PRC	Tangshan & Chengde Environmental Improvement	140.0	25 November 1992
	Total	350.0	
		(\$ '000)	
		Project Preparatory	Advisory & Operational
<b>B. Technical Assistance</b>			
1. 1021-PRC	Industry Energy Conservation Program		830.0
2. 1490-PRC	Industry Energy Efficiency and Environment Management	100.0	
3. 1549-PRC	Qindao Environmental Improvement	100.0	
4. 1754-PRC	Management of Energy Conservation Program		600.0
5. 1758-PRC	Ping Hu Gas Development	600.0	
6. 1831-PRC	Tangshan and Chengde Environmental Improvement	100.0	
7. 1917-PRC	Beijing Environmental Improvement	600.0	
8. 2062-PRC	Hydrocarbon Sector Study		100.0
9. 2087-PRC	Second Energy Conservation and Environment Improvement	393.0	
10. 2100-PRC	Rural Energy Development Study		500.0
		1,893.0	2,030.0
TOTAL		3,923.0	

\* Completed

Note: In addition, Loan No. 1248-PRC: Fertilizer Industry Restructuring (Sector) Project approved on 24 August 1993 in the amount of \$250.0 million had energy conservation as a secondary objective.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Hydro											
Existing	3,296	240	480	480							
Wuqiangxi						60	90	90			
Lingjintan						4,556	4,646	4,736	4,736	4,736	4,736
Installed Capacity	3,296	3,536	4,016	4,496	4,496						
Additions		240	480	480	0	60	90	90	0	0	0
Thermal											
Existing	3,361	250									
Zhuzhou											
Xiangtan					300	300		300	300		
Shimen			300	300	300	300					
Wangcheng							300	300		300	300
Yiyang							300	300			
Leiyang											
Installed Capacity	3,361	3,611	3,911	4,211	4,811	5,711	6,311	7,511	8,411	8,711	9,311
Additions		250	300	300	600	900	600	1,200	900	300	600
Total Installed Capacity	6,657	7,147	7,927	8,707	9,307	10,267	10,957	12,247	13,147	13,447	14,047
Additions		490	780	780	600	960	690	1,290	900	300	600
Cumulative Additions			1,270	2,050	2,650	3,610	4,300	5,590	6,490	6,790	7,390

**DETAILED PROJECT COST ESTIMATES**  
(\$ million)

Items /a	Foreign Exchange Cost	Local Currency Costs /b	Total
<b>A. BASE COSTS /c</b>			
<b>1. Civil Works</b>	<b><u>6.91</u></b>	<b><u>101.93</u></b>	<b><u>107.84</u></b>
Major Civil Works /C1-1	0.00	75.48	75.48
Other Major Civil Works /C1-2	0.00	2.41	2.41
Transportation Works /C4-1	0.00	10.22	10.22
Construction Power Supply /C4-2	0.00	1.27	1.27
Other Temporary & Construction Works /C4-3	0.00	12.55	12.55
Steel /C13	5.91	0.00	5.91
<b>2. Electromechanical Equipment</b>	<b><u>73.42</u></b>	<b><u>10.44</u></b>	<b><u>83.86</u></b>
Other Electromechanical Works /C2-1	0.00	6.09	6.09
Installation Other Electromechanical Works /C2-2	0.00	4.32	4.32
Turbo Generator Units /C-5	65.70	0.00	65.70
Other Electrical Equipment /C-7	4.00	0.00	4.00
Power Plant Control Systems /C6	3.30	0.00	3.30
Microwave Telecommunications System /C-8	0.15	0.00	0.15
Hydrological Forecasting System /C9	0.27	0.03	0.30
<b>3. Metal Structures</b>	<b><u>8.19</u></b>	<b><u>9.12</u></b>	<b><u>17.31</u></b>
Other Metal Structure Equipment/Installation Works /C3-1	0.00	6.91	6.91
Installation Other Metal Structure Equip./Inst. Works /C3-2	0.00	1.93	1.93
Trash rack and rakes /C-10	1.00	0.00	1.00
Hydraulic Crane for Flood Sluice Gates /C11	1.30	0.08	1.38
Switchyard Equipment /C12	1.80	0.20	2.00
Imported Steel /C-13	4.09	0.00	4.09
<b>4. Miscellaneous</b>	<b><u>2.20</u></b>	<b><u>27.71</u></b>	<b><u>29.91</u></b>
Land Acquisition & Resettlement /i	0.00	9.08	9.08
Consulting/Engineering/Design Services	2.20	2.03	4.23
Other	0.00	16.60	16.60
<b>Subtotal (A)</b>	<b><u>89.72</u></b>	<b><u>149.21</u></b>	<b><u>238.93</u></b>
<b>B. CONTINGENCIES</b>			
Physical /d	4.35	11.60	15.95
Price /e	12.01	18.64	30.65
<b>Subtotal (B)</b>	<b><u>16.36</u></b>	<b><u>30.24</u></b>	<b><u>46.60</u></b>
<b>Base Cost (A) + Contingencies (B)</b>	<b><u>106.08</u></b>	<b><u>179.44</u></b>	<b><u>285.52</u></b>
<b>C. IDC /f/g</b>	<b><u>23.36</u></b>	<b><u>57.90</u></b>	<b><u>81.26</u></b>
<b>TOTAL PROJECT COST (A)+(B)+(C) /h</b>	<b><u>129.43</u></b>	<b><u>237.34</u></b>	<b><u>366.77</u></b>

a/ Construction and Supply Contract Number (C1 to C13) for local and foreign supplies

b/ Includes 3.15 percent tax on labour, machinery and materials; exchange rate: Yuan per US\$ 8.7

c/ Base costs reflect end 1993 price level

d/ Based on 10% for Civil Works and 5% for Electro-Mechanical Works for Local and 5% for all Foreign currency components

e/ Cost estimates are given in US dollars and price contingencies are based on international inflation of 3.1% from 1994 onwards on all items, except for 3.9% on local construction works in 1994

f/ Foreign IDC financed through ADB loan

g/ Local IDC on State Development Bank loan included in loan; IDC on Provincial loan by HPEC Company will be due only as from commissioning of first unit from HEPC's normal operating fund

h/ Dedicated transmission line not part of this project will be financed from other sources; costs not included herein

i/ Land acquisition Yuan 13.6 million

## PROJECT IMPLEMENTATION SCHEDULE

ID	Activity	1994				1995				1996				1997				1998				1999				2000			
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
15	Appointment/Service of Consultants																												
19	Implementation Consultants																												
20	Recruitment																												
34	Implementation																												
37	Energy Conservation Consultants																												
38	Recruitment (earliest date)																												
53	Implementation																												
56	Civil Works																												
57	Site Preparation																												
58	Tendering																												
62	Mobilization																												
63	Civil Works Phase 1																												
64	Civil Works Phase 2																												
65	Powerhouse construction																												
66	Mechanical/Electrical Equipment																												
67	Preparation Tender Documents																												
75	Tendering																												
88	Equipment																												
89	Manufacturing																												
92	Delivery																												
95	Install and Commission																												
96	Commissioning Unit 1																												
97	Plant operative																												
98	Transmission Lines																												

**INDICATIVE LIST OF CONTRACT PACKAGES**  
**Mode of Procurement, Source of Financing and Cost**

Package		Procurement Mode /a	Financing	Total Costs, US\$ million
<b>1</b>	<b>Civil Works</b>			<b><u>122.58</u></b>
	Major Civil Works	LCB	HPG/SDB	90.77
	Other Major Civil Works	LCB	HPG/SDB	2.90
	Transportation Works	LCB	HPG/SDB	12.29
	Construction Power Supply	LCB	HPG/SDB	1.53
	Other Temporary and Construction Works	LCB	HPG/SDB	15.09
<b>2</b>	<b>Electromechanical Works</b>			<b><u>95.25</u></b>
	Turbo Generator Units	ICB	Bank	77.98
	Other Electromechanical Works	LCB	HPG/SDB	7.33
	Installation of other Electromechanical Works	LCB	HPG/SDB	5.19
	Other Electrical Equipment	ICB	Bank	4.75
<b>3</b>	<b>Instrumentation</b>			<b><u>4.45</u></b>
	Power Plant Control Systems	ICB	Bank	3.92
	Microwave Telecommunications System	IS	Bank	0.18
	Hydrological Forecasting System	LCB/IS	HPG/SDB	0.36
<b>4</b>	<b>Specialized mechanical equipment</b>			<b><u>2.83</u></b>
	Trashrack and rakes	ICB	Bank	1.19
	Hydraulic crane for flood sluice gates	LCB/ICB	HPG/SDB	1.64
<b>5</b>	<b>Metal structures</b>			<b><u>13.01</u></b>
	Other metal structure equipment/Installation Works	LCB	HPG/SDB	8.31
	Installation of other metal structure equipment	LCB	HPG/SDB	2.33
	Switchyard Equipment	LCB/ICB	HPG/SDB	2.38
<b>6</b>	<b>Steel</b>			<b><u>11.87</u></b>
	Imported steel for metal structures	ICB	Bank	4.85
	Steel for Civil Works	LCB/ICB	HPG/SDB	7.01
<b>7</b>	<b>Miscellaneous</b>	LP	HPG/SDB	<b><u>30.89</u></b>
	Land Acquisition & Resettlement			10.92
	Other			19.97
<b>8</b>	<b>Consulting Services</b>			<b><u>4.64</u></b>
	Implementation & Energy Conservation Consultants		Bank	2.20
	Local Consultant		HPG/SDB	2.44
<b>Sum</b>				<b><u>285.52</u></b>

a/ ICB: International Competitive Bidding, LCB: Local Competitive Bidding, IS: International Shopping,  
 LP: Local procurement

## **OUTLINE TERMS OF REFERENCE FOR IMPLEMENTATION SUPERVISION CONSULTANTS**

### **A. Role of the Consultant**

1. The consultant will be responsible to Hunan Electric Power Company (the owner) and assist the owner in carrying out the Project from the design stage up to the commissioning of the last unit. The Project has been designed by The Mid South Design Institute (MSDI). The services of the consultant are to be carried out in close cooperation with MSDI and the owner as well as the organizations that would be assigned by the owner to provide services for the project.

### **B. Terms of Reference**

2. The scope of services will include, but not necessarily be limited to:

#### **1. Project Preparation**

3. Since by the time the consultant is engaged, the bid documents for the bulb turbine-generators will have been issued, during the implementation of the Project, the consultant will review and advise the owner about compliance and improvement of:

- (i) the general design, especially the powerhouse layout plan and the integration of the Project with the system
- (ii) the main parameters of the bulb turbine-generators
- (iii) the layout of the main auxiliary circuits
- (iv) the basic design of the control system

4. This improvement will consider the necessary compatibility and connections with the Wuqiangxi Hydropower Project with which the Project will operate as a reregulating station.

5. The consultant will pay attention to the ease, reliability and efficiency of operation and maintenance of both power plants as a whole. The consultant will make the best possible use of the experience gained by the owner through the design, construction and operation of the Wuqiangxi project. The consultant will assist the owner in examining possible improvements to the design or to the construction sequences to maximize the benefits of the conjunctive mode of operating of the two power plants.

6. The consultant will review ICB documents except for the bulb turbine-generators, prepared by the owner for the works and equipment. The consultant will need to pay attention that the interface between the various pieces of equipment supplied through different contracts is correct.

7. The consultant will check that the specifications for equipment of the Project will ensure an optimized combined operation and maintenance of both power plants.

8. The consultant will check that all documents are consistent with the Bank's *Guidelines for Procurement* and advise the owner of necessary amendments, if any.

9. The consultant will assist the owner in bid evaluation and contract negotiation.

## **2. Project Implementation**

10. The consultant will assist the owner in reviewing the equipment manufacturer's drawings and calculations, including:

- (i) checking the arrangement drawings with respect to optimized operation and maintenance
- (ii) assistance during technical coordination meetings with the equipment manufacturers
- (iii) checking the compatibility of equipment
- (iv) checking compliance with contract specifications

11. The consultant will assist the owner in checking the procurement and delivery program for each contract to ensure compatibility with other contracts and civil works.

12. The consultant will assist the owner witness turbine model tests when necessary and review the results, including checking the consequences of possible hydraulic transients.

13. If the owner requires, the consultant will provide through subcontracting of an internationally reputable inspection company, assistance to the owner in factory inspection of equipment at the manufacturer's workshops. The consultant will establish for main plant/equipment a relevant quality assurance program. This program will provide appropriate procedures for checking compliance by the manufacturer with national and international standards related to design, manufacturing and testing. The consultant will provide assistance to the owner to check the various stages of the manufacturing process, to control the manufacturing schedule and to examine materials, testing reports, certificates and packaging. The consultant, if appropriate, will witness tests and suggest arrangements for independent tests. The consultant will give recommendations to the owner on any remedial measures proposed.

14. The consultant will assist the owner in the coordination between the various manufacturers and contractors and in the monitoring of the progress of each contract as well as in the preparation of progress reports to financing institutions.

15. The consultant will supervise tests and commissioning of the power plant. During the startup period, the consultant will assign on site highly qualified personnel with experience in testing and commissioning of bulb turbine-generators. The personnel will assist the owner in:

- (i) developing safe startup and test procedures
- (ii) coordinating the performance of tests with the various manufacturers, engineers and other parties involved in commissioning and startup

(iii) coordinating the preparation of final startup and test reports.

16. The Consultant will supervise the drafting of operation and maintenance procedures manuals.

17. The consultant will assist the owner in the formulation and implementation of an appropriate training program for the construction and operation staff.

18. The consultant will itself provide (or subcontract to a qualified company) training for about 30 in number of the owner's personnel totalling up to 900 man-days in the construction management, operation and maintenance of bulb turbine-generator power stations. This training will take place in facilities similar to the project and/or at the consultant's home office.

### **C. Fields of Specialization**

#### **1. Field Experts**

19. The consultant will field experts in the areas of: (i) hydraulic/mechanical works; (ii) electrical services; and (iii) computerized supervisory and control systems.

20. All the consultant's personnel shall have extensive experience in construction and operation of bulb turbine-generator power stations. They shall be dispatched to work in the owner's country as and when required by the owner.

#### **2. Engagement of the Inspection Firm**

21. For manufacturing supervision and factory inspection of the electro-mechanical equipment, apart from the inspection of major items by delegations sent by the owner, the consultant will be in charge of the supervision of the manufacturer's works. If required, the consultant shall engage through international competitive bidding, an international inspection firm to provide assistance in this work.

### **D. Extent of Service**

22. It is estimated that 50 person-months of consulting services will be required over the implementation period.

### **E. Participation of the Owner**

23. The owner shall provide the necessary office space, local transportation and the services (including interpretation services) of counterpart staff to enable the Consultant to undertake the work efficiently.

### **F. Reporting Requirement**

24. The consultants will submit to HEPC, with a copy to the Bank, an inception report within 30 days from the mobilization, and progress reports on their assignment on a quarterly basis.

## **OUTLINE TERMS OF REFERENCE FOR ENERGY CONSERVATION CONSULTANTS**

### **A. Background**

1. Hunan Province is facing severe power shortages. Despite its efforts to increase its power generating capacity, it is unlikely that the current shortages and incremental power demand will be fully met by additional power supply from the Hunan power grid. Hunan Electric Power Company (HEPC) is, therefore, placing high priority on the conservation of electricity, both on the supply side and demand side. HEPC has at its head office an Energy Conservation Office with four permanent staff members, including three senior level engineers. HEPC has energy conservation offices at the prefecture, and county levels. Their activities range from information campaign to energy audit and promoting the use of energy efficient equipment financed with subsidy mechanisms. HEPC's Energy Conservation Office is also responsible for preparing a plan for the reduction of line losses, unit coal consumption, and station use.

2. Given the importance of energy conservation and the magnitude of the work to be carried out, current staff strength of the HEPC's Energy Conservation Offices appears insufficient. Also, the planning for demand side energy conservation activities is currently done on an annual basis and a more strategic approach with clearly defined medium-term targets and measures to achieve these targets will be required. The effectiveness of measures currently used for penalizing inefficient consumers and providing incentives for the use of energy efficient equipment need to be reviewed together with the method of financing and accounting for these measures. Such a review could be carried out against the background of modern demand side management (DSM) and integrated resource planning (IRP) concept adopted by power utilities in industrialized countries.

### **B. Objective**

3. The objectives of the consulting services are to (i) review the energy conservation activities currently undertaken by HEPC and recommend improvements in terms of an activity program, institutional arrangements, financing and accounting; (ii) assist HEPC to prepare a framework medium-term plan for energy conservation for about five years; (iii) conduct training of HEPC's management and staff concerned with DSM and IRP; and (iv) arrange overseas training on DSM and IRP for HEPC's management and staff. In carrying out these tasks, the consultants will also take into account outcomes of ongoing Bank TAs for energy conservation and efficiency in the PRC.<sup>1/</sup>

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<sup>1/</sup> TA No. 1867-PRC: Power Subsector Energy Conservation Study in Jiangsu Province approved in April 1993 and TA No. 1920-PRC: Electricity Efficiency Study approved in August 1993.

**C. Outline Terms of Reference****1. Review of HEPC's Energy Conservation Activities****4. The consultants will:**

- (i) Review energy conservation activities undertaken by HEPC on the supply side, in terms of reduction in line losses, unit coal consumption, and station use, and recommend measures for improvement.
- (ii) Review the availability in HEPC of data required for effective energy conservation activities such as electricity consumption pattern and load characteristics in Hunan Province.
- (iii) Review electricity energy conservation activities undertaken by HEPC on the demand side for different consumer categories (industrial, commercial, residential, etc.)
- (iv) Review the organizational structure of the Energy Conservation Office at the head office and those at prefecture and county levels arrangement for their demand side including financing and accounting.
- (v) Review the status of energy efficiency regulations for electrical appliances.
- (vi) Review the involvement of trade allies such as manufacturers and vendors of appliances in demand side electricity energy conservation.
- (vii) Based on the above review, recommend measures to improve demand side electricity energy conservation, in terms of activities, institutional arrangements, financing and accounting.

**2. Assistance in Preparation of a Framework Medium-Term Plan**

5. The consultants will assist HEPC in the preparation of a framework for a medium-term demand side energy conservation plan, including recommended programs, requirements for institutional changes, human resources enhancement and training, and financing resources. The planning horizon will be five years.

**3. Seminar**

6. The consultants will conduct a five-day seminar in Changsha for HEPC management and staff involved in energy conservation on DSM and IRP. The seminar will be based on the results of the work of the consultants. It will take place in connection with the tripartite meeting to be held after submission of the draft final report.

#### **4. External Training**

7. The consultants will organize about 15 days of overseas training for about ten persons in HEPC management and staff involved in energy conservation activities on DSM and IRP.

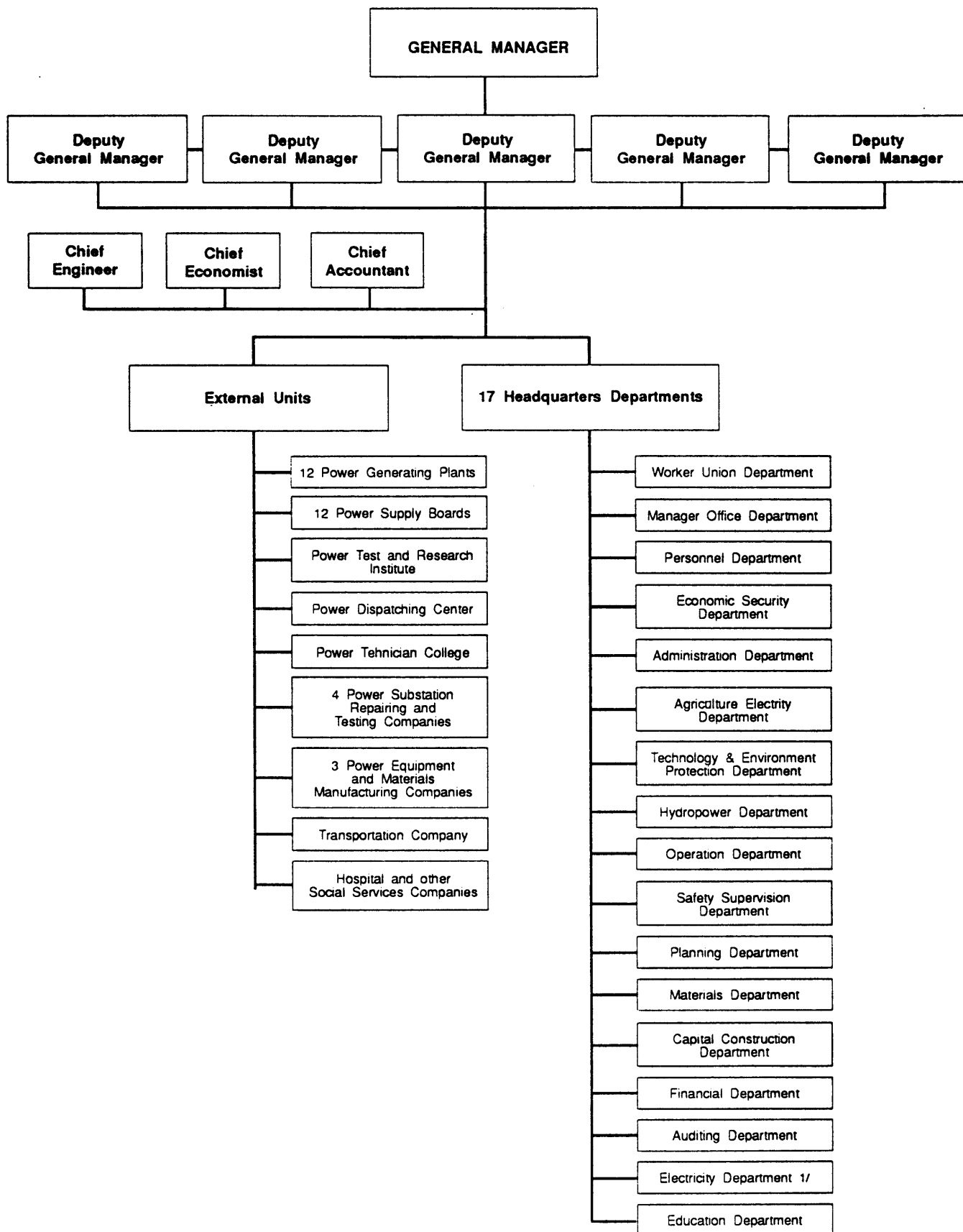
#### **D. Implementation Schedule**

8. It is expected that the consulting services will require eight calendar months to implement, including the seminar, overseas training, and home office work on a part time basis.

#### **E. Reporting Requirements**

9. The consultants will submit to HEPC, with a copy to the Bank, an inception report within 30 days from mobilization, a draft final report by the end of the sixth month, and the final report by the end of the eighth month.

## ORGANIZATION CHART OF HUNAN ELECTRIC POWER COMPANY



(Reference in text: page 24, para. 81)

1/ The Energy Conservation Office is within the Electricity Department

## HUNAN ELECTRIC POWER COMPANY ASSUMPTIONS FOR FINANCIAL PROJECTIONS AND FINANCIAL STATEMENTS

### A. General

The domestic annual inflation rate is assumed at 12 per cent for the year 1994 and 7 per cent for each of the subsequent years. The international inflation rate is assumed at 3.1 per cent.

### B. Income Statement

1. The electricity sales have been derived based on the capacity addition program of HEPC and the amount of power available for purchase. On this basis the growth in electricity sales averages 10.7 per cent per annum over the projections period.

2. The tariffs are adjusted so that the revenues are adequate to achieve the financial performance targets.

3. The fuel costs are based on 1993 prices and increase with the projected local inflation rates.<sup>1</sup>

4. The costs of purchased power are based on purchase price in 1993 and are to increase with the projected local inflation rates.

5. The operation and maintenance expenses include wages, materials and maintenance costs and are projected as follows:

- (i) Wages - based on increase in the number of employees @ 1 per cent per annum and increase in average wages at half the rate of growth in sales, further escalated by local inflation rate.
- (ii) Materials - based on 1993 figures increasing at the rate of growth in gross fixed assets (GFA) and further escalated by local inflation rate.
- (iii) Maintenance Cost - based on 1993 figures increasing at 2.5 per cent of additions in GFA.

6. Depreciation for the year is estimated at 6.5 per cent of the GFA in operation during the year.

7. The value-added tax (VAT) introduced in the PRC on 1 January 1994, applies to electricity sales also. The percentage rate of VAT payable is 17 per cent of sales, excluding VAT. The VAT actually payable is net of VAT paid for the goods and services purchased for producing the commodity. For future financial projections for HEPC, a net VAT rate of 10 per cent of sales revenue has been used.

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<sup>1</sup> For the year 1994, fuel costs, costs for purchased power, operation and maintenance expenses and administration and sales expenses are based on budget figures of HEPC.

8. The administration expenses are based on actuals for 1993, and increase in proportion to the increase in the number of employees, further adjusted for inflation. The sales expenses are estimated at 0.8 per cent of sales revenue.

9. The average interest on long-term loans is taken at 7.38 per cent for new domestic loans. The applicable interest rates have been used for foreign loans.

10. The income tax is 33 per cent of net income before tax.

### **C. Sources and Application of Funds Statement**

11. The capital expenditures are based on the capacity expansion program of HEPC.

12. The borrowings have been adjusted for each year depending on the capital expenditures and availability of internal resources. Except for the Lingjintan Project and the Wuqiangxi Project being implemented with OECF assistance, the capital expenditures are financed by borrowings from State Development Bank and the Hunan Provincial Government in the ratio of 50:50. The average interest rate for these loans is 7.38 per cent per annum, with a repayment period of 12 years including the construction period.

### **D. Balance Sheet**

13. The accounts receivable increase by 20 days of incremental sales revenue every year.

14. The inventories increase every year by one per cent of additional GFA plus one month of additional fuel costs.

15. The accounts payable increase with increases in operating costs less depreciation; such an increase in accounts payable will be at a gradually declining rate of 95 per cent of increase in operating cost less depreciation in 1994 to 40 per cent of increase in operating costs less depreciation by the year 2003.

**HUNAN ELECTRIC POWER COMPANY**

**Income Statement**

Year Ending 31 December

(Yuan million)

Particulars	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Actual)				(Budget)				(Projected)						
Energy sales (Gwh) – Electric Power	14842	15837	16811	18351	19855	21051	23768	27167	29208	32936	37017	40980	43977	50618	55063
Heat sales (MJ) – Heat		294	0	390	0	0	0	0	0	0	0	0	0	0	0
Revenue per unit (fen/kwh) – Elec. Power	10.78	12.09	13.44	16.11	20.39	25.03	28.40	30.00	35.20	37.60	40.70	43.70	47.00	48.20	50.20
Revenue per unit (fen/KJ)		0.74	0.00	0.95											
Sales increase %	5.0	6.7	6.2	9.2	8.9	5.3	12.9	14.3	7.5	12.8	12.4	10.7	7.3	15.1	8.8
Tariff increase %	10.4	12.2	11.2	19.8	26.6	22.8	13.5	5.6	17.3	6.8	8.2	7.4	7.6	2.6	4.1
<b>Operating Revenue</b>	1624	1941	2290	2992	4207	5269	6750	8150	10281	12384	15066	17908	20669	24398	27641
Sales Revenue	4	3	4	8	6	7	7	8	9	10	11	12	13	14	16
Other Sales Income	1628	1944	2294	3000	4213	5276	6757	8158	10290	12394	15077	17920	20682	24412	27657
<b>Operating Expenses</b>															
Fuel	408	555	589	632	715	794	955	1198	1501	2002	2714	3447	4152	5309	6052
Purchased Power	380	292	479	997	1656	1817	2105	2266	2446	2641	2843	3059	3293	4340	5940
Operation and Maintenance	170	223	275	306	486	535	724	968	1232	1539	1861	2270	2684	3078	3491
Depreciation	149	183	249	269	335	536	759	1017	1388	1786	2155	2627	3101	3366	3595
Sales Tax/Value Added Tax a/	279	340	381	415	524	527	675	815	1028	1238	1507	1791	2067	2440	2764
Administration and Sales expenses	117	138	159	205	217	279	309	341	380	421	468	519	571	634	695
<b>Total Operating Expenses</b>	1502	1730	2132	2824	3934	4487	5527	6604	7975	9628	11548	13713	15868	19167	22537
<b>Net Operating Income</b>	126	214	162	175	279	788	1231	1554	2315	2766	3529	4207	4814	5245	5120
Interest b/					54	183	216	198	473	394	435	627	775	1020	1102
Other Income	23	22	27	35	26	29	32	35	38	42	46	51	56	62	68
Other expenses	20	23	28	37	27	30	33	36	40	44	48	53	58	64	71
Construction Expenses Written Off	5	7	30	8	0	0	0	0	0	0	0	0	0	0	0
Non-operating Income	-2	-9	-30	-9	-1	-1	-1	-1	-1	-2	-2	-2	-2	-2	-3
Pretax Income	124	205	132	167	223	604	1013	1355	1840	2371	3092	3577	4037	4222	4016
Taxes On Income	62	53	61	60	64	199	334	447	607	782	1020	1181	1332	1393	1325
<b>Net Income After Tax</b>	61	152	71	106	136	404	679	908	1233	1588	2072	2397	2705	2829	2690

**RATIOS**

Operating Ratio (%)c/	92.3	89.0	92.9	94.2	93.4	85.1	81.8	81.0	77.5	77.7	76.6	76.5	76.7	78.5	81.5
Rate of Return on															
Historically Valued Net Assets (%)d/	2.1	4.3	2.5	2.7	4.0	9.2	11.7	10.3	11.2	10.0	10.7	10.7	10.6	11.4	11.3
Notionally Revalued Net Assets (%)d/	-	-	-	-	-	8.7	9.8	7.9	8.3	6.9	6.9	6.5	6.1	5.9	4.9

a/Since 1 Jan 94 Value Added Tax (VAT) has been introduced in PRC instead of sales tax.

b/For the past years interest expenses are not separately available; They are included in loan repayment figures.

c/Operating Expenses divided by Operating Revenue.

d/Net operating income after income tax divided by average net fixed assets.

**HUNAN ELECTRIC POWER COMPANY**  
Sources and Applications of Funds

Year Ending 31 December															(Yuan Million)	
Particulars	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999 (Projected)	2000	2001	2002	2003	
SOURCES																
Consumer Deposit	44	45	59	67	76	66	71	79	90	98	110	123	137	148	168	
Net income before Interest	61	152	71	106	191	588	895	1106	1706	1982	2507	3024	3480	3849	3792	
Depreciation	149	183	249	269	335	536	759	1017	1388	1786	2155	2627	3101	3366	3595	
Construction Expenses Written-off	5	7	30	8	0	0	0	0	0	0	0	0	0	0	0	
Other non-cash items	-76	-97	-86	-97	-137	0	0	0	0	0	0	0	0	0	0	
Internal Resources	183	289	322	352	466	1190	1725	2202	3184	3867	4771	5774	6718	7363	7556	
Borrowings																
Proposed Bank loan						35	62	165	236	218	232	73	0	0	0	
Other loans for Project						278	333	366	693	384	294	66	0	0	0	
Other Borrowings	1245	693	409	860	1373	3081	2356	2225	2653	3883	4119	4240	4636	4845	5145	
Total Borrowings	1245	693	409	860	1373	3395	2751	2756	3582	4486	4645	4380	4636	4845	5145	
Equity	-71	286	168	431	359											
TOTAL SOURCES	1357	1269	900	1643	2198	4585	4476	4958	6767	8352	9416	10154	11354	12208	12701	
APPLICATIONS																
Capital Expenditure for Project	1237	987	626	1309	1915	3664	3171	3356	3784	5465	6038	6119	6431	6668	6977	
Other Capital Expenditure	1237	987	626	1309	1915	3978	3566	3887	4713	6068	6563	6259	6431	6668	6977	
Total Capital Expenditure																
Interest					54	183	216	198	473	394	435	627	775	1020	1102	
Repayment of loans	69	137	155	194	311	228	464	904	1343	1584	2226	2895	3509	4110	3749	
Total Debt Service	69	137	155	194	365	412	681	1102	1817	1978	2661	3523	4284	5130	4851	
Changes in Working Capital	74	66	-79	68	-184	61	77	69	131	131	180	275	459	216	541	
TOTAL APPLICATIONS	1380	1189	701	1570	2096	4451	4323	5057	6661	8176	9404	10057	11174	12014	12369	
Net Change in Cash	-23	79	199	72	102	134	152	-99	106	176	12	97	180	194	332	
RATIOS																
Debt Service Coverage (Times)a/	2.6	2.1	2.1	1.8	1.3	2.9	2.5	2.0	1.8	2.0	1.8	1.6	1.6	1.4	1.6	
Self Financing Ratio (%) b/		9.2	25.3	7.1	11.9	22.7	25.4	25.4	25.3	30.4	30.7	30.8	30.6	30.1	30.6	

a/Funds from internal sources divided by Debt service(principal plus interest).

b/Funds from internal sources minus Debt service, plus/minus change in working capital divided by 3-year moving average (current plus previous plus following year) of capital expenditure.

**HUNAN ELECTRIC POWER COMPANY**  
Balance Sheet

Year Ending 31 December

(Yuan million)

Particulars	(Actual)			a/ (Budget)			(Projected)								
ASSETS															
Current Assets															
Cash	256	329	497	562	664	798	951	852	957	1133	1145	1242	1422	1616	1948
Accounts Receivable	449	506	620	855	976	1034	1115	1192	1309	1424	1571	1727	1878	2082	2260
Inventories	176	192	144	181	482	497	541	610	701	800	915	1065	1181	1302	1410
Securities	26	31	33	33	3	56	124	205	308	432	583	762	969	1213	1489
Other Current Assets															
Total Current Assets	907	1058	1294	1630	2126	2385	2731	2859	3275	3789	4214	4796	5450	6213	7107
Long Term Investments	0	1	0	0	83	83	83	83	83	83	83	83	83	83	83
Fixed Assets															
Plant in Service	4603	5337	5719	6294	9336	10142	13207	18090	24610	30358	35948	44874	50545	53021	57604
Accumulated Depreciation	1105	1312	1553	1788	3081	3617	4376	5393	6781	8567	10722	13349	16450	19816	23411
Net Plant in Service	3498	4025	4166	4506	6255	6525	8831	12697	17829	21790	25225	31525	34095	33205	34192
Construction- In- Progress	373	580	766	1433	2595	5767	6268	5272	3466	3785	4759	2091	2851	7044	9438
Total Fixed Assets	3871	4605	4932	5939	8850	12292	15099	17969	21294	25576	29984	33616	36947	40249	43631
TOTAL ASSETS															
	4778	5664	6226	7570	11059	14761	17913	20911	24652	29448	34281	38496	42479	46545	50821

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**EQUITY AND LIABILITIES**

<b>Current Liabilities</b>															
Accounts Payable	404	411	525	721	1266	1321	1426	1573	1739	1932	2149	2341	2336	2669	2666
Short Term Loan	21	26	58	67	99	109	120	132	145	160	176	193	212	234	257
<b>Total Current Liabilities</b>	425	437	583	788	1365	1430	1546	1705	1884	2091	2324	2534	2549	2903	2923
<b>Long Term Debt</b>	2048	2604	2859	3525	4588	7755	10041	11893	14132	17034	19452	20837	22064	22799	24195
<b>Equity</b>															
Paid-in Capital	2147	2433	2602	3032	3391	3391	3391	3391	3391	3391	3391	3391	3391	3391	3391
Capital Surplus	44	45	59	67	76	142	212	292	382	480	590	713	850	998	1166
Retained Earnings	115	144	123	158	179	583	1262	2170	3403	4991	7063	9460	12165	14984	17685
Revaluation Surplus					1460	1460	1460	1460	1460	1460	1460	1460	1460	1460	1460
<b>Total Equity</b>	2306	2622	2784	3257	5106	5576	6326	7313	8637	10323	12505	15025	17867	20844	23702
<b>TOTAL EQUITY AND LIABILITIES</b>	4778	5664	6226	7570	11059	14761	17913	20911	24652	29448	34281	38496	42479	46545	50821

**RATIOS**

Current Ratio b/	2.1	2.4	2.2	2.1	1.6	1.7	1.8	1.7	1.7	1.8	1.8	1.9	2.1	2.1	2.4
Debt as % of Debt and Equity c/	47.0	49.8	50.7	52.0	47.3	58.2	61.3	61.9	62.1	62.3	60.9	58.2	55.3	52.2	50.5

a/ During 1993, the assets have been revalued in accordance with government guidelines.

b/ Current Assets divided by Current Liabilities.

c/ Long-term debt divided by long-term debt and equity.

## TARIFF SCHEDULES OF HUNAN ELECTRIC POWER COMPANY (April 1994)

### A. Retail Tariffs

Tariff Category	Energy (Yuan per kilowatt-hour)			Capacity Charge	
	Less than 1 kilovolt < 1 kV	1-10 kilovolts	35 kilovolts and above	Maximum Demand (Yuan per kilowatt per month)	Transformer Capacity (Yuan per kilovolt per month)
Residential	0.25	0.245	0.245		
Lighting and commercial	0.403	0.393	0.393		
General industrial	0.325	0.318	0.306		
Large scale industrial	-	0.238	0.227	15.0	10.0
Electric furnace ferro alloy, electro caustic soda, synthetic ammonia, electric furnace calcium magnesium phosphate, electric furnace yellow phosphorus	-	0.228	0.217	15.0	10.0
Calcium carbide	-	0.218	0.207	15.0	10.0
Agricultural	0.193	0.185	0.175		
Irrigation and drainage in impoverished countries	0.11	0.108	0.105		

### B. Wholesale Tariffs

Tariff Categories	Energy Charge (Yuan per kilowatt-hour)	
	1-10 kilovolt	35 kilovolt and above
Residential	0.187	0.187
Lighting and commercial	0.304	0.304
Industrial	0.226	0.218
Agricultural	0.142	0.13
Irrigation and drainage in impoverished countries	0.078	0.073

## **TECHNICAL ASSISTANCE FOR INSTITUTIONAL STRENGTHENING OF THE HUNAN ELECTRIC POWER COMPANY**

### **A. Objectives and Scope**

1. The objective of the technical assistance (TA) is to assist Hunan Electric Power Company (HEPC) to develop into a more self-sufficient, efficient, and financially-sound modern utility able to provide reliable supplies of power to facilitate Hunan Province's economic development, by: (i) reviewing and recommending improvements in HEPC's organizational structure and management, accounting, financial planning and management control systems; (ii) reviewing and recommending reforms in HEPC's electricity tariff levels and structure taking into account economic, financial, and equity considerations; and (iii) providing external training for HEPC staff.

2. The TA will comprise the following components:

- (i) organization review;
- (ii) accounting and management information system;
- (iii) tariff studies; and
- (iv) external training.

### **B. Terms of Reference**

3. The TA will be undertaken by international consultants in association with local consultants. The team will comprise experts in public utilities organization structure and systems, accounting and financial systems including computer-based systems, and power economics including tariffs. It is expected that about nine person-months of international consultants and about four person-months of local consultants will be required to carry out the TA.

4. The organization review will be implemented in two phases, consisting of a review and recommendation phase and implementation phase. Phase II work will commence after a review by HEPC and the Bank of work done under Phase I and acceptance of the recommendations by HEPC.

5. The external training will be provided for about ten persons from HEPC including staff involved in organization review and management information, finance, accounting systems and tariff matters. During this training, officials from HEPC will visit the head office and facilities of a recognized utility abroad and observe and learn modern commercial utility practices. During their visit, a seminar also will be conducted. For the seminar, in addition to concerned officials from the host utility, experts from other recognized utilities will be invited to share their experience. The focus of the seminar will be on the concepts and recent developments in the area of utility organization, financial and management systems and tariff reforms.

6. The terms of reference of the consultants will include the following:

**1. Organization Review**

**Phase I**

- (i) recommend a program including procedures for defining and separating the functions, responsibilities, and work including staff of the Hunan Province Electric Power Bureau (HPEPB) from HEPC;
- (ii) assist HEPC in defining clearly its mission and corporate objectives and functions and review its present and projected operations;
- (iii) review HEPC's present organization structure and identify areas for improvement;
- (iv) recommend an improved and appropriate organizational structure for HEPC based on HEPC's functional needs as self-sufficient company and taking into account the present enterprise reforms in the PRC power sector;
- (v) recommend appropriate steps to improve HEPC's recruitment and training including training facilities to enhance staff skills;
- (vi) recommend suitable options for corporatization of HEPC including adoption of shareholding system;

**Phase II**

- (vii) based on the recommended structure, prepare an organization manual of the functions, duties and responsibilities of each department and division including the power stations and distribution boards under HEPC control;

**2. Accounting and Management Information System Development**

- (i) conduct a review of relevant Government and other regulations concerning accounting standards and practices, audit, corporate law, operational and reporting requirements as well as requirements imposed by lending agencies to establish a framework in which HEPC must operate;
- (ii) review HEPC's present financial system and procedures; ascertain the adequacy of these systems in the context of introducing new accounting standards and the future scope of HEPC's operations;
- (iii) review Government guidelines for revaluation of assets and recommend an appropriate revaluation methodology for HEPC;
- (iv) develop a corporate planning and budgeting process for the long-term, medium-term and annual plans and budget; design and develop a cost analysis system for planning, budgeting and cost control.

- (v) review the work presently being carried out by the external domestic consultants previously engaged by HEPC in the area of computerization and development of systems. Propose changes in strategy and emphasis where required. The areas of review will include (a) computerization strategy for HEPC including hardware and software requirements; (b) management information and control systems; (c) adequacy of the planned accounting and finance systems, software specifications and hardware requirements; and (d) preparation of terms of reference for the consultants or other experts to carry out additional work as necessary.

### **3. Tariff Studies**

- (i) review HEPC's present tariff structure, levels and methodology to arrive at consumer-end tariffs;
- (ii) recommend an appropriate tariff structure and methodology for tariff calculations with the objective of designing simplified tariff structures which are easier to administer and in which clear relationships can be established between costs and the tariffs;
- (iii) consider the need for an automatic tariff adjustment mechanism and its likely specifications;
- (iv) on the basis of financial projections, determine the average level of electricity tariffs required to meet financial targets during each of the next ten years;
- (v) calculate the long-run marginal cost (LRMC) of electricity supply at different voltage levels adopting economic prices for capital goods and fuel and standard conversion factors to correct distortions in exchange rates and labor costs. The standard conversion factors, discount rate and fuel price projections used will be agreed with the Bank and Ministry of Electric Power (MOEP). Also calculate the LRMC for supply of power to rural and urban consumers;
- (vi) review the existing structure and level of HEPC's tariffs in relation to the LRMCs of supply and financial requirements and recommend improvements taking into account the need to (a) conserve energy and use it efficiently; (b) adopt sound load management; (c) to use installed capacity fully; (d) discourage poor power factor consumption; and (e) to manage demand;
- (vii) review and recommend changes needed in the metering arrangements, as well as meter reading and billing systems as a result of the recommended tariff structure;
- (viii) recommend a program of adjustments to bring the structure and level of electricity tariffs in line with financial requirements and LRMCs of supply;

**4. Training**

- (i) provide on-the-job and classroom training in the new systems and procedures developed by the Consultants;
- (ii) arrange external training including a seminar for about 10 persons from HEPC at a well recognized utility, which has carried out notable work in the areas of organization structure, introduction of modern financial systems and tariff reforms. The consultants will identify the host utility, coordinate the visit of the HEPC staff, and design and organize the seminar in consultation with host utility. The program for the external training should be submitted to the Bank for approval prior to its implementation.

7. The consultants engaged under this TA will take into account the results of ongoing Bank TAs in the PRC including financial and management information systems, energy efficiency, and tariff and financing reforms.

**5. Reporting Requirements**

8. The consultants will prepare and submit progress and other reports to HEPC and Bank as follows:

- (i) An inception report, giving the consultant's work program will be submitted within one month of the inception of the Technical Assistance;
- (ii) A monthly report will be submitted on the progress of the Technical Assistance;
- (iii) A draft final report will be prepared on the completion of Phase I of the organization review and the work on accounting and management information system and the tariff studies. By this time, the external training should also have been complete. The draft final report will detail recommendations for the various components of the TA work. The draft final report will also include a program for implementation of the recommendations and a report on the external training;
- (iv) After a review of the draft final report, a tripartite meeting will be held between HEPC, the Bank and the consultants to discuss the recommendations and agree on the scope and schedule of implementation of the recommendations;
- (vi) A final report is to be prepared after the tripartite meeting dealing with the implementation of the recommendations including the consultants' recommended organizational manual. The final report will advise on any requirements on the follow-up activities.

**Cost Estimates (\$)**

Source/Component	Foreign Cost	Local Cost	Total
<b>I. Financed by the Bank</b>			
<b>A. Consultants</b>			
Remuneration and per diem			
(i) International Consultants (Expertise in Organization Structure and Systems, Accounting, Finance, Tariff)	190,500	—	190,500
(ii) Local Consultants (Expertise in Accounting and Finance, Tariff)	—	23,800	23,800
<b>B. Consultants Travel</b>			
(i) International Consultants	50,000	—	50,000
(ii) Local Consultants	—	2,400	2,400
C. External Training	64,800		64,800
D. Computers	5,000	—	5,000
E. Contract Negotiations	5,000	—	5,000
F. Communications	10,000	1,000	11,000
G. Reports	5,000	1,000	6,000
H. Contingency	38,000	3,500	41,500
Subtotal (I)	368,300	31,700	400,000
<b>II. Financed by HEPC</b>			
A. Counterpart Staff	—	10,000	10,000
B. Office Space	—	10,000	10,000
C. Local Travel	—	15,000	15,000
D. Contingencies	—	5,000	5,000
Subtotal (II)		40,000	40,000
Total (I+II)	368,300	71,700	440,000

## TECHNICAL ASSISTANCE FOR INTRODUCING BOO/BOT CONCEPT FOR SHANGHAI WAIGAOQIAO STAGE II PROJECT

### A. Background

1. The total installed power generation capacity in the People's Republic of China (PRC) increased from 66 gigawatt-hours (GWh) in 1980 to about 181 GWh in 1993, an average growth of about 8 per cent per year. During the same time, the power generation increased from 300 terawatt-hours (TWh) in 1980 to 837 Twh in 1993, again at an average growth of about 8 per cent per year. The forecasts up to the year 2000 show that electricity demand will grow at the rate of about 8-9 per cent per year. In order to meet this demand, the installed capacity will need to increase up to about 300 GW by the year 2000. This requires a capacity addition of about 17 GW each year in the next seven years.

2. The financing needs for such a capacity addition program is very large, estimated to be of the order of \$15-20 billion per year. Innovative financing methods are needed to fund the power sector program. In view of the limitation on domestic financing, the PRC has opened the sector for private and foreign investment, through the modes of joint venture as well as wholly foreign owned companies. Implementation of the power projects under build-own-operate/build-operate-transfer (BOO/BOT) scheme is one of the important options being considered by the Government. A total of 34 thermal power projects with a capacity of over 30,000 MW have been identified for being developed as BOO/BOT projects. Implementation of BOO/BOT power projects under competitive bidding, which the Bank prefers, is new to the PRC. The introduction of BOO/BOT concept for project implementation also calls for preparation of appropriate guidelines and documents for processing, evaluation, and selection of project sponsors. The proposed technical assistance (TA) will assist in preparing a specific project for implementation under BOO/BOT scheme.

3. The Waigaoqiao Stage II Project under the Shanghai Municipal Electric Power Company (SMEPC), with a capacity of 2x800-1000 MW, has been identified by the Government as the priority project to be implemented under the BOO/BOT scheme. The TA will assist the Government and SMEPC in preparing the Project for bidding under the BOO/BOT scheme.

### B. Objective and Scope

4. The objective of the TA is to help SMEPC to prepare the Waigaoqiao Project for implementation under BOO/BOT scheme by assisting in the development of procedures, guidelines and documents for bidding. The TA will:

- (i) identify the scope of the project to be offered for bidding, and recommend an appropriate set of guidelines, rules, regulations and incentives for attracting the most favorable responses from bidders;
- (ii) develop bidding procedures and request for proposal (RFP) documents including, but not limited to, proforma power purchase agreement, fuel supply agreement, and implementation agreement for the Project to be implemented under BOO/BOT scheme;
- (iii) provide a field study to key officials from the Government and SMEPC involved in the policy making and implementation of BOO/BOT projects to the latest developments in this area.

**C. Terms of Reference**

5. The TA will be carried out in two parts. Under Part I, scope of the Project for implementation under BOO/BOT scheme will be identified along with recommendations on preferred set of rules, regulations and incentives for the bidding of the Project. Under Part II, assistance will be provided for the preparation of request for proposal (RFP) documents for inviting bids for the Project.

6. The TA will be undertaken by a team of international consultants in association with local consultants. The team will comprise personnel familiar with BOO/BOT type of power projects and will include (i) power economist/planner, (ii) power engineer with expertise in design/operation of large coal-fired stations, (iii) environmental engineer with experience relating to coal-fired stations, (iv) legal expert with experience in BOO/BOT project documentation and (v) power sector financial analyst/project financing expert. About 15 person-months of international consultants and about 5 person-months of local consultants are expected to be required. The detailed terms of reference (TOR) are:

**Part I - Identification of Project Scope and Terms of Offer for Bidding**

- (i) In order to suitably package the Project to attract the best response from potential bidders, examine the relevant aspects of the Project for implementation under the BOO/BOT scheme; this will include review of (a) technical aspects of the Project such as location, unit size, Project capacity, fuel source and transportation, facilities to be established; (b) the Project cost and the investment requirements, the likelihood of bidders being able to mobilize necessary finances, and the extent of competition in bidding that could be expected; and (c) the impact of the Project on the Shanghai and East China power system, the financial position of SMEPC, and the tariff levels. Based on this review, identify the Project package for bidding.
- (ii) Based on international practice, the requirements of financial institutions and the general expectations of private power developers, identify the framework and incentives and guarantees that may be offered by the Government to attract the best response from bidders for the Project. Such recommendations will be based on a study of existing policies and regulations that govern the generation, transmission and distribution of electricity in the PRC, foreign and private investment in the power sector, and contract and company laws. This study should cover the legal, commercial, and administrative framework of the sector. The recommendations will be based on an assessment of the possible policy changes to attract greater competition in the bidding for the Project, and identification of the corresponding changes which may be made in the rules and regulations. This should cover related areas including fuel supply policies, tariff setting mechanisms, project financing, establishment and ownership structure of private/foreign enterprises, repatriation of profits and currency conversion.
- (iii) Compile a document and make a presentation to the PRC authorities on the comparative picture of the state of development of private power in various countries relevant to the PRC. Subsequent to this, at an appropriate time during the TA work, assist the Ministry of Electric Power (MOEP) in organizing and carrying out a field study with the participation of key officials from the Government and SMEPC who are involved in policy making and implementation of private power projects. The field study will be conducted in selected countries whose experience in private power is of relevance to the PRC, and will enable the officials concerned to obtain first hand information on the status of private power development and the relevant regulatory framework. Prior to undertaking the field study, MOEP will consult the Bank on the

composition of the delegation, itinerary and scope of the study. MOEP will make available to the Bank a copy of the report prepared on the completion of the field study, summarizing the findings during the study.

- (iv) Based on the work carried out under tasks listed above, recommend a set of specific rules, regulations, incentives and guarantees that are necessary to be put in place prior to finalization of the Project for bidding.
- (v) Prepare a brochure on the Waigaoqiao Project, which can be made available to the interested private parties; the brochure will highlight the policies, procedures and incentives for private power developers and will also give a brief description of the Project offered for development under BOO/BOT scheme, along with particulars about SMEPC.

## **Part II - Preparation of the Project for Implementation under BOO/BOT Scheme**

7. On the basis of the outcome of works carried out under Part I, develop necessary procedures and documentation for implementation of the Project under BOO/BOT scheme. Under this Part the consultants shall:

- (i) Review the feasibility report and the engineering design prepared by SMEPC in order to confirm completeness and consistency in Project design, and also to identify the facilities to be established by the Project sponsor. This review will also include fuel handling and power evacuation systems.
- (ii) Review the environmental impact assessment report prepared by SMEPC; identify the equipment and systems to be incorporated in the Project in order to meet (a) the national standards, and (b) the standards adopted by international financial institutions (so that the Project will be eligible to receive at a later stage, if required, financial assistance from these institutions).
- (iii) Prepare request for proposal (RFP) documents. This is a key element in the TA work. The RFP documents will lay down the procedures, ground rules and requirements for the submission of the bids. These documents will delineate the responsibilities of the parties involved in the Project. The RFP documents will include the criteria for evaluation of the offers made by the potential bidders and will prescribe the format for submission of the offers.
- (iv) Prepare proforma implementation agreement, power purchase agreement and fuel supply agreement; these documents will be used by SMEPC for entering into appropriate contracts with the project sponsors.
- (v) Develop a computerized model for financial evaluation of the bids; this model will help the SMEPC make a comparison of the financial and price offer of the various bidders, and analyze the impact of the offers on utility's own finances.
- (vi) The consultant will associate the concerned staff of SMEPC in the various tasks to be performed under this Part. In addition, the consultant will provide classroom training for a total period of five days for selected staff of SMEPC. This training will cover basic BOO/BOT concepts, features of the various agreements and their implications, and procedures for evaluation of offers from the various bidders.

**D. Implementation**

8. SMEPC will be the Executing Agency for the TA. The TA work will commence with tasks under Part I, and preliminary activities under Part II. On completion of work under tasks (i) to (iv) in Part I, the consultant will develop recommendations on the scope of the Project and changes in rules and regulations that may be made for soliciting bids for the Project. At this stage a review meeting will be held between representatives of the Government, including MOEP, SMEPC, the Bank and the consultant to discuss the recommendations and how they can be implemented. In the meantime the consultant will continue work under Part I and Part II. However, Part II will be completed only after agreed recommendations on Part I have been implemented. It is expected that a period of 3 months will be required to put in place the agreed recommendations.

9. In carrying out the tasks, the consultant will take into account studies already carried out by the World Bank and other institutions and the PRC authorities.

**E. Reporting Requirements**

10. The consultants will prepare and submit progress and other reports to MOEP, SMEPC and the Bank as under:

- (i) an inception report giving the consultant's work program will be submitted within one month of the commencement of the technical assistance;
- (ii) a report will be submitted to the Government, including MOEP, SMEPC and the Bank at the end of work on tasks (i) to (iv) under Part I; this report will provide the Project scope to be offered for bidding and list the recommended rules, regulations and incentives to attract good bidder response. This report will form the basis for discussions during the meeting to be held between Government representatives including from MOEP and SMEPC, the Bank, and the consultant as mentioned in the TOR;
- (iii) during the work under Part II, a brief report containing comments and recommendations based on the review of the Project feasibility report and EIA as soon as work on these aspects are completed;
- (iv) during the work under Part II, a draft of various documents to be submitted when they are completed. The consultant shall finalize the documents taking into account comments received from the Government including MOEP, SMEPC and the Bank. The Consultant's services under Part II shall be deemed complete upon receipt by MOEP, SMEPC and the Bank of final copies of all required documents;
- (v) on completion of work under II, the Consultants shall submit a draft Final Report incorporating (i) a summary of observations and recommendations on the work done under the TA, (ii) a final version of all the documents prepared, and (iii) recommendations on further processing of the Project for implementation under BOO/BOT scheme. Within one month of submission of the draft Final Report, comments on this will be offered by the Government including MOEP, SMEPC and the Bank. Within a month thereafter, the Consultants shall submit the Final Report; and
- (vi) in addition to the above, monthly reports presenting the progress of activities under the Technical Assistance to be submitted within one week after the end of the month to which they relate.

**Cost Estimates(\$)**

Source/Component	Foreign Cost	Local Cost	Total
<b>I. Financed by the Bank</b>			
<b>A. International Consultants</b>			
(1) Remuneration	302,000	0	302,000
(2) Per Diem	36,750	0	36,750
(3) Travel	60,000	3,000	63,000
(4) Communications	15,000	0	15,000
(5) Reports, Documents & Training Materials	12,000	0	12,000
Subtotal	425,750	3,000	428,750
<b>B. Field Study</b>	58,000	0	58,000
<b>C. Local Consultants</b>			
(1) Remuneration	0	20,000	20,000
(2) Per Diem	0	9,000	9,000
(3) Travel	0	2,000	2,000
(4) Communications	0	1,000	1,000
(5) Reports & Documents	0	1,000	1,000
Subtotal	0	33,000	33,000
<b>D. Office Equipment including Computer Hardware and Software</b>	12,000	0	12,000
<b>E. Contract Negotiations</b>	5,000	0	5,000
<b>F. Contingencies</b>	59,550	3,700	63,250
Subtotal (I)	560,300	39,700	600,000
<b>II Financed by SMEPC</b>			
A. Counterpart Staff	0	20,000	20,000
B. Office Space	0	10,000	10,000
C. Local Travel	0	15,000	15,000
D. Interpreters	0	10,000	10,000
E. Contingencies	0	9,000	9,000
Subtotal (II)	0	64,000	64,000
<b>TOTAL (I+II)</b>	560,300	103,700	664,000

## CALCULATION AND UNDERLYING ASSUMPTIONS FOR ECONOMIC ANALYSIS OF THE PROJECT

### A. LEAST-COST ANALYSIS

1. A least-cost analysis of the Project was carried out in 1993 by HEPC and MSDI through computer simulations using the IREL P linear programming model developed by Qinhua University. The input data and assumptions were reviewed by Bank TA Consultants. The parameters for the thermal power plants, including the cost of coal and the capital cost of coal-fired projects, were found to be appropriate. The assumed price of coal, \$44 per ton, compares with the World Bank projected price increase between 1992 and 2005 of \$38 to \$42 per ton in 1990 constant prices. Coal consumption, at 320 grams per kilowatt-hour (g/kWh), compares well with power plant consumption rates in the PRC that range from 261 to 432 g/kWh.<sup>1</sup> The average consumption in 1991 in the Central China Power Network, to which Lingjintan will be connected, was 421 g/kWh (including old plants). The capacity cost of coal-fired power plants was fixed at \$612 per kilowatt (kW) based on the prices of the PRC equipment. This compares with the international cost levels of \$1,000 to \$1,200 per kW. The analysis showed that the Project was a part of the least-cost solution.

2. The result of the least-cost analysis is supported by the levelized cost analysis carried out by the Mission. At 10 per cent discount rate and with the application of the average standard conversion factor of 0.9 to the local cost, the unit energy cost of this plant is US¢3.20 per kWh. This is lower than coal-fired base load unit cost of US¢3.42 per kWh and lower than the diesel-fired peak load unit cost of US¢10.8 per kWh (26 per cent of the firm energy from the Lingjintan plant will be for peak load, see Table 1). The weighted average energy cost of combined base and peak load thermal generation is estimated at US¢3.52 per kWh, assuming that all secondary energy from Lingjintan will only replace fuel and other operation and maintenance costs of coal-fired generation, and thus the corresponding thermal generation is US¢2.1 per kWh. Other hydropower plants being planned may have a lower unit energy cost, but their planning is still at a preliminary stage and it would not be possible to implement these before Lingjintan.

3. An equalizing discount rate (EDR) analysis also confirms these findings. In conducting the analysis, the economic life of the various project components was assumed to be 50 years for all civil works, 25 years for mechanical and electrical works, and 35 years for transmission line works. The operation and maintenance costs were assumed to be 0.5 per cent of investment in civil works plus US¢0.45 per kWh generated plus 2 per cent of investment in transmission line works. The value for capital investment in coal-fired thermal plants, and diesel-fuelled power plants was assumed to be \$690 and \$400 per kW respectively. A plant life of 25 years was assumed for coal-fired plants and 20 years for diesel power plants. Coal was costed at \$45.5/ton<sup>2</sup> and diesel oil at \$0.09/l.<sup>3</sup> The result shows that the Lingjintan plant is

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<sup>1</sup> Electric Power Industry in China issued by Ministry of Electric Power (1993).

<sup>2</sup> Based on the \$42 per ton in the year 2000 projected by the World Bank in 1990 prices, adjusted to 1993 prices by the annual inflation rate of 3 per cent.

<sup>3</sup> Based on the \$18 per barrel in the year 2000 projected by the World bank in 1990 prices, adjusted to 1993 prices by the annual inflation rate of 3 per cent.

superior up to the discount rate of 12.9 per cent (see the cash flow table on page 4 of this appendix). In other words, the Lingjintan plant is more beneficial than the thermal alternative in terms of cost.

**Table 1 - Levelized Cost Comparison**

<b>Alternative Method of Generation</b>	<b>Lingjintan</b>	<b>Base Load Coal</b>	<b>Peaking Diesel</b>
Net Installed capacity	240.0 MW	48.4 MW	174.4 MW
Net Energy Generation	1,173 GWh	1,107 GWh	120 GWh
Lingjintan Firm	461	359	120
Lingjintan Secondary	712		
Plant Factor	56%	85%	8%
Design life		25 years	20 years
Civil Works	50 years		
Electromechanical	25 years		
Investment Cost	285 \$ million	690 \$/kW	400 \$/kW
Fuel Costs	none		
Unit fuel consumption		320 g/kWh	0.27 l/kWh
Unit cost fuel		45.5 \$/ton	8.8 US¢/litre
Unit cost of energy		1.46 US¢/kWh	2.37 US¢/kWh
Operation and Maintenance Costs			
Fixed	0.5% of investment	19.3 \$/kW	25.0 \$/kW
Variable	0.45 US¢/kWh	0.33 US¢/kWh	0.23 US¢/kWh
Unit Energy Cost	3.20 US¢/kWh	3.42 US¢/kWh	10.8 US¢/kWh

## **B. ECONOMIC RATE OF RETURN**

### **1. Economic Benefit of Shifting Wuqiangxi's Output From Base to Peak Load**

4. The Lingjintan hydropower plant will serve as a reregulating facility for the Wuqiangxi hydropower plant upstream on the same river and will have a beneficial influence on its operation mode. While the Wuqiangxi's installed capacity is 1,200 megawatt (MW), its dependable capacity is 1,020 MW.<sup>1</sup> Without Lingjintan, 1,248 gigawatt-hour (GWh) per year of firm energy output from the Wuqiangxi has to be used for base load supply at about 150 MW, because downstream navigation requires that the Wuqiangxi releases 380 cubic meters/second (m<sup>3</sup>/s) of water continuously. The remaining available firm energy (892 GWh) can be used during peak hours (six hours a day) at 650 MW, allowing for 220 MW in reserve capacity (1,020 MW - 150 MW - 220 MW). With the Lingjintan plant, the Wuqiangxi plant will no longer need to release water continuously for navigation and, therefore, will be able to generate its firm energy during peaking hours with a dependable maximum peaking capacity of 800 MW. To recapture the

<sup>1</sup> The Wuqiangxi power plant can generate power at its installed capacity of 1,200 MW when the reservoir water level is high (el.108 m) in the rainy season. As the level drops in the dry season, the maximum output will also drop. For planning purposes, the dependable capacity is defined as that maximum output that can be guaranteed at least 95% of the time. The dependable capacity of the Wuqiangxi power plant is 1,020 MW and the corresponding water level is at elevation 90 m.

benefit of this change in the operational mode of the Wuqiangxi plant, the economic benefits of the Project have been calculated based on the capacity and energy balance of the Lingjintan and Wuqiangxi plants as summarized in Table 2 below.

**Table 2: Energy Balance**

Type of Energy (Peak or Base)	Corresponding Thermal Alternative	Gain/Loss in Hydropower		Corresponding Alternative Thermal Power Plant <sup>a</sup>		Plant Factor
		Dep. Capacity (MW)	Energy (GWh)	Dep. Capacity (MW)	Energy (GWh)	
Peak (Wuqiangxi + Lingjintan)	Diesel	+ 980	+ 1,368	1,055	1,378	0.15
Firm base load (Lingjintan)	Coal	+ 40	+ 342	48	360	0.85
Secondary base load (Lingjintan)	Coal	N. A.	+ 712	N.A.	750	
Base load (Wuqiangxi)	Coal	- 150	- 1,248	- 181	- 1,315	0.83
	SUM	+ 870	+ 1,174	922	1,173	

<sup>a</sup> Because of different forced outages, scheduled maintenance periods, transmission losses and station's own use of electricity between hydropower plants and thermal power plants, it is necessary to adjust both installed capacity values and generation estimates of alternative sources of energy. Based on average values for the Central China Electric Power Network, to which HEPC belongs, the adjustment coefficients for coal-fired thermal power plant installed capacity is 1.21 and for energy 1.05. For diesel-fuelled plants, the corresponding coefficients are 1.08 and 1.01.

## 2. Economic Internal Rate of Return

5. The viability of the Project was analyzed from a broader national perspective in terms of its economic internal rate of return (EIRR). The financial costs were adjusted by applying an average standard conversion factor of 0.90 to all local costs. On the benefit side, the firm energy output of the Lingjintan plant was valued at a consumers' willingness to pay (WTP) conservatively estimated at 40 fen per kWh (US\$4.6 per kWh) on the basis of the average consumer price of electricity plus 35 per cent consumer surplus based on the cost of alternative electricity supply options (see Table 3). Because of its unreliability, the secondary output was valued at the savings in fuel and other operation and maintenance cost of coal-fired power plants estimated at 18.1 fen per kWh (US\$2.1 per kWh). The benefit of the shifting of the 1,248 GWh of Wuqiangxi's firm energy output from base load supply to peak load supply was valued at the difference between alternative thermal power supply for peak load (diesel power) and base load (coal-fired power) estimated at 36.3 fen per kWh (US\$4.2 per kWh - see Table 4). System losses of 20 per cent and network cost of 8.7 fen per kWh (US\$1.0 per kWh) were assumed in the calculation. The analysis shows an EIRR of 16.6 per cent (see the cash flow table in page 6).

**Table 3: Cost of Alternative Power Supply Options**

<b>Consumer Type</b>	<b>Supply Option</b>	<b>fen/kWh</b>	<b>cents/kWh</b>
Industrial	Average Tariff	35	4.0
	Medium Diesel	54	6.2
Large Industrial	Average Tariff	29	3.3
	Medium Diesel	54	6.2
Commercial	Average Tariff	72	8.3
	Petro Generator	146	16.8
Residential	Average Tariff	28	3.2
	Kerosene Lighting	110	12.7

Note: Average Tariff: Average HEPC Tariff (25 fen per kWh) plus surcharges (2.0 fen per kWh for Provincial Power Development Fund, 0.4 fen per kWh for Three Gorges Project, and 30.0 fen per kWh for commercial consumer surcharge)

**Table 4 - Levelized Cost Comparison**

<b>Alternative Method of Generation</b>		<b>Base load Coal</b>	<b>Peaking Diesel</b>
Net Installed capacity		200 MW	861 MW
Net Energy Generation		1,312 GWh	1,258 GWh
Plant Factor		75%	17%
Design life		25 Years	20 Years
Investment Cost		690 \$/kW	400 \$/kW
Fuel Costs			
	Unit fuel consumption	320 g/kWh	0.27 l/kWh
	Unit cost fuel	45.5 \$/ton	8.8 US¢/litre
	Unit cost of energy	1.46 US¢/kWh	2.37 US¢/kWh
O & M Costs			
	Fixed	19.3 \$/kW	25.0 \$/kW
	Variable	0.33 US¢/kWh	0.23 US¢/kWh
Unit Energy Cost		3.42 US¢/kWh	7.59 US¢/kWh

Equalizing Discount Rate Computation - (all costs in million Yuan) - Lingjintan Only																					
Cost of Lingjintan Hydropower					Cost of meeting reduction in net hydro base load output by coal fired thermal plants					Savings in peak load supply from diesel fired thermal plants					Net benefits						
Year	Energy Output Hydro GWh	Investment LC	FX	Operation & Maint.	Sum Costs	LJT firm + Secondary Output	Loss of WOX base load <----- GWh ----->	Required Base Load <----- GWh ----->	Invest	O&M	Fuel	Sum	LJT Output	WOX Output <----- GWh ----->	Required Peak	Invest	O&M	Fuel	Sum	Net benefits	
1994	0	(226)	(27)	0	(254)				70			70					194		0	(184)	
1995	0	(232)	(53)	0	(285)				70			70				209			209	(6)	
1996	0	(223)	(144)	0	(366)				70			70				209			209	(88)	
1997	0	(403)	(196)	0	(599)				70			70				209			209	(320)	
1998	293	(158)	(162)	(13)	(333)	277	0	277		15	32	46	30	0	30		40	6	45	(241)	
1999	587	(83)	(151)	(24)	(257)	554	0	554		22	63	85	60	0	60		40	11	52	(120)	
2000	880	(36)	(85)	(34)	(156)	830	0	830		30	95	124	90	0	90		41	17	58	26	
2001	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2002	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2003	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2004	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2005	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2006	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2007	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2008	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2009	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2010	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2011	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2012	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2013	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2014	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		41	22	64	178	
2015	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		209	41	22	273	387
2016	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		209	41	22	273	387
2017	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120		209	41	22	273	387
2018	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
2019	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
2020	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
2021	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
2022	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
2023	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
2024	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
2025	1,173	0	0	(49)	(49)	1,107	0	1,107		37	126	163	120	0	120			41	22	64	178
Asset Value		419	0		419.4	8,883	0	8,883	0			1,234	967	0	967	(282)			(282)	137	
NPV	7,071	(1,084)	(594)	(296)	(1,974)	8,883	0	8,883	243	306	1,013	1,234	967	0	967	766	382	180	1,006	266	
EUEC USc										Cost Energy Base Load, USc			Cost Energy Peaking, USc			EDR:					
Discount Rate										Combined Cost Base and Peak, USc			Discounted Net Energy			GWh					
10%										1.60 /kWh			11.97 /kWh			9,849					

## CALCULATION OF ECONOMIC INTERNAL RATE OF RETURN

Year	Energy Output			Available to Consumer incl. system losses and energy output/benefit adjustment			Hydro Costs	Benefit		Net Benefit
	Lingjintan	Wuqianxi	Lingjintan	Lingjintan	Wuqianxi	Lingjintan	Lingjintan	Lingjintan and Wuqianxi	Lingjintan	
	Firm Energy	Firm Energy	Secondary Energy	Firm Energy	Firm Energy	Secondary Energy		Firm Energy	Secondary Energy	
	GWh	GWh	GWh	GWh	GWh	GWh	Y mill	Y mill	Y mill	Y mill
1994	0	0	0	0	0	0	254	0	0	(254)
1995	0	0	0	0	0	0	285	0	0	(285)
1996	0	0	0	0	0	0	366	0	0	(366)
1997	0	0	0	0	0	0	599	0	0	(599)
1998	461	1,248	88	369	999	71	333	391	7	65
1999	461	1,248	296	369	999	237	257	391	22	156
2000	461	1,248	504	369	999	403	156	391	38	273
2001	461	1,248	712	369	999	569	49	391	53	395
2002	461	1,248	712	369	999	569	49	391	53	395
2003	461	1,248	712	369	999	569	49	391	53	395
2004	461	1,248	712	369	999	569	49	391	53	395
2005	461	1,248	712	369	999	569	49	391	53	395
2006	461	1,248	712	369	999	569	49	391	53	395
2007	461	1,248	712	369	999	569	49	391	53	395
2008	461	1,248	712	369	999	569	49	391	53	395
2009	461	1,248	712	369	999	569	49	391	53	395
2010	461	1,248	712	369	999	569	49	391	53	395
2011	461	1,248	712	369	999	569	49	391	53	395
2012	461	1,248	712	369	999	569	49	391	53	395
2013	461	1,248	712	369	999	569	49	391	53	395
2014	461	1,248	712	369	999	569	49	391	53	395
2015	461	1,248	712	369	999	569	49	391	53	395
2016	461	1,248	712	369	999	569	49	391	53	395
2017	461	1,248	712	369	999	569	49	391	53	395
2018	461	1,248	712	369	999	569	49	391	53	395
2019	461	1,248	712	369	999	569	49	391	53	395
2020	461	1,248	712	369	999	569	49	391	53	395
2021	461	1,248	712	369	999	569	49	391	53	395
2022	461	1,248	712	369	999	569	49	391	53	395
2023	461	1,248	712	369	999	569	49	391	53	395
2024	461	1,248	712	369	999	569	49	391	53	395
2025	461	1,248	712	369	999	569	49	391	53	395
							(419)			419
<b>PV (10%)</b>	3,225	8,728	4,176	2,580	6,983	3,341	1,974	2,736	313	1,075
<b>EIRR</b>										<b>16.6%</b>

**Note:**

(a) Willingness to Pay (WTP) for Firm Energy from Lingjintan

40.0 fen/kWh

(b) Value of Secondary Energy from Lingjintan

18.1 fen/kWh

(c) Value of conversion of Wuxiangba base load to peak load energy

36.3 fen/kWh (difference between generation costs of diesel and coal fired thermal power plants)

(d) Transmission and distribution losses 20%

(e) Network costs 1.00 US\$/kWh 8.7 fen/kWh

**CALCULATION AND UNDERLYING ASSUMPTIONS  
FOR FINANCIAL ANALYSIS OF THE PROJECT**

(Mill. Yuan)				
Year	Capital Costs	O&M Costs	Benefits	Net Cash Flow
1993	0.0			0.0
1994	269.8			-269.8
1995	299.6			-299.6
1996	370.8			-370.8
1997	612.7			-612.7
1998	317.5	16.6	108.7	-225.4
1999	225.1	28.1	217.8	-35.5
2000	116.4	39.6	326.5	170.5
2001		51.1	435.2	384.1
2002		51.1	435.2	384.1
2003		51.1	435.2	384.1
2004		51.1	435.2	384.1
2005		51.1	435.2	384.1
2006		51.1	435.2	384.1
2007		51.1	172.9	121.8
2008		51.1	172.9	121.8
2009		51.1	172.9	121.8
2010		51.1	172.9	121.8
2011		51.1	172.9	121.8
2012		51.1	172.9	121.8
2013		51.1	172.9	121.8
2014		51.1	172.9	121.8
2015		51.1	172.9	121.8
2016		51.1	172.9	121.8
2017		51.1	172.9	121.8
2018		51.1	172.9	121.8
2019		51.1	172.9	121.8
2020		51.1	172.9	121.8
2021		51.1	172.9	121.8
2022		51.1	172.9	121.8
2023		51.1	172.9	121.8
2024		51.1	172.9	121.8
2025	-516	51.1	172.9	637.8
FIRR				9.3%

**Assumptions for Computation of FIRR**

1. Project life of 50 years.
2. Total cost of the Project is Yuan 221.2 million (1993 base price plus only physical contingencies).
3. Incremental annual operation and maintenance (O&M) Costs estimated at 0.5% of civil works cost 3.7 Yuan per KWh of power generated.
4. Output of the Project is valued at the tariffs proposed by HEPC for this Project. Details of tariffs are presented in pages 2 and 3 of this Appendix. The tariffs to be charged during loan repayment period have been discounted to present levels to reflect tariff in real terms. HEPC have stated that these two levels of tariffs will be maintained in real terms.
5. Annual output of the Project at stabilized level of operation will be 1173 GWh.

**HUNAN LINGJINTAN HYDROPOWER PROJECT**  
**Tariff Calculations a/**

1.	<b>Project Cost</b>	(Yuan Million)	3190.63
2.	<b>Average Annual Output</b>	(GWh)	1173
3.	<b>Costs to be Recovered</b>		

**(A) During Loan Repayment Period**

Cost Item	Basis	Annual Cost (Yuan Mill.)
Depreciation	4.5% of Project Cost	143.58
Overhaul Expenses	2.5% of Project Cost	79.77
Interest on Working Capital	@10.98% on 70% of Working Capital calculated as Y10 per KW	0.18
Wages	For 783 employees @Y4500 per capita	3.52
Welfare	15.5% of above	0.55
Materials	@ Y3.2 per KW	0.77
Administrative Expenses	@ Y12.5 per KW	3.00
Maintenance Fund for the Reservoir Area	@ Y0.001 per KWh	1.17
	Total Operating Cost	232.53
	90% of Depreciation	129.22
	Total Operating Cost less 90% Depreciation b/	103.31
Enterprise Reserve Profit	@ Y2000 per employee c/	1.57
Annual Equated Payment of Bank Loan and Interest	Loan: \$116m.(Y1009.2m.) Repayment Period: 19 years Interest Rate: 6.5%	94.01
Annual Equated Payment of SDB Loan and Interest	Loan: Y1091m. Repayment Period: 7 years Interest Rate: 11.16%	232.73
Annual Equated Payment of HPG Loan and Interest	Loan: Y1091m. Repayment Period: 7 years Interest Rate: 3.6%	179.09
	Total Annual Equated Repayment of Loans	505.83
	Total Annual Costs to be Recovered by Tariff d/	609.14

**(B) After Loan Repayment**

Costs excluding Repayment Amounts e/		234.10
Profit	10% of Project Costs c/	319.06
Less Income Tax	@33% of Profit f/	105.29
	Total Annual Costs to be Recovered by Tariff	447.87

4. Tariff g/	Basis	fen/KWh
(A) During Loan Repayment Period	Costs to be Recovered per unit of Output	0.52
(B) After Loan Repayment	-do-	0.38

Notes

- a/ The calculations are based on the guidelines given in the Government's document on "Provisional Regulations for the Financial Evaluation of Hydropower Construction Projects" and the specific parameters pertaining to Lingjintan Project. While these guidelines are under discussion and yet to be finalized, the basic structure as well as the several components forming part of the tariff are not likely to change. The tariff to be charged for the power output from the Lingjintan Project at the station busbar has been computed based on these guidelines. An important feature of the methodology prescribed is that it results basically in two levels of tariff from the power station, a higher level during the period when loans obtained for implementing the Project are being repaid and a lower tariff when loan repayments have been completed. This is because when loans are being repaid, the guidelines allow recovery of loan repayment amounts through the tariff. On the other hand after the loan repayment period, the utility is allowed instead to include a profit component in the tariff.
- b/ During the loan repayment period although the utility is allowed to recover the loan repayment amount through tariff, 90% of the depreciation amount is to be used for loan repayments.
- c/ During loan repayment period, tariff does not include the profit element (except for a nominal amount of Y2000 per employee per annum). However after the loan repayment period, profit is allowed at the rate of 10 per cent of project investment.
- d/ The costs to be recovered by tariff will also include income tax, VAT and other surcharges to be paid by utility. However since these are paid back to the Government, these components of tariff have not been considered for computing FIRR. It is to be noted that the actual tariff to be charged will be higher with the inclusion of these taxes and other charges.
- e/ The SDB loan and HPG loan will be repaid in 7 years after project commissioning. Although the Bank loan will continue to be repaid after this period, since Bank loan repayment amount is less than depreciation, this has not been separately considered.
- f/ 33% of profit is paid as income tax.
- g/ The tariffs arrived at are in nominal terms based on the estimated completion cost of the Project. While computing Project FIRR, these tariffs have been discounted to present levels.