Document of
The World Bank

Report No: 25237

IMPLEMENTATION COMPLETION REPORT
(CPL-36060; SCL-3606A; SCPD-3606S)

ON A

LOAN

IN THE AMOUNT OF US$300 MILLION

TO THE PEOPLE'S REPUBLIC OF CHINA

FOR TIANHUANGPING HYDROELECTRIC PROJECT

December 23, 2002

Energy and Mining Sector Unit
East Asia and Pacific Region

CURRENCY EQUIVALENTS

(Exchange Rate Effective)

Currency Unit = Yuan (Y)
Y 1 = US$ 0.12048
US$ 1 = Y 8.28

Exchange Rate During Project Years

Year	Average
1992	Y5.49
1993	Y5.75
1994	Y8.60
1995	Y8.30
1996	Y8.30
1997	Y8.30
1998	Y8.28
1999	Y8.28
2000	Y8.28
2001	Y8.28
2002	Y8.28

FISCAL YEAR

January 1 December 31

ABBREVIATIONS AND ACRONYMS

APPDC	Anhui Provincial Power Development Company
BERIWREP	Beijing Economic Research Institute for Water Resources and Electric Power
EA	Environmental Assessment
ECEPUC	East China Electric Power United Corporation
ECEPGC	East China Electric Power Group Corporation
ECIDI	East China Investigation and Design Institute
ECPG	East China Power Grid
EMP	Environmental Management Plan
ERR	Economic Rate of Return
EDR	Equalizing Discount Rate
FRR	Financial Rate of Return
GNP	Gross National Product
JPIC	Jiangsu Provincial Investment Company
MOF	Ministry of Finance
NEPA	National Environmental Protection Agency
SAA	State Audit Administration
QAE	Quality at Entry
QAG	Quality Assurance Group
RAP	Resettlement Action Plan
SBC	Special Board of Consultants
SEIC	State Energy Investment Corporation
SPDC	Shenneng Power Development Company
TCC	Technical Cooperation Credit
THPCC	Tianhuangping Pumped Storage Project Construction Company
TPSPC	Tianhuangping Pumped Storage Power Company Ltd.
ZPPDC	Zhejiang Provincial Power Development Company
WTP	Willingness to Pay
ha	hectare
m	meter
m^2	square meter
m^3	cubic meter
km	kilometer
MW	mega watt

Vice President:	Jemal-ud-din Kassum
Country Manager/Director:	Yukon Huang
Sector Manager/Director:	Mohammad Farhandi
Task Team Leader/Task Manager:	Barry Trembath

CHINA

TIANHUANGPING HYDROELECTRIC PROJECT

CONTENTS

Project ID: P003616	*Project Name:* CN-Tianhuangping Hydroelectric Project
Team Leader: Barry Trembath	*TL Unit:* EASEG
ICR Type: Core ICR	*Report Date: January 29, 2003*

1. Project Data

Name: CN-Tianhuangping Hydroelectric Project

L/C/TF Number: CPL-36060; SCL-3606A; SCPD-3606S

Country/Department: CHINA

Region: East Asia and Pacific Region

Sector/subsector: Power (97%); Flood protection (3%)

KEY DATES

			Original	*Revised/Actual*
PCD:	11/27/1991	*Effective:*		11/23/1993
Appraisal:	09/28/1992	*MTR:*		
Approval:	05/18/1993	*Closing:*	12/31/2001	06/30/2002

Borrower/Implementing Agency: PRC/ECEPUC

Other Partners:

STAFF	Current	At Appraisal
Vice President:	Jemal-ud-din Kassum	Gautam Kaji
Country Manager:	Yukon Huang	Department Director: S.J. Burki
Sector Manager:	Mohammad Farhandi	Division Chief: Richard Newfarmer
Team Leader at ICR:	Barry Trembath	Team Leader: Vukota Mastilovic
ICR Primary Author:	Jie Tang	

2. Principal Performance Ratings

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HL=Highly Likely, L=Likely, UN=Unlikely, HUN=Highly Unlikely, HU=Highly Unsatisfactory, H=High, SU=Substantial, M=Modest, N=Negligible)

Outcome: S

Sustainability: L

Institutional Development Impact: H

Bank Performance: S

Borrower Performance: S

	QAG (if available)	ICR
Quality at Entry:		S
Project at Risk at Any Time:	No	

3. Assessment of Development Objective and Design, and of Quality at Entry

3.1 Original Objective:

The project objectives are to: (a) alleviate an acute shortage of peaking power and enable more efficient

use of power plants in a predominantly coal-fired thermal power system by transferring off-peak energy to peak with construction of the cost-effective and environmentally sound Tianhuangping pumped-storage hydroelectric plant and associated facilities; (b) support economic reforms and enabling environment for attracting foreign investments and promoting private sector development by improving the quality of the power supply and enhancing socioeconomic conditions in densely populated East China regions; (c) improve load management and promote energy conservation by introducing appropriate peaking power pricing; (d) support institutional development of the beneficiary by strengthening its organization through an advanced management and staff training program; (e) contribute to the development of an improved power utility regulatory framework; (f) assist in transferring new power technologies for what will be the largest pumped-storage hydroelectric plant in China, and in applying modern power system operation optimization methods; and (g) extend technical assistance in project design and implementation, and in promoting prudent financial management.

3.2 Revised Objective:

The objectives of the project were not revised during project implementation.

3.3 Original Components:

The project's four main components and their estimated costs were: (1) Tianhuangping pumped storage power plant (6 x 300 MW, $270 million); (2) pricing and operation studies ($1 million); (3) training ($3 million); (4) engineering services ($26 million).

3.4 Revised Components:

By end 1998, there were about $ 28.7 million of savings mainly from provisions for contingencies. At ECEPGC's request, a new component, the Sijing and Hangdong 500 kV substations, was added in March 1999, with an estimated cost of $25.97 million. Its rationale was to: (i) reduce critical bottlenecks in the delivery of the project output to Shanghai and Hangzhou; (ii) improve supply reliability; and (iii) help establish a regional power market. The total amount of the loan remained unchanged ($300 million). The revision was appraised, reported to the Board of Directors of the Bank, and the Project Agreement amended.

3.5 Quality at Entry:

The QAE was not rated by the QAG. Using QAG criteria, and on the basis of the Staff Appraisal Report (SAR), the ICR rates it as satisfactory. The relevance of the objectives and components is satisfactory.

The project objectives were responsive to the Government strategy of modernizing the power sub-sector and improving its efficiency. Power shortages, especially peaking power shortages were acute in the area at the time of appraisal and were still significant at project completion. It was, and still is, a priority to rationalize and expand peak load pricing and develop cost-effective and environmentally benign pumped-storage plants such as Tianhuangping for peaking in the East China predominantly thermal power system. The need followed for transfers of technical and managerial know-how and for institutional development in the sector. The Bank's Country Assistance Strategy (CAS), which focused on alleviating infrastructure bottlenecks and furthering the market orientation of China's State-Owned Enterprises, had also identified these priorities. The Project provided a vehicle for the Bank's continued assistance in least-cost investment planning, demand-side management and improvement in power utility regulatory framework. Objective (b) was however a little too vague and its achievement more in the nature of an indirect impact that is difficult to monitor. Objectives (d) and (g) largely overlap one another.

The project was demanding on the Borrower both from technical and sector reform perspectives. The technological requirements of the project were highly complex. Improving peak power pricing and power utility regulatory framework involved the interplay of several government agencies and institutions. The intervention for other objectives was focused on the project site and a limited number of project entities. With its past success in building up smaller pumped-storage projects and implementing Bank financed hydro projects, China had demonstrated its capacity to undertake major hydro-power projects, absorb offshore technology and make the institutional adjustments needed with the help of international consulting services. Therefore, the objectives were generally within the Borrower's reach. An exception is possibly objective (c); as the implementing agency is a regional entity which does not deal with power pricing at the retail level, achieving it required the central government to guide and cause provincial pricing bureaus and utilities to adopt the reforms; this expectation became increasingly unrealistic with the decentralization that took hold in the sector in the mid-1990s.

The components were closely related to achieving the objectives, except objective (e). The implementing agency, the East China Electric Power Group Corporation (ECEPGC) had built up adequate administrative capacity in the project company, the Tianhuangping Pumped Storage Power Station Construction Company (THPCC) through appointment of competent managerial staff. Relevant lessons learned in prior projects in the country were taken into account; in particular, experienced staff and consultants were hired for design and implementation. The financial management capacity of the implementing agency was rightly assessed as adequate.

Plant design was under-pinned by adequate technical studies. Alternative sites and layouts were screened to minimize environmental impacts. World-class experience was tapped through a Special Board of Consultants throughout the design process. The design was technically sound and met all applicable safeguard policies. The economic analysis established beyond doubt that the project was the least-cost solution to meet peak power demand in East China, although it is not so clear how the plant factor was optimized. Environmental analyses followed international standards and led to a well-defined Environment Management Plan (EMP). Implementation preparedness was highly satisfactory in that all the tasks on the first segment of the critical path had been well defined

The financial and institutional risks were well seen and mitigated, i.e. risk of delays due to multi-provincial financing and ECEPGC's lack of experience in managing projects of this kind. Delays in unit commissioning occurred due to powerhouse flooding and equipment supplier's deficiencies, but they had little impact as demand growth stalled for two years following the 1997 Asian financial crisis. The Staff Appraisal Report (SAR) could not possibly foresee the crisis. But it was too optimistic when rating low the risk of delays for such a large and novel hydro project. It was also remiss in not identifying and mitigating the risks looming over the expected regulatory and pricing reforms.

4. Achievement of Objective and Outputs

4.1 Outcome/achievement of objective:

The overall outcome is rated **satisfactory**.

(a) Alleviate an acute shortage of peaking power and enable more efficient use of power plants in a predominantly coal-fired thermal power. The achievement of the objective is rated satisfactory. As expected, Tianhuangping added 1,800 MW of capacity which can be mobilized in a few minutes at peak or as a back-up in case of emergency. In 2000, it reduced by 3,400 MW or 32.44 percent on average the

peak-valley load difference on the East China grid.

(b) Support economic reforms and enabling environment for attracting foreign investments and promoting private sector development The outcome here is satisfactory. While it is hard to measure the increased foreign investments and private sector development attributable to the project, it is a fact that power system frequency stability was greatly enhanced and load shedding reduced. For example, in 2001, Tianhuangping was called ten times for start-up under emergency conditions, and it corrected abrupt grid frequency drops by 0.35 to 0.14 Hz thus bringing the system back to normal operation.

(c) Improve load management and promote energy conservation by introducing appropriate peaking power pricing. The outcome here is unsatisfactory. Efficient peak pricing was introduced only for the project output sales to the grid, thus limiting severely load management and energy conservation by end-users. However, with recent unbundling of the sector, there is increasing pressure on provincial utilities to reflect wholesale price structure in consumer pricing.

(d) Support institutional development of the beneficiary by strengthening its organization through an advanced management and staff training program. The achievement of this objective is rated highly satisfactory. ECEPGC has developed adequate capacity in managing the construction of this first large pumped storage plant, in implementing Resettlement Action Plans (RAPs), in power sales pricing and marketing, and in managing the newly established East China Tianhuangping Pumped Storage Power Company Ltd. (TPSPC), which has been operating the plant efficiently since December 2000.

(e) Contribute to the development of an improved power utility regulatory framework. The outcome is rated partially satisfactory. The direct impact on regulatory reform was negligible. Indirectly, however, the project did play a positive role through the study of the regional power market that it supported (see details in paragraph 4.2), the sale of its output at economic prices and its regulation of peaks and response to emergencies, the project helped the launch and success of the competitive power pool pilot in Zhejiang. This in turn contributed to the Government's far-reaching reform launched nationwide in April 2002 that requires unbundling generation from transmission and distribution, introducing wholesale power markets and re-structuring retail tariffs.

(f) Assist in transferring new power technologies for what will be the largest pumped-storage hydroelectric plant in China, and in applying modern power system operation optimization methods. The achievement of this objective is rated satisfactory. The know-how transferred is being widely used in other projects in China. East China Investigation and Design Institute (ECIDI) developed its competence in pumped storage design, change order management and environment assessment (EA); it is now undertaking six large-sized pumped-storage power projects including Taian (4 x 250 MW), Tongbai (4 x 300 MW), Yixing (4 x 250 MW) and Baoquan (4 x 250 MW). It has also conducted EAs for several other projects including Bank-financed small and medium sized hydro-power projects in China. Similarly, Chinese contractors are now applying their new experience to other projects.

(g) Extend technical assistance in project design and implementation, and in promoting prudent financial management. The outcome here met and sometimes exceeded expectations; it is rated highly satisfactory. By importing financial systems from similar French and British companies, prudent financial management including budget control, fund management, investment appraisal and credit guarantee procedures was established. ECEPGC became highly skilled in large project implementation management and plant operation and its financial performance more than met covenants.

4.2 Outputs by components:

The output is satisfactory for all five components as these were successfully completed as defined in the SAR.

(1) DAM & POWERHOUSE. Implementation of all sub-components **(Annex 8)** was achieved, albeit modestly behind schedule, while meeting all relevant quality and safety standards. Unit commissioning delays varied between five and twelve months but the project was completed on schedule in December 2000. All facilities have functioned well and were accepted by the State Safety Inspection of September 2001.

(2) ENVIRONMENTAL MANAGEMENT PROGRAM. All three objectives of the program were satisfied: the adverse impacts were properly assessed and mitigation measures formulated; the impacts were mitigated or reduced to acceptable levels through implementation of a monitoring and mitigation program **(Annex 9)**; and a unit of 15 full time staff members was established for environment monitoring and protection during implementation.

(3) CONSTRUCTION MANAGEMENT AND ENGINEERING SERVICES. All procurement processes were carried out on schedule. Implementation delays were generally due to a major landslide which occurred in March 29, 1996 [1], heavy rainfalls in early 1995, uneven settlement of the upper reservoir after impoundment, and quality problems with two main transformers. While some of the key target dates were missed, the Project was still finally completed as scheduled and cost overrun minimized through various measures including efficient procurement arrangements [2].

(4) TECHNICAL ASSISTANCE AND STUDIES. The study of the power market strongly supported the launch and success of the competitive power pool pilot in Zhejiang and contributed to the successful launch of GOC's far-reaching power sector reform (see details in Paragraph 4.1 e.). **Studies of optimal power plant operation and pricing** were completed by an offshore consultant in June 1997. Because, by 1995, the likelihood of studies under the project being able to influence retail tariff reforms had strongly decreased, the pricing study was re-oriented to cover tariff structure of the plant output. Recommendations on the power plant dispatching and output pricing were fully implemented and those for optimal plant operation procedures are being gradually implemented [3]. **The TA and training for strengthening the beneficiary's organization** covered management training for construction, plant operation, environment protection, human resources and finances as well as technical topics (298 persons sent abroad in 39 groups). Technical capacity on mechanical and electrical engineering was also enhanced through attendance at design liaison meetings, factory tests, and site erection and commissioning. For power plant operation, training of operators (651 man-month) took place in other pumped-storage power plants in China and as part of equipment supply and international consulting service contracts.

(5) SIJING AND HANGDONG 500 kV SUBSTATIONS. Sijing was commissioned in December 2000 and Hangdong in May 2001, respectively three and five months behind a very ambitious schedule, but still in time to serve the winter peak demand in 2000-01.

Covenants. All covenants were met including those with respect to consolidated financial indicators for the East China Grid, which were included in the 1993 Loan Agreement. But in 1997, de-consolidation procedures were issued by Ministry of Electric Power (MOEP) and followed by ECEPGC. Resulting financial statements formed the basis of covenants for ECEPGC alone as part of the Bank financed East China Jiangsu Transmission Project. In accordance with the most recent Project Supervision Report for that project, compliance is rated satisfactory. With the establishment of TPSPC, it is proposed that financial covenants be formulated for TPSPC alone. Discussions are under way and on the basis of financial projections, TPSPC will make proposals on values to be inserted in model financial covenants.

4.3 Net Present Value/Economic rate of return:

The economic benefits of the project are quantified as the value of its power generation based on the 1404 hours of capacity utilization approved by state authorities. Gas turbines are the appropriate thermal alternative for a capacity factor of 16 percent (1404 hours), and it is on that basis that the project equalizing discount rate (EDR) was estimated at appraisal to be 23 percent and this was also used as proxy for economic rate of return (ERR). The re-estimated EDR is 18.7 percent. With regard to ERR, two valuation methods are used for the current evaluation: (i) the current two-part tariff equivalent to 70.05 fen/kWh (including VAT) and (ii) a willingness to pay (WTP) for alternative generation at peak load. However, since no such turbines are presently operating in the grid, the WTP method conservatively uses the price paid for the output of a combined cycle plant at a 35 percent capacity factor. The ERR is 13.9 percent with the current tariff and 17.7 percent with the WTP (90.09 fen/kWh [also including VAT]) . Based on recent studies carried out for the Yixing Pumped Storage Plant in the same region, environmental benefits are deemed modest and not included in the calculations.

The updated EDR and the ERRs exceed the opportunity cost of capital which is 12 percent or less in today's China. Today, the EDR and the ERR with WTP to which it can be compared, are lower than SAR values mostly because of the downward trend in thermal cost and changed methodologies. Delays in unit commissioning had a much smaller impact given the slow down of growth that followed the 1997 Asian financial crisis. The cost over-run is so modest in real terms that it also has a very small impact.

4.4 Financial rate of return:

The financial benefits are the sales at the current tariff as above but after netting out the VAT and cost of sales. The tariff is 470 Yuan/kW per year for capacity and 26.4 fen/kWh for energy. With operating costs including power purchase costs adjusted for inflation at two percent per year, the financial rate of return (FRR) is 9.54 percent. If the tariffs are similarly adjusted, the FRR is 11.85 percent. With no adjustment for inflation, the FRR is 10.70 percent.

4.5 Institutional development impact:

The impact on institutional development is rated substantial. It is high on Chinese technical know-how (paragraph 4.1.g), modest on policy reforms and substantial on utility restructuring and corporatization. THPCC was set up for project construction management and supported the set up of TPSPC for plant operation and business management through input of experienced human resources. ECEPGC's development as a utility and TPSPC's as an Independent Power Producer are remarkable; they improved efficiency, transparency and accountability, and the pool of human resources for future pumped storage projects.

5. Major Factors Affecting Implementation and Outcome

5.1 Factors outside the control of government or implementing agency:

Natural disasters. Excessive rainfalls in early 1995 and a major landslide of about 300,000 cubic meters (m3) on March 29, 1996 delayed construction by 8 months and caused a direct cost increase of Y258.37 million [1].

Foreign exchange rate and inflation. The devaluation of the Yuan in 1992-96 and the high inflation in the 1993-96 period (14.7, 24.1, 17.1 and 8.3 percent) contributed to a substantial project cost overrun in local currency (41.2 per cent).

Manufacturing defects. Delays of two to fourteen months in unit commissioning were partly attributable to lapses in quality control during manufacturing for three of the main transformers. Foreign elements in one of them caused a break-down of winding insulation and this was also suspected to be the cause of test failure for the other two. The probable cause of the problem was traced to the transformer cooling systems supplied by a subcontractor. One of the failed transformers was repaired and the other two were rejected and re-ordered from a supplier in China. Compensation was paid to the transformer supplier.

5.2 Factors generally subject to government control:

Reform sequencing. The emphasis on sector decentralization at the expense of other reforms limited the ability of the project to be used as a vehicle for peak pricing and regulatory framework reforms.

5.3 Factors generally subject to implementing agency control:

The performance of the implementing agency was a very positive and key factor to the outcome.

5.4 Costs and financing:

The appraisal cost excluding interest during construction (IDC) was $547.3 million equivalent at late 1992 and early 1993 prices, of which $302.9 million (55.3 percent) were foreign costs. The actual cost was $609.6 million, of which $263.0 million were foreign costs. The cost overrun is about 11.4 percent when expressed in US dollars and 41.2 percent when expressed in local currency. Overruns in local cost terms were caused mostly by a higher-than-expected inflation in China during the implementation early stages [4] which coincided with currency devaluations in dollar terms from Y5.51 at appraisal at late 1992 and early 1993 to Y8.62 in 1994 and Y 8.30 in the ensuing years.

At late 1992 and early 1993 prices, i.e. after netting out the devaluation and inflation, the cost was $526.03 million, of which $230.31 million were foreign costs. Compared to appraisal estimates (excluding price contingencies), there was an overrun of 31.6 percent for local costs, and an under-run of 14.9 percent for foreign costs. The overrun for total costs was 6.2 percent [5]. The local cost overrun can be attributed mainly to costs of remedial treatment of the landslide. The foreign cost under-run was achieved due to the under-run of mechanical and electrical equipment cost of $39.9 million (in current terms) as a result of the international competitive bidding process, despite the overrun of $12 million for the upper reservoir bituminous concrete lining.

Financing departed from the appraisal plan in two ways: (i) the Bank contributed less because prices of procurement packages through international competitive bidding (ICB) were lower than appraisal estimates [6]; (ii) local financiers increased funding in proportion to their shares in the project to cover cost overruns [7].

6. Sustainability

6.1 Rationale for sustainability rating:

Sustainability is rated **likely**. Tianhuangping has been constructed in a technically sound manner and all necessary conditions for operating and maintaining it were, or are likely to be, achieved. The project is financially sustainable as shown by its comfortable debt coverage ratio and FRR. Future sales revenues are secure because of the tight supply and high demand for peaking power in East China. For the environment, negative impacts were mitigated and minimized, monitoring is continuing, and additional measures can be devised and implemented as necessary. Resettlement associated with the new substation component was well addressed and living standards of affected people were improved **(Annex 10)**

6.2 Transition arrangement to regular operations:

For project operation, the Tianhuangping Pumped-Storage Power Plant was set-up in March 1997 and started to function in September 1998. It is staffed with 100 persons in three departments (production and management, operation, and maintenance). Operating procedures were laid down with the help of international consultants. The plant achieved good operating indicators: 97.4 percent success rate for start-ups, about 78 percent plant round trip cycle efficiency in 2001. A Power Purchase Agreement was signed specifying the two-part sales tariff and a power purchase price for pumping. The plant is directly dispatched by the East China Power Grid (ECPG) control center as recommended by the operation studies.

Additional performance indicators to watch are the sales tariff as practiced, the revenue from energy sales and ancillary services provided by the plant, the covenanted financial indicators and the environmental impact indicators defined in the plan. All monitoring systems to that effect are in place except for the financial covenants for TPSPP that are yet to be finalized.

7. Bank and Borrower Performance

Bank

7.1 Lending:

Bank performance is rated **satisfactory**. The Bank provided adequate expertise in assisting the Borrower. It foresaw the need for studies on plant operation optimization and power pricing and worked well with the ECEPGC in preparing the EA, EMP and RAP and the program to strengthen ECEPGC's capacity. But project design was not supportive enough of the objectives of improving power retail pricing and the regulatory framework and it failed to recognize that without strong central government support, these objectives were likely to become out of reach. Loan approval was timely.

7.2 Supervision:

Bank supervision was **satisfactory**. It was regular and proactive with a focus on development impacts and the Bank's safeguard policies and fiduciary duties. The Bank worked effectively with the Borrower in detecting and tackling issues, modifying the components and the financial covenants as soon as needed. It facilitated or provided world-class advice to ECEPGC for catching up on construction delays and improving contract management and unit performance.

7.3 Overall Bank performance:

Overall performance is rated **satisfactory**. While the quality at entry left something to be desired, the Bank helped ECEPGC resolve all the major physical and financial issues while not substituting for the Borrower

in making decisions and facilitated capacity building in all involved Chinese parties.

Borrower

7.4 Preparation:

The Government's performance is rated **satisfactory**. The Ministry of Energy supported the power sector objectives. The central and provincial governments were very supportive to the Project financing through their financial arms. It delegated full responsibility to ECEPGC for all the design and preparation and employed foreign consultants as needed. It invested considerable resources to complete the preparation works, the EA and EMPs in a timely and satisfactory manner.

7.5 Government implementation performance:

Government performance is rated **satisfactory**. The Government let ECEPGC take charge of the project implementation, but was particularly supportive to the implementation of EMP and RAP; it approved the innovative pricing structure for the Project outputs and the new project component. The Ministry of Electric Power organized a panel of experts in a timely manner to advise on resolutions of problems caused by the landslide. But it was not until after the project approached closure, that the Government became really active in retail pricing and regulatory reforms.

7.6 Implementing Agency:

ECEPGC's performance was **highly satisfactory**. Project management effectiveness was high especially for scheduling, costing, and financial and quality controls due to the clear accountability of parties involved and task assignment. Responses to construction delays and equipment defects were prompt and effective. With Government support, ECEPGC ensured adequate local financing and a timely and justified change in components. It was open to new technologies and construction techniques, made good use of TA, and demonstrated commitment to national and international standards for resettlement and environment. Its progress and implementation reports were timely and well documented.

7.7 Overall Borrower performance:

Overall Borrower performance is rated **satisfactory**. While it demonstrated scant ownership of some policy objectives, it met all the covenants and showed a great commitment to build and operate efficiently and sustainably the first large-sized pump storage in China while following strictly Bank procedures and criteria.

8. Lessons Learned

The following are the key lessons learned from the project:

(a) Be more thorough on geology. The bank instability in the lower reservoir and the excessive local ground settlement in the upper reservoir were all unforeseen and delayed work progress.

(b) Be more cautious in choosing the right supplier and ensuring that vigorous quality control procedures are in place. Failures of very high voltage transformers have occured several times in China. Great care must be taken to assess the capability of key equipment supplier's during contract award and to ensure apppropriate quality control during subsequent shop inspections.

(c) Focus consultants on well-defined issues. That was the case here and furthermore, using short-term consultants proved very successful and efficient, as it made it easier to choose the right consultants and

ensure that their services were highly relevant.

(d) Pay special attention to broad objectives. Discard them when their achievement cannot be monitored or achieved. And if the main implementing agency has little to do with them, include components and agreements that are appropriate and fully owned by the authorities who are key to success.

9. Partner Comments

(a) Borrower/implementing agency:

The Borrower's comments were mainly editorial and were included in this ICR. See details in the Completion Report on the Tianhuangping Pumped Storage Power Project prepared by the Borrower.

(b) Cofinanciers:

No comments received from cofinanciers.

(c) Other partners (NGOs/private sector):

No comments received from other partners.

10. Additional Information

Notes to the main text:

[1] **Landslide.** Construction of the upper reservoir started in November 1993 on schedule, but completion was delayed by heavy rains in early 1995, which in turn delayed the start of bitumenous concrete lining and then the reservoir impoundment by four months. A major landslide of 300,000 m^3 on March 29, 1996, two thirds of which went into the river bed within the future lower reservoir. The landslide was caused by persistent heavy rainfall, which resulted in saturation of the mountain mass and a subsequent slippage. The underground powerhouse was used to divert the Daxi River while dealing with the slide which resulted in delays to equipment erection. The landslide also endangered another mountain mass of about 600,000 m^3 above the power intake and substation. Additional measures for treatment of the landslide and securing the endangered bank areas caused a delay in construction of these facilities of eight months and a direct cost increase of Y258.37 million. Initial commissioning of power generating equipment was also consequently delayed.

[2] **Proper procurement arrangement.** The most technologically advanced parts of the project were procured through ICB in 41 contracts, including the mechanical and electric equipment and the upper reservoir bituminous concrete impervious lining. All other services and goods were procured through local competitive bidding procedures. The most competitive local contractors were selected through local competition. This way, local participation was maximized and costs controlled. The risks of the performance of power generating equipment and upper reservoir lining were properly handled. But major defects in three main transformers suggest the need for stricter qualification requirements and shop inspection programs.

[3] Studies. The conclusion of the report recommended that THP plant should be operated under the grid general dispatching with a two-part tariff (capacity tariff and energy tariff). Following the recommendations, the power plant is directed dispatched by the East China Power Dispatch Center and the electricity is sold with a two-part tariff which is approximately in line with the grid long run marginal costs at peak time. The report also recommended procedures for plant optimal operation, which are being gradually implemented.

[4] Inflation rate: 8 percent for 1993, 7 percent for 1994, 6 percent for 1995-96, 5 percent for 1997-98, and 4 percent thereafter were projected compared to actual rates of 14.7, 24.1, 17.1, and 8.3 percent in 1993-96 respectively.

[5] Costs. The costs at appraisal and the actual cost after netting out price inflation and local currency devaluation.

	Local	Foreign	Total	Local	Foreign	Total
	----	Y million	----	----	$million	----
Appraisal						
Base Cost	1188.5	1487.8	2676.3	204.9	256.5	461.4
Physical Contingency	106.8	81.2	188.0	18.4	14.0	32.4
Tax and Duties	9.0	0.0	9.0	1.4	0.0	1.4
Total	1304.3	1569.0	2873.3	224.7	270.5	495.2
Actual						
Total	1715.2	1335.8	3051.0	295.7	230.3	526.0
Overrun	31.5%	-14.9%	6.2%	31.6%	-14.9%	6.2%

Note:

1. Exchange rate at appraisal ($ 1 = Y 5.80) was used.

[6] Bank Financing by components (actual vs. appraisal):

Components	Plan at Appraisal ($ million)	Actual Disbursement ($ million)	Percent
Civil works	10	23.2	228.2
Equipment and materials	260	232.1	89.2
Services, training and research	10	5.3	53
Contingencies 1	20		
Sub-total		260.6	86.87
New substation component		17.18	
Total	300	277.78	92.59

Note 1. Uses of contingencies were included in the Actual Disbursements for individual component.

[7] Sources of Financing (actual vs. appraisal):

Sources of Financing	Plan at Appraisal ($ million)	Actual Disburs. ($ million)	Per cent (%)
IBRD			
Loan3606 CHA	300.0	260.5	86.83
New substation component 1	(25.9)	17.2	66.15
Sub-total	300.0	263.0	86.82
TCC	2.9	2.5	71.71
Government Companies			
State Energy Investment Corporation (SEIC-1/4)	139.13		
East China Electric Power United Company (ECEPUC-1/12)	34.78		
East China electric Power Group Corp. (ECEPGC-5/12) 2		219.48	126.20
Shenneng Power Development Company (SPDC-1/4)	104.35	131.69	126.20
Jiangsu Provincial Investment Company (JPIC-1/6)	69.57	87.79	126.20
Zhejiang Provincial Power Develop. Company (ZPPDC-1/9)	46.38	58.53	126.20
Anhui Provincial Power Develop. Company (APPDC-1/18)	23.19	29.26	126.20
Sub-total	417.40	526.75	126.20
Total	720.3	789.7	109.64

Note:

1) Used savings from the IBRD loan of $300 million;

2) ECEPUC was restructured into ECEPGC. ECEPGC also took over central government commitment when SEIC was restructured.

Annex 1. Key Performance Indicators/Log Frame Matrix

Outcome / Impact Indicators:

Indicator/Matrix	Projected in last PSR[1]	Actual/Latest Estimate

Output Indicators:

Indicator/Matrix	Projected in last PSR[1]	Actual/Latest Estimate

[1] End of project

The log Frame matrix was not yet introduced when the project was appraised. The key indicators specified in the SAR were followed for monitoring (see next tables).

1. Key dates of project implementation

	Completion Date (SAR)	Completion Date (Actual)
1. Project Implementation of Civil Works		
(a) Underground Powerhouse and Lower Reservoir		
Bid opening	11-20-1992	11-20-1992
Contract signing	03-10-1993	03-15-1993
Contractor to site	04-01-1993	04-01-1993
Commencement of civil works	07-01-1993	07-04-1993
River closure	12-31-1993	03-12-1994
Impounding	04-01-1997	02-26-1998
(b) Upper Reservoir embankment dams		
Bid opening	02-05-1993	02-24-1993
Contract signing	05-10-1993	05-26-1993
Contractor to site	06-01-1993	06-20-1993
Commencement of civil works	11-01-1993	11-01-1993
Completion of work	12-31-1996	04-30-1997
(c) Water Conveyance System		
Bid opening	06-10-1993	07-10-1993
Contract signing	09-15-1993	08-30-1993
Contractor to site	10-05-1993	10-15-1993
Commencement of civil works	01-01-1994	02-18-1994
Completion date:		
No.1 inclined shaft	05-31-1997	09-30-1997
No.2 inclined shaft	09-30-1998	11-10-1998
(d) Upper Reservoir Lining		
Bid opening	01-15-1994	08-31-1994
Contract signing	06-05-1994	04-17-1995
Contractor to site	07-01-1994	08-10-1995
Works start	04-01-1995	04-18-1996
Commencement of facing	05-31-1997	08-12-1997
Impounding of upper reservoir	06-01-1997	10-05-1997
2. Procurement and Erection of major Plant Equipment		
(a) Main units and control system		
Bid opening	03-05-1992	03-05-1993
Contract signing	09-01-1993	10-15-1993
First shipment	09-xx-1995	05-xx-1995
Commencement of unit installation	11-xx-1995	01-29-1996
Commissioning date:		
No.1 Unit	09-30-1997	09-03-1998
No.2 Unit	03-31-1998	12-27-1998
No.3 Unit	09-30-1998	03-12-2000
No.4 Unit	02-28-1999	09-24-1999
No.5 Unit	07-31-1999	12-18-1999
No.6 Unit	12-31-1999	12-25-2000
Completion of the project	12-31-2000	12-25-2000
(b) Step-up Substation Equipment		
Bid opening	07-02-1994	10-06-1994
Contract signing	12-31-1994	07-31-1995
First shipment	06-xx-1996	12-xx-1996
Installation of equipment	08-xx-1996	12-xx-1997
Commissioning	06-xx-1997	05-18-1998

2. Key dates for Sijing and Hangdong 500 kV substations component implementation

	Schedule		Implementation	
I. Preparatory Work			**Sijing**	**Hangdong**
1)Approval of the feasibility study report by SDPC	08/07/98		02/13/98	07/24/98
2)Request by MOF to IBRD for revision of loan agreement	11/30/98			
3)Submission to IBRD reports on EIA and RAP	10/15/98		11/06/98	11/06/98
4)Review of pre-initial design	08/26/98		08/26/98	08/30/98
II. Bidding and Procurement				
1)Signing of contract	07/01/99		12/10/99	
2)Delivery of equipment to site	04/01/00-05/16/00		05/01/00-12/31/00	
III. Design, Construction, Erection and Testing	**Sijing**	**Hangdong**	**Sijing**	**Hangdong**
1)Completion of substation investigation and design, submission of general layout and land requisition drawings	10/31/98	10/31/98	10/xx/97	05/xx/98
2)Completion of land requisition and resettlement	11/30/98	12/31/98	09/xx/98	03/xx/99
3)Completion of water and electricity supply, access road and ground leveling	12/31/98	03/31/99	10/xx/98	07/xx/99
4)Supply of construction drawings	10/98-05/99	10/98-12/99	09/98-03/00	02/01
5)Civil works construction	12/98-03/00	04/99-02/00	12/98-07/00	03/01
6)Erection and testing of substation equipment	12/99-09/00	02/00-12/00	07/00-12/00	04/01

3. Main performance indicators of Project operation

Indicator	Target	1999	2000	2001	2002*
Availability of unit	88%	81.97%	54.90%	86.30%	93.22%
Ratio of plant service power	/	0.29%	0.23%	0.26%	0.20%
Overall conversion efficiency	74%	80.12%	81.60%	80.63%	79.0%
Ratio of successful start-up	/	90.91%	92.74%	97.38%	98.80%
-- generator start-up	99%	94.46%	97.00%	98.99%	99.31%
-- pump turbine start-up	97%	86.09%	86.14%	94.36%	97.72%
Ratio of successful shut-down	99.5%	97.01%	98.98%	99.43%	99.78%
Ratio of successful mode change	/	98.51%	98.81%	99.79%	99.69%

Notes:

* Figures for 2002 are up to November 30, 2002.

4. Highlights of Historical Financial Performance and Projectoins

a) Key Financial Indicators

East China Tianhuangping Pumped Storage Company, Ltd.
Key Financial Indicators
Unit: Y million
As of 31 December

Item	1998	1999	2000	2001	2002	2005	2010
Energy Sales (GWh)	16	792	1,436	2,225	2562	2562	2562
Increase in Energy Sales (%)		4722.1%	81.3%	54.9%			
Average Tariff (fen/kWh)	27.89	36.80	56.78	59.68	59.73	63.24	69.82
Increase in Average Tariff (%)		31.96%	54.27%	5.11%			
Average Tariff (VAT Included) (fen/kWh)	32.63	43.06	66.43	69.82	69.89	73.99	81.69
Operating Revenue (after VAT)	4.58	291.45	815.34	1,327.53	1530.38	1620.10	1788.72
Interest payment	34.46	263.53	291.33	404.50	262.6	197.2	82.8
Depreciation	0.00	44.37	238.64	272.58	288.4	288.4	288.4
Net Income After Tax	(35)	(182)	(87)	39	260.7	250.5	387.4
Debt service					256.2	444.0	325.4
Annual Capital Expenditure	(1,795)	3,037	364	290	0	0	0
Net Fixed Assets	2,485	5,461	5,570	5,614	5329.7	4464.6	3022.7
Construction in Progress	0	0	23	4	4.3	4.3	4.3
Rate of return							
- on Historically Valued Net Assets (%)	0.0%	2.1%	3.7%	7.9%	9.6%	9.7%	14.9%
Operating Ratio (%)	105.5%	71.9%	75.1%	66.3%	65.6%	64.5%	62.8%
Current Ratio(times)	0.1	0.1	0.3	0.3	1.0	1.7	1.1
Long-term Debt/Long-term Debt & Equity (%)	72.6%	90.2%	91.7%	90.4%	85.6%	69.1%	37.5%
Debt Service Coverage Ratio (times)	0.0	0.3	0.9	1.1	1.6	1.1	1.9
Cumulative Debt Service Coverage Ratio (times)/1					1.6	1.7	2.7

Note:

/1 Assumptions: Assumes that dividends not paid unless a debt service reserve account equalling six months payment of interest and principal is fully funded, which is the likely form of the new covenants for TPSPC.

b) Balance Sheet

East China Tianhuangping Pumped Storage Company, Ltd.
Balance Sheet
Unit: Y million
As of 31 December

Item	1997	1998	1999	2000	2001	2002	2005	2010
ASSETS								
CURRENT ASSETS								
Cash	52.03	2.13	21.18	69.64	32.29	71.8	311.7	131.6
Accounts Receivable	0.00	5.36	17.75	40.53	95.24	149.2	158.0	174.4
Inventories	0.00	0.25	1.66	2.35	3.54	61.7	61.7	61.7
Others	4.74	0.02	0.64	26.96	4.31	4.4	4.6	5.1
Total Current assets	56.77	7.76	41.23	139.47	135.39	287.1	536.0	372.8
Long term Investments	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0
FIXED ASSETS								
Plant in Service	62.57	2,485.03	5,505.15	5,853.41	6,169.40	6169.4	6169.4	6169.4
Accumulated Depreciation	0.00	0.00	44.37	283.01	555.59	844.0	1709.1	3151.0
Net Plant in Service	62.57	2,485.03	5,460.78	5,570.40	5,613.81	5325.4	4460.3	3018.4
Work in Progress	4,294.64	0.00	0.00	23.28	4.29	4.3	4.3	4.3
Total Fixed Assets	4,357.21	2,485.03	5,460.78	5,593.68	5,618.11	5329.7	4464.6	3022.7
Deferred and Intangible assets	0.00	77.13	94.07	86.24	79.63	79.6	79.6	79.6
TOTAL ASSETS	4,413.98	2,569.92	5,596.07	5,819.39	5,833.12	5696.4	5080.2	3475.2
EQUITY AND LIABILITIES								
CURRENT LIABILITIES								
Accounts Payable	0.00	4.20	0.00	1.08	15.15	80.2	84.9	93.7
Short Term Loans	0.00	0.00	190.00	366.00	280.00	71.8	74.8	80.4
Others	4,413.98	60.16	186.48	53.37	138.91	141.0	149.6	165.2
Total Current Liablities	4,413.98	64.35	376.48	420.45	434.06	292.9	309.2	339.3
Long term debt	0.00	1,820.28	4,710.26	4,952.13	4,883.00	4626.8	3296.5	1176.4
EQUITY								
Paid-in Capital	0.00	720.00	720.00	720.00	720.00	720.0	720.0	720.0
Capital Surplus	0.00	0.00	5.82	30.37	60.18	60.2	60.2	60.2
Reserve Surplus	0.00	0.00	0.00	0.00	0.00	39.1	143.8	393.0
Retained Earnings	0.00	(34.71)	(216.48)	(303.55)	(264.11)	-42.5	550.5	786.3
Total Equity	0.00	685.29	509.34	446.82	516.07	776.8	1474.5	1959.5
TOTAL EQUITY AND LIABILITY	4,413.98	2,569.92	5,596.07	5,819.39	5,833.13	5696.4	5080.2	3475.2

c) Income Statement

East China Tianhuangping Pumped Storage Company, Ltd.
Income Statement
Unit: Yuan Million
As of 31 December

Item	1997	1998	1999	2000	2001	2002	2005	2010
Energy Sales (Gwh)		16.42	791.92	1,436.06	2,224.55	25.62	25.62	25.62
Increase (%)			4722%	81%	55%			
Average Tariff (Including VAT) (fen/Kwh)		32.63	43.06	66.43	69.82	69.89	73.99	81.69
Average Tariff (fen/Kwh)		27.89	36.80	56.78	59.68	59.73	63.24	69.82
Increase (%)			32.0%	54.3%	5.1%			
Operating Revenues (Including VAT)		5.36	341.00	953.95	1,553.21	1790.5	1895.5	2092.8
Value-Added Tax (VAT)		0.78	49.55	138.61	225.68	260.2	275.4	304.1
Operating Revenues (excluding VAT)		4.58	291.45	815.34	1,327.53	1530.4	1620.1	1788.7
Operating Expeses		4.83	209.69	611.94	880.47	1003.9	1045.6	1124.0
Operating Income		(0.25)	81.76	203.40	447.06	526.5	574.5	664.7
Taxable Incomes		(34.71)	(181.77)	(87.07)	39.44	260.7	373.9	578.2
Income Tax		0.00	0.00	0.00	0.00	0.0	123.4	190.8
Net Income After Tax		(34.71)	(181.77)	(87.07)	39.44	260.7	250.5	387.4

d) Cash Flow Statement

East China Tianhuangping Pumped Storage Company, Ltd.
Cash Flow Statement
Unit: Y million
As of 31 December

Item	1998	1999	2000	2001	2002	2005	2010
SOURCES							
Net Income	(34.71)	(181.77)	(87.07)	39.44	260.7	250.5	387.4
Depreciation	0.00	44.37	238.64	272.58	288.4	288.4	288.4
Borrowings	1,842.16	3,061.01	429.12	195.84	0.00	0.00	0.00
Equity	720.00	5.82	24.55	29.81	0.00	0.00	0.00
TOTAL SOURCES	2,527.45	2,929.43	605.24	537.67	549.1	538.9	675.8
APPLICATIONS							
Capital Expenditures	(1,795.1)	3,037.06	363.71	290.40	0.00	0.00	0.00
Long-term Investments	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Change in Working Capital	4,350.52	(297.71)	5.82	19.65	253.3	-2.5	-2.7
Divident	0.00	0.00	0.00	0.00	0.0	0.0	329.3
Loan Repayment	21.88	171.03	187.25	264.97	256.2	444.0	325.4
TOTAL APPLICATION	2,577.34	2,910.38	556.78	575.02	509.6	441.6	651.9
Changes in Cash	(49.90)	19.05	48.46	(37.35)	39.5	97.3	23.8
Cash Balance at Beginning of Year	52.03	2.13	21.18	69.64	32.3	214.4	107.8
Cash Balance at End of Year	2.13	21.18	69.64	32.29	71.8	311.7	131.6

Annex 2. Project Costs and Financing

Project Cost by Component (in US$ million equivalent)

Component	Appraisal Estimate US$ million	Actual/Latest Estimate US$ million	Percentage of Appraisal
Works	135.90	259.00	190.44
Goods	279.80	288.40	103.07
Services(1)	49.10	62.20	126.68
Taxes and duties (2)	1.40		
Total Baseline Cost	466.20	609.60	
Physical Contingencies	32.40		
Price Contingencies	48.70		
Total Project Costs	547.30	609.60	
Interest during construction	173.00	180.10	104.10
Front-end fee			
Total Financing Required	720.30	789.70	

Notes

(1) The costs of service include the TCC of $3.5 million at appraisal and $2.5 million of real expenditures respectively;

(2) The actual expenditures on taxes & duties and contingencies are incorporated into the actual costs of indivivual project component.

Project Costs by Procurement Arrangements (Appraisal Estimate) (US$ million equivalent)

Expenditure Category	Procurement Method[1] ICB	NCB	Other[2]	N.B.F.	Total Cost
1. Works	18.40	0.00	0.00	145.60	164.00
	(12.50)	(0.00)	(0.00)	(0.00)	(12.50)
2. Goods	318.90	0.00	7.00	0.00	325.90
	(269.20)	(0.00)	(7.00)	(0.00)	(276.20)
3. Services	0.00	0.00	35.00	19.00	54.00
	(0.00)	(0.00)	(11.30)	(0.00)	(11.30)
4. TCC-related Financing	3.50	0.00	0.00	0.00	3.50
	(2.90)	(0.00)	(0.00)	(0.00)	(2.90)
Total	340.80	0.00	42.00	164.60	547.40
	(284.60)	(0.00)	(18.30)	(0.00)	(302.90)

Project Costs by Procurement Arrangements (Actual/Latest Estimate) (US$ million equivalent)

Expenditure Category	Procurement Method[1] ICB	NCB	Other[2]	N.B.F.	Total Cost
1. Works	111.75	0.00	0.00	147.25	259.00
	(24.50)	(0.00)	(0.00)	(0.00)	(24.50)
2. Goods	284.70	0.00	0.00	3.70	288.40
	(230.70)	(0.00)	(0.00)	(0.00)	(230.70)
3. Services	0.00	0.00	44.40	15.30	59.70
	(0.00)	(0.00)	(5.30)	(0.00)	(5.30)
4. TCC-related Financing	2.50	0.00	0.00	0.00	2.50
	(2.50)	(0.00)	(0.00)	(0.00)	(2.50)
Total	398.95	0.00	44.40	166.25	609.60
	(257.70)	(0.00)	(5.30)	(0.00)	(263.00)

[1/] Figures in parenthesis are the amounts to be financed by the Bank Loan. All costs include contingencies.

[2/] Includes civil works and goods to be procured through national shopping, consulting services, services of contracted staff of the project management office, training, technical assistance services, and incremental operating costs related to (i) managing the project, and (ii) re-lending project funds to local government units.

Project Financing by Component (in US$ million equivalent)

Component	Appraisal Estimate			Actual/Latest Estimate			Percentage of Appraisal		
	Bank	Govt.	CoF.	Bank	Govt.	CoF.	Bank	Govt.	CoF.
Works	12.50	151.50		24.50	234.50		196.0	154.8	
Goods	276.20	49.70		230.70	57.70		83.5	116.1	
Services	11.30	42.70		5.30	54.40		46.9	127.4	
TCC-Related Financing	2.90	0.60		2.50	0.00		86.2	0.0	
IDC		173.00			180.10			104.1	
Total	302.90	417.40		263.00	526.70		86.8	126.2	

2. Project Costs and Financing for the New Substation Component

Project Cost by Component (in US$ million equivalent)

Project Cost By Component	Appraisal Estimate US$ million	Actual/Latest Estimate US$ million	Percentage of Appraisal
Works	18.32	25.72	140.39
Goods	39.27	30.09	76.62
Construction Management	3.01	0.71	23.59
Taxes and duties (1)	9.82		
Total Baseline Cost	70.41	56.52	80.27
Physical Contingencies	5.21	1.89	
Price Contingencies	2.97	2.02	
Total Project Costs	78.58	60.42	
Interest during construction	9.55	3.62	
Front-end fee			
Total Financing Required	88.14	64.04	

Notes

(1) The actual expenditures of taxes & duties are incorporated into the actual costs of individual project component.

Project Costs by Procurement Arrangements (Appraisal Estimate) (US$ million equivalent)

Expenditure Category	ICB	Procurement Method[1] NCB	Other[2]	N.B.F.	Total Cost
1. Works (1)				23.84	23.84
2. Goods	25.57 (25.72)		0.35 (0.35)	28.82	54.74 (25.92)
3. Services					
Total	25.75 (25.72)		0.35 (0.35)	52.66	78.58 (25.92)

Notes

(1) Cost of works including the cost for construction management.

Project Costs by Procurement Arrangements (Actual/Latest Estimate) (US$ million equivalent)

Expenditure Category	Procurement Method[1]				
	ICB	NCB	Other[2]	N.B.F.	Total Cost
1. Works				29.62	29.62
2. Goods	17.18 (17.18)			12.91	30.90 (17.18)
3. Services				0.71	0.71
Total	17.18 (17.18)			43.24	60.42 (17.18)

[1/] Figures in parenthesis are the amounts to be financed by the Bank Loan. All costs include contingencies.

[2/] Includes civil works and goods to be procured through national shopping, consulting services, services of contracted staff of the project management office, training, technical assistance services, and incremental operating costs related to (i) managing the project, and (ii) re-lending project funds to local government units.

Project Financing by Component (in US$ million equivalent)

Component	Appraisal Estimate			Actual/Latest Estimate			Percentage of Appraisal		
	Bank	Govt.	CoF.	Bank	Govt.	CoF.	Bank	Govt.	CoF.
Works		23.84			29.62			124.25	
Goods	25.92	28.82		17.18	12.91		66.28	44.80	
Services		3.01			0.71			23.59	
IDC		9.55			3.62			37.91	
Total	25.92	62.22		17.18	46.86		66.28	75.31	

Annex 3. Economic Costs and Benefits

1. Economic Rate of Returns (ERR)

Common assumptions for calculation of economic returns:

1) Capital cost: economic costs at 2001 prices (taxes excluded) with a conversion factor of 1.08.

2) Tariff

a) WTP: 90.09 fen/kWh (including VAT) for the peak electricity generated by the project at a 16% capacity factor, which is a conservative estimation of consumer's WTP based on the actual tariff paid for a combined cycle plant at a 35% capacity factor in the same region.

b) Actual tariffs in 2001: 26.4 fen/kWh for energy sales and 470 Yuan/kW per year for available capacity plus VAT.

Average tariff = (1+17%)(Capacity Charges + Energy Charges)/Sales Volume

= 1.17*[1800*(1-0.4%)*470/10 + 2527.2*0.996*26.4] / 2517.1 = 1.17*59.88 = 70.05 fen/kWh

3) Energy output: actual outputs for 1998-2001, and projected for 2002-2030 based on capacity utilization of 1404 hours/year.

Energy output = Capacity * utilization hours = 1800 *1404/1000 = 2527.2 GWh

4) Plant overall conversion efficiency: 78% (energy generation / energy purchased)

5) Plant Service Power Rate: 0.4% of generation

6) Operating and maintenance cost

a) fixed cost: assumed at 2.0% of investment cost.

b) cost of pumping:

Variable cost = purchase price * energy output / plant efficiency

Purchase price = shadow cost of fuel (pumping is usually done during the night time)

Shadow cost of fuel = Coal consumption rate (300.0 gce/kWh) * Coal price (380.0 Yuan/tce)/1000000

Coal price is estimated based on economic costs of port price, handling and transportation.

1.1 Calculation of ERR

ERR Case A - with actual energy and capacity tariffs in 2001

ERR Case B - with estimated consumers' WTP in 2001

ERR Case A - with actual energy and capacity tariffs in 2001

ERR 13.9%

Year	Gen.	Tariff	Cost				Benefit	Net	
		Incl.	Investment	O&M cost		Total	Gen.		
		17%VAT	Plant	Variable	Fixed				PV
	GWh	fen/kWh		Y million				Y million	
1992			144.2			144.2		-144.2	-144.2
1993			200.3			200.3		-200.3	-200.3
1994			736.7			736.7		-736.7	-736.7
1995			705.0			705.0		-705.0	-705.0
1996			1272.7			1272.7		-1272.7	-1272.7
1997			1232.0			1232.0		-1232.0	-1232.0
1998	40.6	70.05	452.3	5.9	94.87	553.1	28.3	-524.8	-524.8
1999	804.0	70.05	587.3	117.5	106.61	811.5	561.0	-250.5	-250.5
2000	1451.4	70.05	208.3	212.1	110.78	531.2	1012.7	481.5	481.5
2001	2238.0	70.05	417.0	327.1	119.12	863.2	1561.6	698.3	698.3
2002	2300.0	70.05	0.0	336.2	119.12	455.3	1604.8	1149.5	1149.5
2003	2400.0	70.05	0.0	350.8	119.12	469.9	1674.6	1204.7	1204.7
2004	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2005	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2006	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2007	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2008	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2009	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2010	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2011	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2012	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2013	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2014	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2015	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2016	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2017	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2018	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2019	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2020	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2021	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2022	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2023	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2024	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2025	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2026	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2027	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2028	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2029	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
2030	2527.2	70.05	0.0	369.4	119.12	488.5	1763.3	1274.9	1274.9
Total	77468.5		5956.0	11322.3	3885.8	21164.1	54053.2	32889.1	**32889.1**

Note: Present values are discounted to 2001 with the social discount rate **12.00%**

ERR Case B - with estimated consumers' WTP in 2001

ERR 17.7%

Year	Gen	Tariff Incl. 17%VAT	Cost				Benefit	Net	
			Investment	O&M cost		Total	Gen.		
			Plant	Variable	Fixed				PV
	GWh	fen/kWh		Y million				Y million	
1992			144.2			144.2		-144.2	-400.0
1993			200.3			200.3		-200.3	-495.9
1994			736.7			736.7		-736.7	-1628.7
1995			705.0			705.0		-705.0	-1391.6
1996			1272.7			1272.7		-1272.7	-2243.0
1997			1232.0			1232.0		-1232.0	-1938.6
1998	40.6	90.09	452.3	5.9	94.87	553.1	36.4	-516.7	-725.9
1999	804.0	90.09	587.3	117.5	106.61	811.5	721.4	-90.0	-112.9
2000	1451.4	90.09	208.3	212.1	110.78	531.2	1302.4	771.2	863.7
2001	2238.0	90.09	417.0	327.1	119.12	863.2	2008.2	1144.9	1144.9
2002	2300.0	90.09	0.0	336.2	119.12	455.3	2063.8	1608.5	1436.2
2003	2400.0	90.09	0.0	350.8	119.12	469.9	2153.5	1683.6	1342.2
2004	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	1266.4
2005	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	1130.7
2006	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	1009.5
2007	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	901.4
2008	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	804.8
2009	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	718.6
2010	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	641.6
2011	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	572.8
2012	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	511.5
2013	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	456.7
2014	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	407.7
2015	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	364.1
2016	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	325.0
2017	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	290.2
2018	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	259.1
2019	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	231.4
2020	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	206.6
2021	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	184.4
2022	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	164.7
2023	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	147.0
2024	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	131.3
2025	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	117.2
2026	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	104.7
2027	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	93.4
2028	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	83.4
2029	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	74.5
2030	2527.2	90.09	0.0	369.4	119.12	488.5	2267.6	1779.2	66.5
Total	77468.5		5956.0	11322.3	3885.8	21164.1	69512.2	48348.1	**7115.8**

Note: Present values are discounted to 2001 with the social discount rate **12.00%**

1.2 Calculation of EDR by the Borrower

Tianhuangping						Gas Turbine					Net Benefit
Year	Energy	Cost				Energy	Cost				
	Generation	Investment	O&M Cost		Total	Generation	Investment	O&M Cost		Total	
			Fixed	Variable				Fixed	Variable		
	GWh	Y million				GWh	Y million				Y million
1992		144.2			144.2					0.0	-144.2
1993		200.3			200.3					0.0	-200.3
1994		736.7			736.7					0.0	-736.7
1995		705.0			705.0					0.0	-705.0
1996		1272.7			1272.7					0.0	-1272.7
1997		1232.0			1232.0		610.1			610.1	-622.0
1998	40.6	452.3	94.9	5.9	553.1	41.7	1743.0	94.1	16.8	1854.0	1300.9
1999	804.0	587.3	106.6	117.5	811.5	825.6	1743.0	163.8	333.2	2240.1	1428.6
2000	1451.4	208.3	110.8	212.1	531.2	1490.3	1133.0	209.2	601.6	1943.7	1412.5
2001	2238.0	417.0	119.1	327.1	863.2	2298.0		209.2	927.6	1136.8	273.5
2002	2300.0		119.1	336.2	455.3	2361.6		209.2	953.3	1162.4	707.2
2003	2400.0		119.1	350.8	469.9	2464.3		209.2	994.7	1203.9	734.0
2004	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2005	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2006	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2007	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2008	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2009	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2010	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2011	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2012	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2013	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2014	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2015	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2016	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2017	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2018	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2019	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2020	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2021	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2022	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2023	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2024	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2025	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2026	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2027	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2028	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2029	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
2030	2527.2		119.1	369.4	488.5	2594.9		209.2	1047.4	1256.6	768.1
Total	77468.5	5956.0	3885.8	11322.3	21164.1	79545.0	5229.0	6741.9	32108.3	44079.2	22915.1
NPV	22230.1	9035.9	1308.7	3249.0	13593.6	22825.9	6128.6	2195.6	9213.7	17537.8	3944.2
EDR	**18.74%**										

Assumptions:

Tianhuangping		**Gas Turbine**	
Efficiency of Tianhuangping Station:	78%		
Power Supply Coal Consumption:	300.00 gce/kWh	Fuel consumption rate:	351.00 gce/kWh
Coal Price:	380.00 Yuan/tce	Fuel Price:	1150.00 Yuan/tce
Plant Consumption Rate:	0.4%	Plant Service Power Rate:	3%
Fixed O&M Rate:	2.0%	Fixed O&M Rate:	4%
Levelized Cost: 0.61 Yuan/kWh	Social Discount Rate: 12%	Levelized Cost: 0.77 Yuan/kWh	Social Discount Rate: 12%

Note: This calculation was updated by the TT. For details of assumptions, see Borrower's Economic Analysis Report in the project file.

3. Financial Rate of Returns (FRR)

Based on the historical financial performance and financial projection for THPPC made by SP Power Economic Research Center, the FRR is assessed as follows:

Assumptions for Tianhuangping FRR calculation

1) Investment: all investment costs are expenditures in normal Yuan as they were recorded (excluding IDC);

Unit: million Yuan

	Item	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	Total
1	Domestic expenditures	69.5	106.6	333.1	392.2	622.4	398.1	54.8	475.3	169.0	187.2	2808.1
2	Foreign expenditures	3.0	3.1	193.2	166.7	481.3	696.0	342.0	71.8	25.8	203.6	2186.5
3	WB loan (in million USD)			20.9	20.0	57.9	84.0	41.0	8.7	3.1	24.6	260.5
4	TCC (in million USD)	0.4	0.5	1.6								2.5
5	Exchange rate	5.515	5.762	8.619	8.351	8.314	8.290	8.279	8.278	8.279	8.277	
6	Sub-total (1+2)	72.5	109.7	526.3	558.9	1103.7	1094.1	396.8	547.1	194.8	390.8	4994.7
7	Item 6 in USD	13.1	19.0	61.1	66.9	132.7	132.0	47.9	66.1	23.5	47.2	609.7
8	IDC of WB loan											237.4
9	IDC of domestic loan											1333.2
10	Total investment (6+8+9)											6565.2

Note: Total investment outlays = 4994.7 million Yuan or 609.7 million USD equivalent

2) Plant Service Power Rate = 0.4% since 2002;

3) Energy Sales: actual figures for 1998-2001, 2517.2 GWh for 2002 and ensuing years based on 1404 hours/year
Energy generation = Capacity * Utilization Hours = 1800 *1404/1000 = 2527.2 GWh
Energy Sales = Energy Generation * (1-Plant Usage Rate) = 2527.2*(1-0.4%) = 2517.1 GWh

4) Available Capacity = Installed Capacity*(1- Plant Usage Rate) = 1800*(1-0.4%) =1792.8 MW;
Capacity Charges = Available Capacity * Capacity Tariff
Energy Charges = Sales Volume * Energy Tariff

5) Tariff (excluding VAT)
Actual tariffs are used for years up to 2001;
The two-part tariff in 2001 is used for future years: capacity tariff: 470 Yuan/kW/year; energy tariff: 0.264 Yuan/kWh;
Average tariff = (Capacity Charges + Energy Charges)/Sales Volume
= [1800*(1-0.4%)*470/10 + 2517.1*26.4] / 2517.1 = 59.88 fen/kWh

6) Plant Overall Conversion Efficiency: 78% (energy generation = energy purchased * plant efficiency 78%);

7) Cost = Cost of Power Purchasing for Pumping + O&M Cost + Overhead + Sales Tax & Fees = Operating Cost - Depreciation
Cost of purchasing electricity for pumping: actual expenditures for 1998-2001, and for ensuing years:
Energy Purchase = Energy Generation / (Plant Efficiency) = 2527.2/0.78 = 3240 GWh
Purchase Price = 0.1829 Yuan/kWh;
O&M Cost = (Material Cost + Maintenance Cost + Salaries) * Escalation Factor
material cost = 4.1 Yuan/kW of installed capacity (1800 MW);
maintenance cost = maintenance cost in 2001
+ 0.74% * (historically valued fixed assets at start of 2001 - that at start of current year)
Salaries = 32000 yuan/person * 150 persons * (1 + 14%Welfare + 12% Housing + 17% Pension) / 1000000.
Operating Cost = Cost of Power Purchase + O&M Cost + Overhead + Tax & Fees + Depreciation
Cash Operating Cost = Cost of Power Purchase + O&M Cost + Overhead + Sales Tax & Fees
Overhead = [33.45 Yuan/kW * Installed Capacity (GW)] * Escalation Factor
overhead assumed at 33.45 Yuan/kW of installed capacity (1800 MW);

8) Inflation rate (by mid of year)

	2001	2002	2003	2004	2005	2006	2007-2021
local cost	1.5%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
foreign cost	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
local cost escalation factor	1.0000	1.0075	1.0251	1.0456	1.0665	1.0878	

9) Cases: inflation adjustment was made to see inflation impacts on the FRR

Case A No adjustment for inflation;

Case B All cash operating costs adjusted for inflation;

Case C Both tariffs and cash operating costs adjusted for inflation.

FRR Case A - No adjustment for inflation

FRR = 10.70%

Year	Invest. Plant	Sales Volume	Price Escalat. Factor	Tariff Capacity	Tariff Energy	Tariff Average	Oper. Revenue	Oper. Cost	Net Cashflow	PV
	Y Million	GWh		Yuan/kW	Fen/kWh	Fen/kW	Y Million		Y Million	
1992	72.5								-72.5	-181.0
1993	109.7								-109.7	-247.4
1994	526.3								-526.3	-1072.3
1995	558.9								-558.9	-1028.7
1996	1103.7								-1103.7	-1835.0
1997	1094.1								-1094.1	-1643.2
1998	396.8	16.42				27.89	4.5	4.8	-397.1	-538.8
1999	547.1	791.92				36.80	290.6	165.3	-421.8	-517.0
2000	194.8	1436.06				56.78	817.0	400.6	221.6	245.3
2001	390.8	2224.55	1.0000	470.0	26.4	59.68	1327.5	600.5	336.2	336.2
2002	0.0	2290.80	1.0000	470.0	26.4	63.18	1447.4	698.1	749.3	676.8
2003	0.0	2390.40	1.0000	470.0	26.4	61.65	1473.7	698.6	775.1	632.5
2004	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	595.6
2005	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	538.0
2006	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	486.0
2007	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	439.0
2008	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	396.6
2009	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	358.2
2010	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	323.6
2011	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	292.3
2012	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	264.1
2013	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	238.5
2014	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	215.5
2015	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	194.6
2016	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	175.8
2017	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	158.8
2018	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	143.5
2019	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	129.6
2020	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	117.1
2021	0.0	2517.09	1.0000	470.0	26.4	59.88	1507.1	699.1	808.0	105.7
Total	4994.7	54457.8					32489.0	15152.2	12342.0	0.0

Note: the FRR After Tax is used as the discount rate for the Present Values discounted to 2001 in this table.

FRR Case B - All cash operating costs adjusted for inflation

FRR = 9.54%

	Investment Plant	Sales Volume	Price Escalat. Factor	Tariff Capacity	Tariff Energy	Tariff Average	Oper. Revenue	Oper. Cost	Net Cashflow	
										PV
	Y Million	GWh		Yuan/kW	Fen/kWh	Fen/kW	Y Million		Y Million	
1992	72.5								-72.5	-164.6
1993	109.7								-109.7	-227.3
1994	526.3								-526.3	-995.7
1995	558.9								-558.9	-965.3
1996	1103.7								-1103.7	-1740.3
1997	1094.1								-1094.1	-1575.0
1998	396.8	16.42				27.89	4.5	4.8	-397.1	-521.9
1999	547.1	791.92				36.80	290.6	165.3	-421.8	-506.1
2000	194.8	1436.06				56.78	817.0	400.6	221.6	242.7
2001	390.8	2224.55	1.0000	470.0	26.4	59.68	1327.5	600.5	336.2	336.2
2002	0.0	2290.80	1.0075	470.0	26.4	63.18	1447.4	703.1	744.2	679.5
2003	0.0	2390.40	1.0251	470.0	26.4	61.65	1473.7	715.5	758.2	631.9
2004	0.0	2517.09	1.0456	470.0	26.4	59.88	1507.1	729.8	777.3	591.4
2005	0.0	2517.09	1.0665	470.0	26.4	59.88	1507.1	743.9	763.2	530.2
2006	0.0	2517.09	1.0878	470.0	26.4	59.88	1507.1	758.3	748.8	474.9
2007	0.0	2517.09	1.1096	470.0	26.4	59.88	1507.1	772.9	734.2	425.1
2008	0.0	2517.09	1.1318	470.0	26.4	59.88	1507.1	787.9	719.2	380.2
2009	0.0	2517.09	1.1544	470.0	26.4	59.88	1507.1	803.1	704.0	339.7
2010	0.0	2517.09	1.1775	470.0	26.4	59.88	1507.1	818.7	688.4	303.3
2011	0.0	2517.09	1.2011	470.0	26.4	59.88	1507.1	834.5	672.6	270.5
2012	0.0	2517.09	1.2251	470.0	26.4	59.88	1507.1	850.7	656.4	241.0
2013	0.0	2517.09	1.2496	470.0	26.4	59.88	1507.1	867.2	639.9	214.5
2014	0.0	2517.09	1.2746	470.0	26.4	59.88	1507.1	884.1	623.1	190.7
2015	0.0	2517.09	1.3001	470.0	26.4	59.88	1507.1	901.2	605.9	169.3
2016	0.0	2517.09	1.3261	470.0	26.4	59.88	1507.1	918.7	588.4	150.1
2017	0.0	2517.09	1.3526	470.0	26.4	59.88	1507.1	936.6	570.5	132.9
2018	0.0	2517.09	1.3796	470.0	26.4	59.88	1507.1	954.8	552.3	117.4
2019	0.0	2517.09	1.4072	470.0	26.4	59.88	1507.1	973.4	533.7	103.6
2020	0.0	2517.09	1.4354	470.0	26.4	59.88	1507.1	992.4	514.8	91.2
2021	0.0	2517.09	1.4641	470.0	26.4	59.88	1507.1	1011.7	495.4	80.1
Total	4994.7	54457.8					32489.0	18130.0	9364.3	0.0

Note: the FRR is used as the discount rate for the Present Values discounted to 2001 in this table.

Although costs may escalate with inflation, tariff increase needs government's approval.

FRR Case C - Both tariffs and cash operating costs adjusted for inflation

FRR = 11.85%

Year	Invest. Plant	Sales	Price Escalat. Factor	Tariff Capacity	Tariff Energy	Average	Oper. Revenue	Oper. Cost	Net Cashflow	PV
	Y Million	GWh		Yuan/kW	Fen/kWh	Fen/kW	Y Million		Y Million	
1992	72.5								-72.5	-177.6
1993	109.7								-109.7	-240.3
1994	526.3								-526.3	-1030.7
1995	558.9								-558.9	-978.6
1996	1103.7								-1103.7	-1727.7
1997	1094.1								-1094.1	-1531.1
1998	396.8	16.42				27.89	4.5	4.8	-397.1	-496.8
1999	547.1	791.92				36.80	290.6	165.3	-421.8	-471.8
2000	194.8	1436.06				56.78	817.0	400.6	221.6	221.6
2001	390.8	2224.55	1.0000	470.0	26.4	59.68	1327.5	600.5	336.2	300.6
2002	0.0	2290.80	1.0075	473.5	26.6	63.65	1458.2	703.3	754.9	603.4
2003	0.0	2390.40	1.0251	481.8	27.1	63.20	1510.7	716.1	794.6	567.8
2004	0.0	2517.09	1.0456	491.4	27.6	62.61	1575.9	731.0	844.8	539.7
2005	0.0	2517.09	1.0665	501.3	28.2	63.86	1607.4	745.6	861.7	492.2
2006	0.0	2517.09	1.0878	511.3	28.7	65.14	1639.5	760.5	879.0	448.8
2007	0.0	2517.09	1.1096	521.5	29.3	66.44	1672.3	775.8	896.6	409.3
2008	0.0	2517.09	1.1318	531.9	29.9	67.77	1705.8	791.3	914.5	373.2
2009	0.0	2517.09	1.1544	542.6	30.5	69.12	1739.9	807.1	932.8	340.3
2010	0.0	2517.09	1.1775	553.4	31.1	70.50	1774.7	823.2	951.4	310.4
2011	0.0	2517.09	1.2011	564.5	31.7	71.91	1810.2	839.7	970.5	283.0
2012	0.0	2517.09	1.2251	575.8	32.3	73.35	1846.4	856.5	989.9	258.1
2013	0.0	2517.09	1.2496	587.3	33.0	74.82	1883.3	873.6	1009.7	235.3
2014	0.0	2517.09	1.2746	599.1	33.6	76.32	1921.0	891.1	1029.9	214.6
2015	0.0	2517.09	1.3001	611.0	34.3	77.84	1959.4	908.9	1050.5	195.7
2016	0.0	2517.09	1.3261	623.3	35.0	79.40	1998.6	927.1	1071.5	178.5
2017	0.0	2517.09	1.3526	635.7	35.7	80.99	2038.5	945.6	1092.9	162.7
2018	0.0	2517.09	1.3796	648.4	36.4	82.61	2079.3	964.6	1114.8	148.4
2019	0.0	2517.09	1.4072	661.4	37.2	84.26	2120.9	983.8	1137.1	135.3
2020	0.0	2517.09	1.4354	674.6	37.9	85.94	2163.3	1003.5	1159.8	123.4
2021	0.0	2517.09	1.4641	688.1	38.7	87.66	2206.6	1023.6	1183.0	112.5
Total	4994.7	54457.8					39151.2	18243.3	15913.2	0.0

Note: the FRR is used as the discount rate for the Present Values discounted to 2001 in this table.

Annex 4. Bank Inputs

(a) Missions:

Stage of Project Cycle	No. of Persons and Specialty (e.g. 2 Economists, 1 FMS, etc.)		Performance Rating	
Month/Year	Count	Specialty	Implementation Progress	Development Objective
Identification/Preparation				
09/1991	*4*	Engineers		
Preparation	*1*	Financial specialist		
	1	Environmental specialist		
02/1992	*1*	Power engineer		
Pre-appraisal	*1*	Operation officer		
06/1992	*2*	Engineers		
Follow-up	*1*	Financial specialist		
	1	Procurement specialist		
	1	Operation officer		
Appraisal/Negotiation				
10/1992	*1*	Energy specialist		
	1	Financial Specialist		
	1	Legal counsel		
	1	Economist		
	2	Engineers		
	1	Procurement specialist		
	1	Operation officer		
Supervision				
03/17/1995	*1*	Power engineer	S	S
	1	Consultant		
04/18/1996	*1*	Power engineer	HS	S
	1	Financial specialist		
07/10/1996	*1*	Power engineer	HS	S
	1	Financial specialist		
04/21/1997	*1*	Power engineer	HS	S
10/23/1997	*1*	Power engineer	HS	S
05/19/1998	*1*	Power engineer	HS	S
11/19/1998	*2*	Power engineers	HS	S
	1	Legal counsel		
	1	Resettlement specialist		
09/06/1999	*1*	Power engineer	HS	S
	1	Energy specialist		
	1	Resettlement specialist		
05/08/2000	*1*	Power engineer	HS	S
	1	Energy specialist		
	1	Financial specialist		
	1	Consultant		
06/07/2001	*1*	Power engineer	HS	S
	2	Consultants		
11/12/2001	*1*	Power Engineer	HS	S
	1	Operations officer		
04/12/2002	*2*	Power engineers	HS	S

ICR	*1* *1* *1* *1* *2*	Operation officer Economist Economist Operation Officer Engineers	S	S

Note:

The implementation progress was rated HS in early stages of implementation because construction progress closely adhered to SAR schedule (see Annex 1 Key Dates of Project Implementation). It was still rated HS after the landslide and transformer problems occurred and caused delays as the Government's and the implementing agency's response were prompt and efficient, and negative impacts were minimized (it appeared that while first unit delays would be substantial then delays to subsequent unit commssionings would be reduced and last units would be commissioned on schedule). However, transformer failures resulted in subsequent unit commissioning delays from 5 to 12 months. Therefore the overall performance of project implementation is downgraded to S by the ICR mission.

(b) Staff:

Stage of Project Cycle	Actual/Latest Estimate	
	No. Staff weeks	US$ ('000)
Identification/Preparation	49.7	197.1
Appraisal/Negotiation	38.8	165.3
Supervision	54.1	255.5
ICR	8.0	30.0
Total	150.6	647.9

Note:

Above a full cost and assume 25% mark-up to direct costs for fiscal years prior to FY99.

Annex 5. Ratings for Achievement of Objectives/Outputs of Components

(H=High, SU=Substantial, M=Modest, N=Negligible, NA=Not Applicable)

	Rating
☒ *Macro policies*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☒ *Sector Policies*	○ *H* ○ *SU* ● *M* ○ *N* ○ *NA*
☒ *Physical*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☒ *Financial*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☒ *Institutional Development*	● *H* ○ *SU* ○ *M* ○ *N* ○ *NA*
☒ *Environmental*	● *H* ○ *SU* ○ *M* ○ *N* ○ *NA*
Social	
☒ *Poverty Reduction*	○ *H* ○ *SU* ● *M* ○ *N* ○ *NA*
☒ *Gender*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☐ *Other (Please specify)*	○ *H* ○ *SU* ○ *M* ○ *N* ○ *NA*
☒ *Private sector development*	○ *H* ○ *SU* ○ *M* ○ *N* ● *NA*
☒ *Public sector management*	○ *H* ● *SU* ○ *M* ○ *N* ○ *NA*
☐ *Other (Please specify)*	○ *H* ○ *SU* ○ *M* ○ *N* ○ *NA*

Annex 6. Ratings of Bank and Borrower Performance

(HS=Highly Satisfactory, S=Satisfactory, U=Unsatisfactory, HU=Highly Unsatisfactory)

6.1 Bank performance	*Rating*
☒ *Lending*	○ *HS* ● *S* ○ *U* ○ *HU*
☒ *Supervision*	○ *HS* ● *S* ○ *U* ○ *HU*
☒ *Overall*	○ *HS* ● *S* ○ *U* ○ *HU*

6.2 Borrower performance	*Rating*
☒ *Preparation*	○ *HS* ● *S* ○ *U* ○ *HU*
☒ *Government implementation performance*	○ *HS* ● *S* ○ *U* ○ *HU*
☒ *Implementation agency performance*	● *HS* ○ *S* ○ *U* ○ *HU*
☒ *Overall*	○ *HS* ● *S* ○ *U* ○ *HU*

Annex 7. List of Supporting Documents

1. ICR Mission aide memoire
2. Completion Report on the Tianhuangping Pumped Storage Project, prepared by the Borrower
3. Project Completion Report for the new component (Sijing and Hangdong Substations), prepared by the Borrower
4. Economic Evaluation on Tianhuangping Pumped Storage Power Station, prepared by SP Power Economic Research Center
5. Financial Analysis for Tianhuangping Pumped Storage Station, prepared by SP Power Economic Research Center
6. Environmental Management and Monitoring Report, prepared by the Nanjing Environment Protection Research Institute
7. Project files, containing full records of preparation and supervision activities.

Additional Annex 8. Outputs and Ratings

The outputs and ratings of the Dam & Powerhouse and the Substation Components are as follows:

(a) Preparatory Works. This component is rated satisfactory. Started in June 1992 as scheduled, all works were ready for commencement of the project construction on March 1, 1994, preparatory works completed included access road of 21.4 km in total and access tunnel of 999 m; water supply with two pump stations of 988 m3/hour in total; power supply with a 110 kV/35kV substations of 12.6 MVA and another 35 kV/10 kV substation and power distribution lines of 69 km in total at different voltage levels; communication system with an optical cable of 18 km, a program-controlled exchanger of 250 ports and communication cables of 47 km in total; a diversion tunnel of 445 m long, 5.0 m wide and 5.6 m high.

(b) Construction of a pumped-storage hydroelectric power plant together with upper and lower reservoirs, a water conveyance system, an underground power house, and a switchyard. This component is rated satisfactory. Construction of these facilities satisfied all relevant quality and safety standards. They have generally been in smooth operation since September 1998 when the first unit was commissioned. Cracks due to uneven settlement were found in the upper reservoir bottom lining during the initial impoundment in 1998 and were repaired. The State Safety Inspection in September 2001 rated the safety of these facilities satisfactory and monitoring is continuing.

(c) Provision and installation of six single-stage 300-MW reversible pimp-turbine units and associated equipment. This component is rated satisfactory. The first generating unit was commissioned in September 1998 (12 months delay), the last in December 2000 (12 months delay); delays for intermediate units varied between 5 and 9 months. The project was completed in December 2000 (as scheduled in SAR), adding a capacity of 1800MW (6x300 MW) for peaking, and an off-peak load of 1,900 MW to the ECPG, accounting for regulating 3,700 MW peak-valley load difference (33.24 percent) of the grid.

(d) Erection of 500-kV transmission lines (about 250 km long) and reinforcement of the existing power transmission networks. This component is rated satisfactory. Two 500 kV transmission lines were installed in length of 39.8 and 39.5 km respectively. The lines were put into operation in May 1998 and have been functioning satisfactorily.

(e) Provision of elected equipment for civil works and dam safety. This component is rated satisfactory. All necessary construction equipment was ordered and delivered to the satisfactory of civil works construction. See Annex 13 of the Borrower's Completion Report for the list of equipment.

(f) construction of Sijing and Hangdong 500 kV substations. This is a new component and is rated satisfactory. Sijing substation was commissioned in December 2000 and Hangdong substation in May 2001, delayed 3 and 5 months than scheduled respectively. But the commissioning of the first substation served the peak demand need in the winter of 2000, as did commissioning of the later substation in the summer of 2001.

Additional Annex 9. Implementation of Environment Management Plan

The program had three objectives: (i) to identify the adverse impacts of the project; (ii) to formulate a set of measures to be taken during project implementation and operation, so as to mitigate or reduce the adverse impacts to acceptable levels; and (iii) to set up an institution responsible for carrying out the mitigation measures and the monitoring program.

Headed by THPCC with participation of Supervision Engineers, ECIDI, contractors and the power plant, an organization of 15 full time staff members was established for environment monitoring and protection during construction.

(a) Impact Assessment: The EIA studies of the Project had been carried out by ECIDI since 1986 and the final Environment Assessment Report was prepared in April 1992, taking into account the Bank's comments and suggestions. Possible adverse impacts identified are: (i) reservoir inundation; (ii) land requisition and resettlement; (c) downstream effects; (iv)induced earthquake; (v) land slide; and (vi) impact of construction on the surrounding environment.

(b) Monitoring and Mitigation. This component is rated satisfactory

(b.1) Reservoir inundation and resettlement. An area of 186.2 ha was acquired for the facilities and reservoirs inundation; 223.3 ha temporarily borrowed for construction. There were no inhabitants or agricultural activity in the area except for some bamboo growing. Construction had little impact on wildlife. Cost for the land acquisition or recovery of the vegetation of the borrowed areas was Y 61.3 million, about 16 times the annual production of the said areas.

(b.2) Water quality. Waste water was treated to meet standards before discharge. The lower reservoir impoundment improved river water turbidity from 8.87 to 5.5 mg/l. The Daxi river was monitored by ECIDI, and drinking water, by the Public Health Bureau of the local county government.

(b.3) Downstream effects. There was no shipping and fishing activity on the Daxi River. A total of 154, 000 m3 of bed load which accumulated during construction was removed and the river course enhanced to handle larger floods. The lower reservoir is regulating inflows to the downstream Pancun Reservoir, which is serving local communities for portable water and irrigation.

(b.4) Prevention of landslide. The materials of the landslide on March 29, 1996 were removed and unstable slopes consolidated to prevent further landslides. Monitoring of these slopes is continuing.

(b.5) Seismic activity. This component was canceled because no possibility of reservoir-induced earthquake existed as concluded by Zhejiang Provincial Seismic Research Laboratory after a seismic safety evaluation conducted for both of the reservoirs.

(b.6) Hydrological and meteorological forecasting and monitoring. A forecasting station was set up close to both the upper and lower reservoirs. It was operated by the Meteorological Bureau of the local county government.

(b.7) Bed Load. Bed load downstream of the lower reservoir was monitored by the engineering department of THPCC.

(b.8) Vegetation. As the project has no impacts on wildlife, only changes in vegetation was monitored by the Departments of Land, Forestry Industry and Water Conservation of the Provincial government. More than 20 staff from the departments and 2 from THPCC were engaged in the monitoring. Results show that vegetation outside the project site remained intact. An area of about 200,000 m2 in total was reforested in the affected areas. A soil and water conservation plan approved by the Ministry of Water Resources was implemented to the satisfaction of relevant standards.

(b.9) Public Health. The sources of potential impact were dust and noise during construction. They were monitored by Supervision Engineers. No related illness was detected.

Additional Annex 10. Implementation of Resettlement Action Plan

A resettlement action plan (RAP) for the added Hangdong and Sijing 500 kV substations component was prepared by ECEPG, and was reviewed and approved by the Bank in late 1998. The overall resettlement implementation for both substations followed the RAP and proceeded smoothly due to good planning, adequate compensation policies, and available farmland resources for re-establishment of livelihood of affected individuals. The per capita income among affected villages or companies has steady increased over the past few years. A recent survey demonstrated the affected villages' and individuals' satisfaction with the resettlement process and outcomes. The use of compensation funds among affected villages was closely monitored by different levels of resettlement institutions and individual resettlers and is transparent to the affected people.

1. Scope

According to the RAP, a total of 286 mu farmland needed to be acquired for the two substations (140 mu for Sijing and 146 mu for Hangdong); no people needed to be resettled nor houses relocated; 143 rural persons (134 for Sijing and 9 for Hangdong) were affected and needed full economic rehabilitation; and 93 affected rural labors needed compensation for lost jobs. But during implementation less land was acquired and fewer people were affected (Table 1).

Table 1 Comparison of Scope of Resettlement for Tianhuangping Cost Saving Component

Substations	Land requisition (mu)		Farmer affected (person)		Rural Labor affected (person)	
	RAP	Actual	RAP	Actual	RAP	Actual
Sijing	140	122	134	118	87	78
Hangdong	146	147	9	9	6	6
Total	286	269	143	127	93	84

2. Implementation Status

Implementation of the RAP was initiated in September and November 1998 for Sijing and Hangdong respectively. For Sijing, the land acquisition was completed in December 1998; same amount of farmland as acquired had been re-allocated to affected village groups and all compensation funds disbursed to the affected villages and individuals by the end of September 1999. The substation was commissioned in December 2000. For Hangdong, the land acquisition was completed in early 1999; land compensation funds were fully paid to an affected company, villages and individuals by the end of October 1999. The substation was commissioned in May 2001.

3. Outputs and Outcomes

Some 269 mu land areas in total (vs. 286 mu in the RAP) were acquired in a timely manner, including 122 mu for Sijing and 147 mu for Hangdong. Due to reduction of land acquired, the number of affected people who needed full economic rehabilitation was also reduced from 143 persons in the RAP to 127 persons (118 for Sijing and 9 for Hangdong), and the number of affected workers was reduced from 93 in the RAP to 84 (78 for Sijing and 6 for Hangdong) (Table 1). In terms of compensation rates, all compensation rates delivered were either higher or equal to the amount in the RAP except for green crop compensation rate for Hangdong. The green crop compensation rate was set at half of the annual output value for Hangdong in

the RAP. The actual average yield was Y700 per mu for summer seasons and Y500 per mu for winter seasons. Because land acquisition took place in a winter season, the rate of Y500 per mu was well accepted.

Table 2 Comparison of Compensation for Tianhuangping Cost Saving Component

Substations	Total Compensation (Yuan/mu)		For Land (Yuan/mu)		For Labor [1] (Yuan/person)		For Young Crops (Yuan/mu)	
	RAP	Actual	RAP	Actual	RAP	Actual	RAP	Actual
Sijing	127929	140000	8800	8800	40000	40000	1600	2000
Hangdong (village)	79056	75000	7200	7200	9600	9600	600	500
Hangdong (ZXADC)	1442280	7310380						

Notes:
1. compensation rates were set as 40,000 Yuan/labor for Sijing and 9600 Yuan/mu for Hangdong.

Sijing Substation. The 122 mu land was acquired from Xiaochang Village. Compensation was made based on the compensation rates negotiated with participation of affected villages (Table 2). The actual compensation rates for individual items were either the same as (for land and job) or higher (for green crop compensation) than the rates in the RAP. A total of Y17.1 million for compensation of 122 mu land were fully disbursed to Sijing Town Government in 1998 while compensation for green crop was paid directly to affected individuals. Out of the Y17.1 million, Y4.19 million including compensations for land (Y8,800/mu) and for job (Y40,000/labor) were disbursed to the affected village in 1999 after the same amount of paddy land (122 mu) from the village reserved land was re-allocated to the affected village groups; (In Xiaochang Village, each farmer was allocated 0.4 mu for food grain and the rest was kept by the village as reserved farmland. Use of the reserved farmland was subject to majority approval by farmers and income generated from the land was distributed among all village members.) about Y6.9 million was used for setting up a pension fund to provide basic living allowance for all old people (male over 60 and female over 55) in the affected village.

Hangdong Substation. A total of 146.5 mu of land was acquired, with 141.4 mu from Zhejiang Xinghai Agricultural Development Company (ZXADC--a state farm), and 5.1 mu from Hongqi Village. Almost all the acquired lands were paddy fields. Since these paddy fields belong to two different types of land tenures (the state and the rural collectives), the compensation policies were quite different.

For ZXADC, which owned 45,000 mu farmland excluding the 141.4 mu acquired and employed 3,000 workers, compensation for land was negotiated at Y7.3 million in total, averaging Y51,700/mu, which was much higher than that in the RAP (Y10,200/mu). Given such high compensation rate and sufficient resources remaining, no major impacts were expected on the livelihood of the state farm workers. In addition to the land compensation, the Project also paid Y1.58 million to ZXADC to restore or improve the affected irrigation, power line and other related infrastructure facilities.

For Hongqi Village, the 5.1 mu land was acquired for access road, including 3.7 mu paddy land and the rest of road and canal areas. The compensation paid was based on the RAP with Y7,200 per mu for land, Y9,600 per mu for lost jobs, and Y500 per mu for green crops. Compensation for young crops was paid directly to the affected individuals while Y85,680 (Y16,800 x 5.1) for land and jobs compensation were disbursed to Hongqi Village. Partial compensation (Y55,680) were distributed to all village group members and the remaining (Y30,000) were used to improve village infrastructure facilities. Same amount of paddy land (3.7 mu) was re-allocated from the village reserves to the affected farmers.

Income Restoration. The resettlement monitoring and evaluation report completed by ECIDI by the end of 2001 demonstrated that per capita annual income of the affected villages (in both cases) had steadily increased over the past few years. In Xiaochang Village (Sijing), it increased from Y6,500 in 1998 to Y7,300 in 2000 by 12.3 percent. Growth of income from farming (by converting grain production into vegetable production) and non-farming activities contributed to the increase. For (Hangdong), it also increased over the same period by 21 percent in ZXADC from Y6,250 in 1998 to Y7,550 in 2000, and by 6 percent in Hongqi Village from Y4,697 in 1998 to Y4,979 in 2000. Rapid increase of non-agricultural employment and income contributed to such increase. According to the survey in 2001, all the two affected villages and 53 interviewed expressed satisfaction with the resettlement process and outcomes.

Additional Annex 11. Executive Summary of Borrower's Completion Report

1. Project Description

1.1 General information

Tianhuangping Pumped Storage Power Plant, locating at Anji County, Zhejiang Province China, with a total installed capacity of 1800 MW (6X300 MW), is the largest of its kind either operating or under construction in East China Area. After putting it into operation, it mainly serves East China Power Grid, which is a predominantly coal-fired thermal power system, to balance the load peak and valley, and also has the functions of phase and frequency adjusting, emergency backing-up, etc.

The project mainly consists of the lower reservoir, upper reservoir, water conveyance system, underground powerhouse and tail-water system, 500 kV switchyard and Control Center Building. See Table 1 for the main characteristics of the Project.

No.	Name	Quantity	Project Characteristics	Remarks
1	Upper Reservoir	1	Normal Pool Level: El 905.2 m; Effective Capacity: 881.23 m3	Daily regulated
2	Lower Reservoir	1	Normal Pool Level: El 344.5; Effective Capacity: 802.08 m3	Daily regulated
3	Inclined Shaft	2	Length: 882.2 m Diameter: 7 m	Concrete Lined
4	Penstock	6	Length: 229.9~314.7 m; Diameter: 3.2~2.0 m	Concrete Manifold + Penstock
5	Tail-water Tunnel	6	Length: 229.3~246.6 m Diameter: 4.4 m	Concrete Lined + Steel Lined
6	Underground Power House	1	LxWxH: 198.7x21x47.73 m	Max. Dimension
7	Switchyard	1	500 kV GIS	Surface
8	Pump/Turbine	6	Output(P/T):306/336 MW	
9	Generator/Motor	6	Output(G/M):333/336 MW	
10	Main Transformer	6	360 kVA (4 from Peebles, 2 from Toshiba Changzhou)	
11	500kv Cable	3	500 kV (Dry-type)	
12	GIS	1	500 kV	

1.2 Change of design

According to the original design, the 500 kV Switchyard was placed on the top of the mountain, North West side of the upper reservoir, the elevation was about El 850 m. That place was far away from the control center and the HV out-going lines of the main transformers, which is not convenient for operation and management. The construction cost was quite high. During the implementation of this Project, it was discussed with the design institute and approved by the State Power Company of China, the 500 kV switchyard was move to the current position (at El 350.3 m by the control center). The 500 kV dry cables from the HV side of the main transformers were directly connected with the 500 kV GIS of the switchyard, which reduced the investment of equipment and made the operation and management very convenient.

The 500 kV switchyard occupies an area of 208x35 m. It mainly consists of one GIS building and an outdoor switchyard. Two circuits of 500 kV out-going lines were connected to the 500 kV TIANPING (Tianhuangping-Pingyao) Line through GIS switches. The arrangement is compact and the operation is flexible and convenient.

1.3 Project Investment and Financing

The total cost at appraisal excluding interest during construction was $547.3 million (excluding interests during construction--IDC), of which RMBY 720 million was equity investment from the investors. Except for the loan of $300 million provided by the World Bank, the rest were provided by the investors through getting loans from domestic commercial banks in proportion to their investments.

2. Project Objectives

As same as the World Bank evaluated, the project objectives are to:

1) alleviate an acute shortage of peaking power and enable more efficient use of power plants in a predominantly coal-fired thermal power system by transferring off-peak energy to peak with construction of the cost-effective and environmentally sound Tianhuangping pumped-storage hydroelectric plant and associated facilities;

2) support economic reforms and enabling environment for attracting foreign investments and promoting private sector development by improving the quality of the power supply and enhancing socioeconomic conditions in densely populated East China regions;

3) improve load management and promote energy conservation by introducing appropriate peaking power pricing;

4) support institutional development of the beneficiary by strengthening its organization through an advanced management and staff training program;

5) contribute to the development of an improved power utility regulatory framework;

6) assist in transferring new power technologies for what will be the largest pumped-storage hydroelectric plant in China, and in applying modern power system operation optimization methods;

7) extend technical assistance in project design and implementation, and in promoting prudent financial management.

3. Project implementation

3.1 Construction conditions and main achievements

The Project construction was featured with large scale, tight construction schedule, and highly difficult technically challenging. The preparation work for construction started from June 1992 and on March 1, 1994 the main project construction started. On Dec. 25, 2000, the last unit was put into production. The total construction period is 82 months. The Owner (East China Electric Power Group Company--ECEPGC) and the construction company (Tianhuangping Pumped-storage Power Plant Construction Company--THPCC) tried their best to strengthen the project management, and to carefully organize, timely coordinate, and to successfully overcome the great difficulties caused by the "3.29" landslide in lower reservoir area in 1996, with joint efforts of all parties involved, the project was completed as scheduled and the construction quality is good.

3.2 Resettlement Action Plan Implementation

An area of 186.2 ha was permanently acquired for Tianhuangping project, among which 0.284 km2 was inundated by the upper reservoir and 0.28 km2 by the lower reservoir. There was no farmland in the area, in which only bamboos and bushes grew. Construction had little impacts on local inhabitants, wildlife and ground layout. Cost for the areas borrowed and acquired was RMBY 61.3 million, about 16 times of the annual production (bamboo) of the said area. An area of 233.3 ha was temporarily borrowed for construction activities. The Owner paid compensation as agreed for reclaiming the area again. The local government organized farmers to reclaim the areas after the project was finished.

There was no relocation caused by this project.

3.3 Implementation of Environment Management Plan

Headed by THPCC with participation of Supervision Engineers, East China Investigation and Design Institute (ECIDI), contractors and the Tianhuangping Pumped-storage Power Plant (TPSPP--set up in March 1997), an organization of 15 full time staff members was established for environment monitoring and protection during construction.

3.3.1 Water quality. Waste water was treated to meet standards before discharge. The lower reservoir impoundment improved river water clarity from 8.87 to 5.5 mg/l of mud. The Daxi river was monitored by ECIDI, and addible water, by the Public Health Bureau of the local county government.

3.3.2 Downstream effects. There was no shipping and fishing activity on the Daxi River. A total of 154, 000 m3 of bed load accumulated during construction was removed and the river course enhanced to handle larger floods. The lower reservoir is regulating the downstream Pancun Reservoir, which is serving local communities for drinking and irrigation.

3.3.3 Prevention of landslide. The materials of the landslide on March 29, 1996 were removed and unstable slopes consolidated to prevent further landslides. Monitoring of these slopes is continuing.

3.3.4 Seismic activity. This component was canceled because no possibility of reservoir-induced earthquake would occur as concluded by Zhejiang Provincial Seismic Research Laboratory after a seismic safety evaluation conducted for both of the reservoirs.

3.3.5 Hydrological and meteorological forecasting and monitoring. A forecasting station was set up close to both the upper and lower reservoirs. It was operated by the Meteorological Bureau of the local county government.

3.3.6 Bed Load. Bed load downstream of the lower reservoir was monitored by the engineering department of THPCC.

3.3.7 Vegetation. As the project has no impacts on wild animals, only changes in vegetation was monitored by the Departments of Land, Forestry Industry and Water Conservation of the Provincial government. More than 20 staff from the departments and 2 from THPCC were engaged in the monitoring. Results show that vegetation outside the project site remained intact. About 200,000 m2 in total were reforested in the affected areas. A soil and water conservation approved by the Ministry of Water Resources was implemented to the satisfaction of relevant standards.

3.3.8 Public Health. The sources of potential impact were dust and noise during construction. They were

monitored by Supervision Engineers. No related illness was detected.

3.3 Achievement of Objectives

The overall outcome of the objectives is satisfactory except the one "improve load management and promote energy conservation by introducing appropriate peaking power pricing", which was limited due to gradually reforming of our state. While it is delightful that the policy of peak-valley power tariff has been put in practice in Each China area though the price difference was still quite small. We have reason to believe that this objective will be achieved along with continuous progress of our reform.

3.5 Actual Costs and Financing, and Overrun Reasons

The actual cost of the project was $609.6 million, with an overrun of $62.3 million comparing to the World Bank's evaluation of $547.3 million. The cost overrun is about 11.4 percent. The local part had an overrun of $102.2 million, while the foreign part had an under-run of $39.9 million. The plant cost is $338.6/kW. Overruns were caused by: (1) higher-than-expected costs of civil works, especially treatment of the "3.29" landslide in the lower reservoir area, (2) escalations of labor and materials prices due to adjustment of state policy.

Excluding the capital of RMBY 720 million provided by the investors and a loan of $260 million from the World Bank, the rest were supplied by the investors through getting loans from domestic commercial banks in proportion to their investments. After the East China Tianhuangping Pumped Storage Power Co. Ltd (TPSPC). was set up in December 1998 according to The Company Law of People's Republic of China, all the bank debts for financing were transferred to it.

4. Comments on Relevant Parties

- The World Bank's performance is highly satisfactory.
- The Borrower ECEPGC's performance is highly satisfactory.
- THPCC's performance is satisfactory.
- TPSPP's performance is satisfactory.
- The designer ECIDI's performance is satisfactory.
- The Supervision Engineer's performance is satisfactory.
- The Contractors' performance is satisfactory.

5. Future Operation

5.1 Operation Management System

For plant operation, the TPSPP was set-up in March 1997 and started to function in September 1998. It is staffed with 100 persons in three departments (production management, operation, maintenance). Operating procedures were laid down with the help of international consultant. The operation management system became perfect gradually.

5.2 Achievements since Operation

The plant achieved good operating indicators: 97.4 percent successful rate for start-ups and 78 percent for plant cycle efficiency. A Power Purchase Agreement was signed specifying the two-part sale tariff and a power purchase price for pumping. The plant is directly dispatched by the East China Power Grid

Dispatching Center.

Inspection results show that the hydraulic structures such as dams, underground powerhouse, water conduct and tailrace system, and also the landslide portion of the lower reservoir are safe and reliable.

The environment is in good condition now.

5.3 Financial Situation and sustainability

Actual sale price, power sale, rate paying, benefits from the plant's auxiliary services and monitoring to the financial index in the agreement are suitable.

The estimated profit (including tax) of 2002 can reach RMBY 100 million and future financial situation is optimistic.

6. Benefits of Project Execution

For East China Grid
1800 MW of peak capacity and 1900 MW of valley capacity were supplied to the East China Power Grid, which improved the grid's operation conditions; back-up capacity of the grid was increased, which improved the grid's reliability for safe and stable operation.

Construction Management System
Management system reform of hydroelectric construction was accelerated.

Human Resources Management
Human resources using system reform was promoted; staff quantity was reduced and staff's quality improved.

Power Plant's Economic Benefits
The plant's economic benefits are good. According to operating of 2001 (including tax, the profit is RMBY40 million), the estimated return rate of 8%-12% can be achieved.

Social Benefits
The social benefits are remarkable after the project was completed. Local facilities such as traffic, communications, etc. were improved; local economy (including tourism) was developed.

7. Lessons Learned and recommendations

The bank instability of the lower reservoir and local uneven settlement of the upper reservoir bottom caused "3.29" landslide of the lower reservoir and local cracks in the bituminous concrete lining of the upper reservoir respectively, which made adverse impacts on the project. The geological work shall be more thorough to reduce the loss.

Equipment's quality
Two main transformers were rejected due to poor quality control of the transformer supplier and the project progress was influenced. Shop inspections must be more careful for the key equipment during early stage.

Short-term consultants on special subjects

Using short-term consultants on special subjects were proved successful and efficient, as the issues were well-defined and the consultants' services were highly relevant.

IMAGING

Report No.: 25237
Type: ICR