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PROJECT PERFORMANCE AUDIT REPORT

CHINA: TACHIEN POWER PROJECT
(Loan 574-CHA)

December 30, 1976

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Operations Evaluation Department

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Currency Equivalent

New Taiwan Dollar (NT$)	Year	Inflation Index (Consumer Prices)
US$1.00 = NT$ 40.0	1967	100
US$1.00 = NT$ 40.0	1968	107
US$1.00 = NT$ 40.0	1969	111
US$1.00 = NT$ 40.0	1970	115
US$1.00 = NT$ 40.0	1971	118
US$1.00 = NT$ 40.0	1972	122
US$1.00 = NT$ 38.2	1973	132
US$1.00 = NT$ 38.0	1974	194
US$1.00 = NT$ 38.0	1975	204

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PROJECT PERFORMANCE AUDIT REPORT

CHINA: TACHIEN POWER PROJECT
(Loan 574-CHA)

Preface

This memorandum presents the results of a performance audit on Loan 574-CHA made to Taiwan Power Company for the country's first power project. The loan for US$50 million was signed in December 1968 and closed in July 1975. The audit is based on information contained in the attached Project Completion Report (PCR) prepared by the East Asia and Pacific Regional Office; a review of Bank files and project documents; and discussions with Bank staff.

The memorandum expands on aspects of the project experience which deserve special emphasis.

PROJECT PERFORMANCE AUDIT BASIC DATA SHEET

CHINA: TACHIEN POWER PROJECT
(Loan 574-CHA)
(Amounts in US$ mln)

As of Sept.30, 1976

	Original	Disbursed	Cancelled	Repaid	Outstanding
Loan 574-CHA	50.00	50.00	nil	2.7	47.3

Project Data

	Original Plan	Revision	Actual or Est. Actual
Conception in Bank	-	-	9/65
Board Approval	11/26/68	-	11/26/68
Loan Agreement	-	-	12/ 2/68
Effectiveness	3/10/69	4/10/69	5/29/69
Physical Completion	Mar.1974	-	Sept.1974
% of original project actually completed by that date	90% (est.)		100%
Loan Closing	9/30/74	-	7/75
Total Costs 1/	76.6	-	130.8
(Incremental) Internal Rate of Return 2/	12%	-	8%

Mission Data

	Month, Year	No.of weeks	No.of Persons	Manweeks	Date of Report
Identification	2/66	1	2	2	2/22/66
Preparation	7/66	1	2	2	7/20/66
Appraisal 3/	1/68	3	3	9	11/13/68
Sub-total	-	-	-	13	
Pre-Supervision I 3/	5/69	½	1	½	5/26/69
Supervision I	6/70	1	1	1	7/23/70
Supervision II	12/70	1	1	1	1/ 6/71
Supervision III 4/	4/71	½	1	½	5/ 5/71
Supervision IV	6/71	1	1	1	7/27/71
Supervision V 4/	3/72	½	1	½	4/ 3/72
Supervision VI	4/72	1	1	1	5/ 9/72
Supervision VII 4/	11/72	½	2	1½	12/15/72
Supervision VIII 4/	6/73	1	1	1	10/ 5/73
		6½		7½	

Follow-on Project

Loan 671-CHA, of US$44.5 mln, signed in May, 1970 for Second Power Project.

1/ Excludes Transmission Component, estimated at appraisal to cost US$12.6 million.
2/ Original and actual are not comparable.
3/ Brief missions (invariably detours, while on missions elsewhere) are excluded.
4/ Includes supervision of subsequent Bank-assisted projects.

PROJECT PERFORMANCE AUDIT REPORT

CHINA: TACHIEN POWER PROJECT
(Loan 574-CHA)

Highlights

This hydroelectric project, in a very difficult geographic environment, has become economically more attractive since appraisal despite a 71% cost overrun, because of the steep increase in post-1973 fuel oil prices. On the other hand, the increase in fuel oil prices reduced the country's economic growth and consequently greatly reduced the envisaged growth in power demand. The borrower is, therefore, likely to have a large excess in generating capacity in the early 1980's, and this could lead to premature retirement of some older thermal plant and to placement in reserve of substantial gas turbine capacity.

The project was successful, largely a reflection of the borrower's technical and managerial competence. An unfortunate aspect of its construction experience was the high rate of injuries, some 300 workers being injured, 31 fatally.

The following points may be of particular interest:

Cost overruns and delays (para. 3 and PCR paras. 2.01-2.04).

Procurement under Bank guidelines (paras.4 and 13).

Reduction in envisaged load growth and its effects on system's capacity (paras.6 and 7 and PCR paras. 12.01-12.10).

Economic justification (paras.9, 10 and 18 and PCR paras. 11.03-11.05).

Injuries during construction (paras. 14 and 18 and PCR para. 7.17).

Bank's technical and other contributions to the borrower's success (paras. 16 and 17).

PROJECT PERFORMANCE AUDIT MEMORANDUM

CHINA: TACHIEN POWER PROJECT
(Loan 574-CHA)

1. Taipower was organized in 1946 by the Chinese Government to take over and operate the electricity system inherited from the Japanese. It is the only public electricity supply company in Taiwan, operates throughout the island, and is almost wholly owned (over 90%) by the National and Provincial Governments.

2. Through November 1968, the Bank had made seven loans (totalling US$106.3 million) and four credits (totalling US$15.3 million) to China. Loan 574-CHA was the first loan[1/] for a power project in the country. It was intended to cover the project's foreign exchange cost amounting to about 56% of the estimated total cost of US$89.2 million equivalent. The main component of the project consisted of: a concrete dam 180 metres high on the Tachien river creating a reservoir with an active water storage of some 180 million m^3, spillways, etc.; an underground 3 x 78 MW power plant; and a surface control building and switchyard - at an estimated total cost of US$76.6 million equivalent. The other component consisted of: a 285 Km, 345 KV transmission line creating a direct and efficient interconnection between the Northern and Southern generating centres, and the principal hydro peaking capabilities in the middle of the island by three substation facilities at Tienlun, Panchiao and Kaohsiung; and a 17 Km, 154 KV transmission connection from Tachien to Tienlun - at an estimated cost of US$12.6 million. The project also included improvements to Taipower's long-term financial planning with the help of consultants.

3. The main component was implemented, substantially as planned, with a total cost overrun of 71% in current terms (25% in real terms, Table A). It was completed about 7 months behind schedule as indicated in the table below. Actually, the civil engineering work was some 13 months behind schedule, thereby delaying the expected increase in power output from downstream plants[2/]. Reasons for this are: delay in awarding civil work contract; problems with the registration of civil contractor's branch office in Taiwan; geological,atmospheric and construction difficulties which also increased the work content; difficulties in local procurement; and contractor's financial problems (PCR paras. 2.01, 7.02, 8.03, 8.05 and 9.01); and additionally, the communication problems,in the earlier stages, between the contractor and the borrower. In retrospect, the original construction schedule seems optimistic, an opinion also expressed by Bank supervision mission of 1970.

1/ Two more loans have been made since, Ln 671-CHA for US$44.5 million in May 1970, and Ln 749-CHA for US$55.0 million in 1971.

2/ The storage from the reservoir also firmed up the capability of the three existing hydroelectric stations downstream of the project, and permitted increase in the capacity of two of those stations for relatively small capital investments. The total benefit from the project and from the two investments is a net increase of 640 MW in dependable peaking capability and 700 GWh in annual output to the system (PCR paras. 6.05, 6.07 and 11.01).

Item	Completion or Commissioning Date Original	Actual
Civil Engineering Work	May 1973	June 1974
Tachien No. 1 unit, 78 MW	June 1973	June 1974
Tachien No. 2 " " "	Jan. 1974	July 1974
Tachien No. 3 " " "	Mar. 1974	Sept.1974

4. The other component of the project was subsequently integrated with the transmission and substation component in the second power project assisted by Bank loan 671-CHA. However, by the end of 1970, for political reasons[1/], Taipower was unable to award the transmission lines contract to the lowest bidder. It therefore arranged with the Bank to have the lines and other items from the transmission element financed from other sources, and to use the proceeds intended for this element, to finance the cost of enlarged substation facilities. Details of the actual costs of transmission and substation components are not available. This audit therefore does not cover that part of the project.

5. The estimated and actual allocation of proceeds of the Bank loan are given in the table below:

	Category	Estimated (in US$ million)	Actual
I.	Tachien Dam, Reservoir and Powerplant		
	(a) Civil Engineering Works (including penstock, valves, etc.)	21.50	27.84
	(b) Permanent Powerplant Equipment (including turbines, generators, transformers, auxiliary equipment, etc.)	6.60	7.62
II.	Transmission Facilities		
	(a) 345 KV & 154 KV Transmission Lines	4.60	-
	(b) Terminals, transformers, etc.	2.70	5.43
III.	Consulting Services	2.00	2.55
IV.	Interest and Other Charges During Construction	6.60	6.56
V.	Unallocated	6.00	-
	TOTAL	50.00	50.00

1/ The precise reason seems to have been made known to the Bank rather gradually. One circuit, of the 345 KV double-circuit transmission line, was to be strung under each of the two Bank loans. When bids were called under the first loan, an Italian firm was the lowest bidder. But, as Italy had earlier established diplomatic relations with mainland China, the Government would not allow Taipower to accept the Italian bid. Therefore, Taipower was forced to exclude this part of the project from financing under the two Bank loans. It was subsequently financed through a loan from the Ex-Im Bank of USA.

6. The actual and estimated annual peak load and energy sales are given in Table B. The actual growth rate of peak load through '73 was 14.3% p.a., and though the oil crisis of 1973 caused a subsequent drop in this rate, the average for the period 1968-75 was 13% p.a., still well above the appraisal estimate of 10% p.a.[1/]. In addition to decreasing the long-term growth rate in power requirements[2/], the oil crisis has had the effect of increasing the cost of generation from thermal plants, thus making nuclear generation and the complementary pumped storage relatively more attractive. In response to this situation, Taipower reduced its investment program (of which some 5,000 MW, including four nuclear units, were already committed by the end of 1973); it also readjusted this revised program, giving a greater role to nuclear plant as supplier of base load energy in the future. By 1984, nuclear capacity is expected to constitute about 46% of total installed capacity (PCR para. 12.08). Despite the reduction in the investment program, the system will continue to have a substantial excess of firm capacity[3/] reaching its maximum of about 1,600 MW around 1981; and because of the enlarged role of nuclear plants in the system, smaller and older thermal plants face premature retirement or placement in reserve.

7. The major victim of the oil crisis has been the system's gas turbine capacity, whose average cost of fuel per unit generated, in 1974 and 1975, exceeded Taipower's average tariff for the period by about 20%, and was about twice the corresponding cost of steam plant generation (Table C). As the system already has and will continue to have adequate low cost peaking power from the present hydro stations and from the planned pumped storage units, most of the system's gas turbine capacity in the future will be placed in reserve or, at most, serve in a standby role[4/]. This is already reflected in the fact that while the system's annual energy generated has been increasing, commensurate with the increase in the total installed capacity, the energy generated by gas turbines in 1975 (after the commissioning of the Tachien units) has dropped substantially, despite a large increase in their installed capacity.

1/ At the time of appraisal there was an awareness that the load projections, which were linked to the minimum expected growth in the country's economy, probably understated future demand. The Government's 4 year plan (1969-72) aimed at maintaining a minimum GNP growth rate of 7% p.a. (against an average annual growth rate of 11.1% for the previous 6 years and actual growth of 10.7% p.a. in 1968-73).

2/ Forecast made in 1973 (pre-oil crisis) estimated a peak load of 12,727 MW in 1983; subsequently, this was revised downwards, and, in 1975 to 7,300 MW. (Source: Taipower's Annual Reports). The latest estimate of average growth rate of peak load from 1975-85 is 9.3% p.a.

3/ A one year delay in the commissioning of the investment program would reduce the excess firm capacity by about 500 MW; similarly an increase in the average growth rate in peak load by 1% p.a., i.e., from 9.3% p.a. to 10.3% p.a., would reduce the excess firm capacity by about 500 MW (and vice-versa) in the 1980's.

4/ In this particular role, the gas turbines would save the cost of the fuel which would otherwise be required to maintain the steam plant under prolonged hot stand-by conditions.

8. Yet, it was only in late 1972 and early 1973 that Taipower had, along with other measures (namely, speeding up the construction of Talin No. 4, 375 MW steam unit, and implementing an improved plant maintenance program to reduce downtime on large generating units), initiated a crash program for commissioning a total gas turbine capacity of 532 MW[1/] in 1974 (4 x 71.2 MW at Linkou in the North and 4 x 61.9 MW at Talin in the South). Taipower made the decision on gas turbines because of government criticism for curtailing load in the preceding years, and because of a probable large power deficit in 1974 arising from greater than envisaged peak load growth on the one hand, and the obvious delays in the completion of Tachien project on the other.

9. At the time of the appraisal, the project was the least cost solution for discount rates of around 10% when compared with the two other alternatives - a base load steam plant, and a combination of base load steam plant and gas turbines. The actual project, despite the 71% cost overrun, is still the least cost solution (using the same parameters as those believed to have been used at the appraisal[2/], Table D1) for discount rates of up to 20%, compared with an alternative base load steam plant, because of the steep increase in post 1973 fuel oil prices.

10. However, this solution is rather biased in favor of the Tachien project, because it does not take into account the system's total fuel cost savings from the proposed steam plant alternative (which would have generated over 3,000 GWh annually, instead of only 700 GWh attributed to Tachien). Therefore, the least cost solution has been tested again, this time under the worst possible case for the Tachien project, i.e., by weighting the steam alternative with the benefit from two additional inputs (Table D2) namely: a) fuel cost savings through the displacement of some energy generated by lower merit order plant and b) capital cost saving by dispensing with the need for half of the 532 MW gas turbine capacity ordered in late 1972, partly because of the anticipated delays to Tachien project. These two inputs did not reduce the equalizing discount rate below 9%, thus confirming that the actual project, even without the allocation of fuel cost saving from spinning reserve and standby capacity, for all purposes remains economically justified[3/]. The actual incremental internal rate of return on the project, together with the other development downstream, is estimated at 8% in real terms (Table E), against 12% estimated in the appraisal report[4/].

11. Taipower's financial performance was generally satisfactory and in some areas better than forecast. The Bank-recommended financial reforms enabled Taipower to raise tariffs substantially, such that they kept pace with inflation in 1974 and 1975. Aided by greater than forecast energy sales and subsequently by tariff increases, Taipower's rate of return was consistently higher than the stipulated 10%[5/], and even higher than that forecast

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1/ Taipower's annual cost on this investment(@ US$90/KW), excluding the benefits of its standby role, would be about US$5.0 million.

2/ Records are not available to indicate the precise parameters used in the appraisal solution.

3/ The actual equalizing discount rate would therefore lie somewhere between 9% and 20%, probably around 15%.

4/ Records are not available to show how this 12% internal rate of return was arrived at.

5/ 9.5% stipulated for FY 1970 in the Loan Agreement.

throughout the 1968-75 period. Mainly because of the large increase in fuel bill[1] (a three-fold increase in 1975 over the level estimated), the operating cost per unit in 1975 had increased by about one and a half times over that of 1967. This increase was higher than the corresponding increase in consumer prices over the 8-year period (Table F). The actual debt service during this period and the net internal cash generation, in absolute terms, were both marginally greater than those estimated (Table G). In relative terms, however, the net internal cash generation contributed only 21% (against an estimated 37%) to the construction expenditure, which itself had more than doubled. The higher than expected proportion of borrowings (55% actual, 35% estimated) to finance the large construction expenditure had increased the debt/equity ratio from 1972 onwards. The current ratio also deteriorated[2] after 1972, but the two ratios were still within an acceptable range. All loan covenants were met.

12. In Taipower's latest 10-year (1976-85) financial plan (Table H), little change is expected in the current ratio[3], but the debt/equity ratio would improve substantially over the years. The internal cash generation will just about meet the debt service coverage in the first two years of the plan, but over the ten year period, it is expected to contribute nearly 50% of the large construction expenditures. These are expected to exceed NT$211 billion in current prices (about three times the 1968-75 figure).

13. Bank procurement guidelines were adhered to in all relevant bids except four; two of these cases were, however, eventually resolved in favor of the borrower's actions[4]. A more unusual problem of procurement was the action forced by the government upon Taipower on the original bidding for transmission lines which amounted to blacklisting the goods and services from a certain country (para. 4).

1/ Partly responsible for the increase in Taipower's fuel bill is the substantial increase in energy generated from thermal plants which, at 17,000 GWh in 1975, may have been about 50% greater than initially projected.

2/ Arising from the loan negotiations between the Bank and the Chinese Government, Taipower has been assured of substantial overdraft facilities at the local banks. It is not unusual for an entity undergoing a huge investment program to be faced with large accounts payable (and consequently a low current ratio).

3/ Nuclear fuel is treated as a depreciable fixed asset instead of a current asset.

4/ Three of these bids involved renegotiation of prices; the Central Trust of China, the purchasing agent for the borrower, finding that the budgeted price for the equipment was lower than that of the lowest successful bidder, renegotiated with the bidder for a reduction in price. The Bank, after expressing disappointment at these practices, approved payment from loan funds in two of these cases, because renegotiations were carried out with the original lowest bidder in each case. In the third case, renegotiation was carried out with two bidders, both from the same country, but the renegotiated prices reversed the ranking of the two bidders; therefore, the Bank asked the borrower to pay for the equipment from other sources. The fourth case was dealt with in the same manner as the last one; but in this case the borrower had made the award and the supplier had initiated the manufacture of the equipment before the Bank was even advised of the results of the bidding.

14. An unfortunate aspect of this otherwise successful project was the magnitude of injuries (307 recorded injuries, including 31 fatal) during its construction. The majority of these injuries are understood to have been caused by landslides and falling rocks, and no doubt reflect the hazardous and difficult construction conditions encountered. Sufficient information is, however, not available to comment on the extent to which these injuries might have been attributed to inadequate precautions of the contractor or the borrower, or to unsound practices.

15. The loan agreement did not include covenants on institutional matters. Taipower had an effective organizational structure and a competent, professional management. These were reflected in the standard efficiency indicators namely: high customer/employee ratio; low system losses; low number of average days bills outstanding. Taipower established a good working relationship with the Bank (the four instances on procurement were more the exception than the norm, and the exclusion of the transmission element from the loan was government imposed), and produced comprehensive and timely progress and other reports. Probably the only weak area in Taipower's management at the time of appraisal was its long term financial planning; however, as agreed during loan negotiations, Taipower employed Gilbert Associates, the management consultants, to assist in implementing its long-term financial plans and to improve its accounting systems. These were satisfactorily accomplished. Perhaps a final indication of the competence of Taipower's management is that all the standard efficiency indicators have in fact improved[1/], despite the burdens of the rapid growth of the organization between 1967 and 1975 (tripling the installed capacity and energy sales, and quadrupling total fixed assets).

16. By highlighting the need to modify the tariff policies and to raise the ceiling on the rate of return, to which both Taipower and the Government responded promptly and favorably, and by identifying the need for improvement in other areas including long term financial planning, the Bank helped Taipower to take financially sound measures which have been very useful in its subsequent construction program. Another equally important, and probably more original, Bank contribution lay in identifying the need for the 345 KV transmission line, which has enabled Taipower to install large blocks of generating plant nearer the northern and southern load centres, and at the same time permitted economic exchange of power between the two centres.

17. The Bank supervision missions, half yearly in the first few years, did more than supervise the projects. They provided technical and project management assistance to the borrower, identified and recommended measures to eliminate communication problems between the borrower and the civil contractor, and recommended the need for greater involvement of the borrower's top management in the financial planning system devised by the management consultants. Nevertheless, a question arises whether, given a technically and managerially competent borrower, half yearly Bank supervision missions were justified, or a lesser frequency would have served equally well. Projects elsewhere, under managerially and technically less competent borrowers, have frequently received fewer than one supervision mission annually, when additional assistance would seem to have been justified.

1/ Wages/salaries bill as % of total operating costs have decreased; so has the cost of wages/salaries per KWh sold (relative to consumer price increases).

18. The experience with this project points up the difficulty of accurately estimating the cost and construction time of large civil works projects under uncertain geological and weather conditions. The experience also stresses the need for ample contingencies on costs, and allowances on construction time for such projects when making economic comparisons with alternative projects. The large number of injuries during project construction suggests that the Bank, in its relations with the borrowers, may wish to express its concern that safe practices be used and due care be given to the safety of the workers in the execution of the project.

Table A

PROJECT COSTS IN CURRENT AND CONSTANT PRICES
(in NT$ million)

Calendar Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	Actual Total	Appraisal Est.Total	Increase (%) Over Appraisal Estimate
Annual Disbursements (current prices)	47.0	84.5	365.5	451.2	905.7	1309.5	1288.0	309.5	360.6	5121.7	3071	71%
Deflator (wholesale prices)	100	100	103	103	109	132	185	186	176	-	-	-
Annual Disbursement (1968 prices)	47	85	355	438	831	992	696	176	205	3825	3071	25%

Table B

GROWTH OF LOAD, CAPACITY AND ENERGY SALES (1967-1975)
ESTIMATED V/S ACTUAL

Calendar Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	Average Growth Rate % p.a. 1967-1973	1967-1975
Peak Load (MW)											
Estimate	1,417	1,546	1,771	1,959	2,151	2,341	2,570	2,799	3,051	10.5	10.0
Actual	1,417	1,616	1,848	2,131	2,399	2,734	3,134	3,452	3,765	14.2	13.0
Installed Capacity (MW)											
Estimate	1,580	1,940	2,240	3,020	3,320	3,320	3,656	4,334	4,743	15.0	15.0
Actual	1,580	1,940	2,245	2,720	2,774	3,519	4,124	4,358	5,300	17.0	16.5
Dependable Capacity (MW)											
Estimate	1,299	1,644	1,917	2,281	2,645	2,645	3,205	3,767	3,767	12.0	14.0
Actual	1,299	n.a.	1,929	2,254	n.a.	n.a.	n.a.	n.a.	n.a.	n.a	n.a
Energy Sales (GWh)											
Estimate	7,470	8,751	9,423	10,408	11,422	12,487	13,634	14,881	16,229	10.5	10.2
Actual	7,470	8,762	10,051	11,964	13,836	16,081	17,938	18,881	21,217	15.0	14.0
GNP Growth (% p.a.)											
Actual	-	8.9	8.6	10.8	11.7	12.0	11.9	0.6	2.8	10.7	8.4

Table C

ROLE OF GAS TURBINES IN THE SYSTEM (1967-1975)

Calendar Year	1967	1968	1969	1970	1971	1972	1973	1974	1975	Ave. Increase % p.a. 1967-1975
Installed Capacity (MW)										
Gas Turbines	158	218	218	218	218	218	218	218	679	21
Internal Combustion 1/	4	4	9	9	63	93	93	93	74	
Steam	697	997	1,297	1,592	1,592	2,307	2,682	2,682	3,182	
Hydro	721	721	721	901	901	901	1,131	1,365	1,365	
TOTAL	1,580	1,940	2,245	2,720	2,774	3,519	4,124	4,358	5,300	16
Energy Generated (GWH)										
Gas Turbines	429	701	782	567	703	704	629	710	480	2
Internal Combustion	8	12	15	27	79	225	237	139	109	
Steam	5,334	5,215	7,263	9,770	11,312	12,894	15,559	15,000	17,070	
Hydro	2,469	3,569	2,835	2,639	2,870	3,415	3,207	4,190	4,642	
TOTAL 2/	8,412	9,802	11,119	13,213	15,171	17,449	19,805	20,534	22,894	13
Fuel Cost/KWH) Generated (NT$)										
Gas Turbines	.326	.469	.425	.388	.431	.452	.606	1.136	1.290	
Internal Combustion	1.028	1.011	.980	.456	.251	.252	.268	.611	.670	
Steam	.205	.215	.183	.172	.193	.200	.199	.558	.591	
Gas Turbines										
Installed Capacity as % of total	10	11	9	8	7	6	5	5	14	
Energy Generated as % of total	5	7	7	4	4	4	3	3	2	
Approximate Annual Load Factor %	30	36	40	29	36	36	32	37	7	

1/ Includes Isolated Plant.
2/ Total includes purchased energy.

LEAST COST SOLUTION IN 1975 BETWEEN TACHIEN HYDRO & STEAM ALTERNATIVE
(million NT$)

	HYDRO: (Net Total Benefits - 640 MW; 700 GWh) (current costs)					STEAM ALTERNATIVE: 2 x 325 MW (@ NT$ 4,100/KW) (current costs)						
								700 GWh				
	Capital Expenditure		Repl. Ins.[2]	O & M[3]	TOTAL	Capital	Repl.Ins.	Fuel	Fuel Stor-	Other O &	TOTAL	Defla-
	Tachien	Others[1]	etc. Cost	Cost	COST	Expend.	etc. Cost	Cost	age Cost	M. Cost	COST	tor
												1.00
1968	43	-	-	-	43	-	-	-	-	-	-	
1969	77	-	-	-	77	175	-	-	-	-	175	1.00
1970	332	-	-	-	332	263	-	-	-	-	263	1.03
1971	410	57	-	-	467	877	-	-	-	-	877	1.03
1972	823	107	-	-	930	877	-	-	-	-	877	1.09
1973	945	262	-	-	1,207	307	-	-	-	-	307	1.32
1974	1170	131	-	-	1,301	167	-	-	-	-	167	1.85
1975	606	33	30	94	763	-	34	400	6	62	500	1.76
1976	-	-	30	94	124	-	34	400	6	62	500	1.76
'			'	'	'	'	'	'	'	'	'	'
'			'	'	'	'	'	'	'	'	'	'
'			'	'	'	'	'	'	'	'	'	'
1993	-	-	30	94	124	-	34	400	6	62	500	1.76
1994	-	-	30	94	124	308	34	400	6	62	808	1.76
1995	-	-	'	'	124	449	'	'	'	'	949	'
1996	-	-	'	'	124	1,490	'	'	'	'	1,990	'
1997	-	-	'	'	124	1,408	'	'	'	'	1,908	'
1998	-	-	'	'	124	409	'	'	'	'	909	'
1999	-	-	'	'	124	160	'	'	'	'	660	'
'	'	'	'	'	'	-	'	'	'	'	500	'
'	'	'	'	'	'	-	'	'	'	'	'	'
'	'	'	'	'	'	-	'	'	'	'	'	'
2030	-	-	30	94	124	-	34	400	6	62	500	1.76

Equalizing Discount Rate ≃ 20%

Notes and Assumptions

1/ Lower Tachien units 3 & 4, and Tienlun unit 4.

A. Sunk costs on infrastructure, not included in the cost of thermal alternative, are offset against cost of transmission for Hydro.

B. Capital Expenditures exclude interest during construction and customs duties.

C. No account is taken of the costs of spinning reserve and standby plant incurred with the thermal alternative.

D. No account is taken of fuel cost savings arising from thermal alternative (through displacement of some energy generation from lower merit order plant, see Table D2).

Operating costs (other than fuel cost) are based on average cost of generation per KWh in 1975 (NT$0.169 for hydro and NT$0.089 for steam) given in Taipower's Financial Information.

1/ Lower Tachien units 3 & 4; and Tienlun unit 4.
2/ Replacement Insurance
3/ Operating and Maintenance Costs

Table D1

Table D2

Thermal Alternative

2 x 325 MW units; Heat Rate = 9,100 BTU/KWh

Input 1

Say Load Factor for first 5 years is 70%. Therefore Annual Generation 3,900 GWh.
" " " " next 5 years is 60%. " " " 3,400 GWh.
" " " " next 10 years is 50%. " " " 2,800 GWh.

Annual Generation from Tachien 700 GWh.

Say the thermal alternative creates an average fuel saving of 500 BTU/KWh over the energy generated from low merit order plant, totalling 680 MW (units from 35 MW to 200 MW). At fuel oil price of US$1.62 per 10^6 BTU, the cost saving per KWh

$$= 1.62 \times \frac{38.1 \times 500}{10^6} = \text{NT\$ } .031$$

Saving on Fuel Cost per annum (see Note below)

Year 1 to year 5 = $(3,900 - 700)\ 10^6 \times .031$ NT$ = NT$ 99 million

Year 6 to year 10 = $(3,400 - 700)\ 10^6 \times .031$ NT$ = NT$ 84 million

Year 11 to year 20 = $(2,800 - 700)\ 10^6 \times .031$ NT$ = NT$ 65 million

Input 2

Say cost of Gas Turbines is US$90/KW (excluding interest and customs duties) and only half of the total (532 MW) gas turbine capacity had to be installed.

Saving on Capital Investment = $90 \times 38.1 \times 266 \times 10^3$ = NT$ 910 million

Note:

Analysis on fuel cost saving should be carried out by taking the system as a whole, and not on a piece meal basis like this one. The former is important particularly because, in the very near future, the low merit order plant would be a very small proportion of the total base load plant comprising several steam units of 300 MW and above and nuclear units. Also, the fuel costs of providing appropriate spinning reserve and standby capacities (ignored in this exercise to the detriment of the hydro project) would be significant.

Table E

(INCREMENTAL) INTERNAL RATE OF RETURN
(Costs and Revenues in NT$ million)

	Costs				Revenues			Net Revenues (Costs)
	Current Prices				Current Prices			1968 Prices
	Capital Expenditure			Operating Cost	Capacity Value	Energy Sales	Deflation Factor	
	A	B	C	D	E	F	G	
1968	43	-	-	-	-	-	1.00	(43)
1969	77	-	-	-	-	-	1.00	(77)
1970	332	-	-	-	-	-	1.03	(322)
1971	410	70	184	-	-	-	1.03	(654)
1972	823	130	184	-	-	-	1.09	(1,042)
1973	945	320	184	-	-	-	1.32	(1,098)
1974	1,170	160	184	-	-	-	1.85	(818)
1975	606	40	184	189	480	420	1.76	(67)
1976	-	-		189	480	420	1.76	403
'				'	'	'	'	'
'				'	'	'	'	'
'				'	'	'	'	'
50 years				50 years	50 years	50 years	50 years	50 years

(Incremental) Rate of Return $\simeq$ 8%

Notes & Assumptions:

A. Capital Expenditure on Tachien as disbursed (excludes interest during construction).

B. Capital Expenditure on Lower Tachien, Units 3 & 4 (Total - NT$360 million); and estimated Capital Expenditure on Tienlun Unit 4 *(Total - NT$350 million).

C. Cost of Transmission and Substation element (half of the provisional actual total cost of EHV line and substations is allocated to the Tachien development; this amounts to about 18% of the capital expenditure on generation component).

D. Cost of operation, maintenance, transmission (but not distribution), administration, etc., estimated at NT$0.27 per unit generated.

E. Full additional capacity of 640 MW (less 4% transmission loss) multiplied by monthly demand charge (estimated at NT$65.4 per KW to high tension industrial customer) for the full 12 months.

F. Full additional energy of 700 GWh (less 4% transmission loss) supplied to above industrial customers (estimated at NT$0.632 per KWh).

G. Wholesale Price Index.

* Capital Expenditure of NT$350 million on Tienlun Unit 4, 26.5 MW (or @ US$355/KW) is rather high.

EFFICIENCY INDICATORS

CALENDAR YEAR		1967	1968	1969	1970	1971	1972	1973	1974	1975	Average Growth Rate 1967-1975 (%)p.a.
Energy Sales (GWh)	Est.	7,470	8,751	9,423	10,408	11,422	12,487	13,634	14,881	16,229	10.2
	Act.	7,470	8,762	10,051	11,964	13,836	16,081	17,938	18,881	21,217	14
Average Tariff (NT$/KWh)	Est.	.495	.49	.51	.54	.56	.56	.56	.56	.56	1
	Act.	.495	.500	.537	.565	.567	.564	.576	1.031	1.069	9
Total Operating Revenue (NT$ mln.)	Est.	3,848	4,501	5,024	5,780	6,642	7,255	7,911	8,622	9,391	12
	Act.	3,848	4,557	5,598	6,986	8,220	9,445	10,772	20,278	23,818	25
Fuel Cost (NT$ mln.)	Est.	1,241	1,399	1,659	1,519	1,666	1,747	1,954	2,136	2,067	7
	Act.	1,241	1,464	1,677	1,911	2,510	2,959	3,534	9,263	10,784	31
Operating Cost/KWh Sold (NT$)	Est.	.368	.367	.388	.370	.375	.367	.367	.369	.353	
	Act.	.368	.369	.370	.371	.400	.390	.427	.800	.853	
Wage Bill/KWh Sold (NT$)	Act.	.0501	.0470	.0431	.0414	.0448	.0424	.0495	.0637	.0760	
Wage Bill as % of Operating Cost	Act.	13.6	12.8	11.6	11.1	11.2	10.9	11.6	8.0	8.9	
Consumer Price Index	Act.	100	107	111	115	118	122	132	194	204	
Customers to Employee Ratio	Act.	180	188	203	199	202	203	211	222	225	
System Losses %	Act.	11.2	10.6	9.6	9.1	8.5	7.6	9.2	7.8	7.1	
No. of Ave. Days Bills Outstanding	Act.	18	17	18	17	16	16	16	13	12	

Table F

SOURCES AND APPLICATION OF FUNDS
(million NT$)

ESTIMATE V/S ACTUAL

	1968		1969		1970		1971		1972		1973		1974		1975		Total 1968-1975	
SOURCES OF FUNDS	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual
Internal Cash Generation																		
Operating Income	1,293.1	1,306	1,367.1	1,798	1,925.1	2,447	2,357.9	2,528	2,674.9	1,294	2,908.4	2,860	3,136.0	3,936	3,658.6	5,088	19,321.1	21,257
Depreciation	652.6	672	741.3	808	888.8	1,035	1,019.5	1,166	1,117.6	665	1,164.0	1,520	1,328.2	2,323	1,465.9	2,839	8,377.9	11,028
Non Cash Operating Expenses	-	12	-	19	-	48	-	180	-	120	-	91	-	148	-	141	-	759
Sub-Total	1,945.7	1,990	2,108.4	2,625	2,813.9	3,530	3,377.4	3,874	3,792.5	2,079	4,072.4	4,471	4,464.2	6,407	5,124.5	8,068	27,699.0	33,044
Equity																		
Income Tax Reinvested	141.0	85	145.2	208	246.7	56	304.6	9	361.0	4	381.7	4	413.4	-	487.5	-	2,481.1	366
Issuance of Stock to Private Shareholders	-	-	228.4	-	46.6	226	54.7	118	63.4	-	70.7	90	79.6	-	91.4	137	634.8	571
Sub-Total	141.0	85	373.6	208	293.3	282	359.3	127	424.4	4	452.4	94	493.0	0	578.9	137	3,115.9	937
Long-Term Loans	2,831.4	2,086	2,996.8	1,515	2,069.7	1,400	1,872.2	3,599	2,036.3	2,744	2,362.0	7,611	2,090.6	14,399	1,305.5	15,411	17,564.5	48,765
Contributions in Aid of Construction	100.1	204	100.2	228	103.2	211	100.0	266	99.8	139	99.9	396	99.5	735	98.5	1,263	802.2	3,442
Salvage Value of Retired Assets	77.6	186	88.2	255	99.6	181	119.9	278	132.5	208	136.4	212	153.8	391	170.8	656	978.8	2,367
TOTAL	5,095.8	4,551	5,668.2	4,832	5,379.7	5,603	5,828.8	8,144	6,485.5	5,175	7,123.1	12,785	7,301.1	21,932	7,278.2	25,535	50,160.4	88,555
APPLICATIONS OF FUNDS																		
Construction Expenditure (excl. interest charged for construction)	3,909.5	3,217	3,950.3	3,103	3,393.4	3,816	3,372.5	6,615	3,602.2	4,005	4,268.4	10,144	4,099.6	18,650	3,584.4	20,577	30,180.3	70,127
Debt Service																		
Interest	615.9	625	810.7	717	882.9	775	938.5	820	1,003.7	545	1,053.3	1,333	1,115.7	1,845	1,145.1	2,595	7,610.8	9,255
Amortization	521.0	572	813.1	641	1,017.5	799	1,099.8	1,050	1,152.5	533	1,168.2	1,335	1,266.0	1,434	1,480.2	1,944	8,518.3	8,308
Sub-Total	1,136.9	1,197	1,623.8	1,358	1,900.4	1,574	2,083.3	1,870	2,156.2	1,078	2,221.5	2,668	2,381.7	3,279	2,625.3	4,539	16,129.1	17,563
Cash Dividends (Private Shareholders)	26.2	27	29.6	29	33.3	74	38.0	107	43.5	54	49.8	134	56.9	163	64.8	192	342.1	780
Other	-	59		1	-	40	-	113	-	-	-	42	-	76	-	243	-	574
Increase of Working Capital	23.2	52	64.5	342	52.6	99	335.0	(561)	683.6	37	583.4	(205)	762.9	(236)	1,003.7	(17)	3,508.9	(489)
TOTAL	5,095.8	4,551	5,668.2	4,832	5,379.7	5,603	5,828.8	8,144	6,485.5	5,175	7,123.1	12,785	7,301.1	21,932	7,278.2	25,535	50,160.4	88,555

Note: Estimates refer to Calendar Year; Actuals refer to Fiscal Year, and are based on unaudited accounts.

Table G

CONDENSED STATEMENT OF FINANCIAL FORECAST 1976 - 1985
(in million NT$ unless otherwise indicated)

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	TOTALS
Energy Sales (GWh)	22,000	23,700	24,308	26,607	29,073	31,793	34,928	38,512	42,579	47,141	320,641
Average Tariff	1. 06	1.21	1.23	1.29	1.35	1.40	1.40	1.40	1.46	1.46	
Total Operating Revenue	24,879	29,251	31,258	35,764	40,908	46,300	50,811	55,944	64,285	71,050	450,450
Operating Income (less deprec.)	4,864	7,269	9,068	11,589	13,320	16,021	17,493	19,844	23,234	25,466	148,168
Operating Cost per Unit (NT$)	.89	.95	.91	.91	.95	.95	.95	.94	.96	.97	
Total Internal Cash Generation	7,862	10,797	14,054	18,431	21,658	26,543	30,057	34,550	41,442	45,892	251,286
Debt Services	7.214	9,976	11,486	13,865	15,453	16,719	17,906	18,654	18,879	18,307	148,459
Net Internal Cash Generation	648	821	2,568	4,566	6,205	9,824	12,151	15,896	22,563	27,585	102,827
Long Term Loans	13,958	20,410	20,238	13,199	8,627	4,754	4,902	4,988	4,744	9,517	105,339
Construction Expenditure (less interest charged for construction)	16,932	22,624	24,394	19,195	16,510	15,925	19,305	20,891	23,112	32,243	211,128
Average Net Fixed Assets in Operation	55,283	68,305	79,925	98,993	118,466	137,469	149,148	163,308	196,552	199,877	
Rate of Return 1/	0.09	.11	.11	.12	.11	.12	.12	.12	.12	.13	
Current Ratio	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	
Debt/Equity Ratio	52/48	58/42	58/42	58/42	55/45	52/48	48/52	44/56	38/62	33/67	
Debt Service Coverage	1.09	1.08	1.22	1.33	1.40	1.59	1.68	1.85	2.20	2.51	1.70
Internal Cash Generation as % of Construction Expenditure	4	4	10	24	38	61	62	76	97	85	49

Table H

1/ Excl. Consumer Contribution; but incl. allowance for working capital.

Source: Taipower's Long Term Financial Forecast (1976-85).

CHINA

TAIWAN POWER COMPANY (TAIPOWER)

LOAN 574-CHA

TACHIEN POWER PROJECT

Project Completion Report

1.	Borrower:	Taiwan Power Company
2.	Guarantor:	Republic of China
3.	Loan Amount:	US$ 50.0 million
4.	Date Loan Signed:	December 2, 1968
5.	Effective Date:	May 29, 1969
6.	Closing Date:	September 20, 1974 (Original) July 28, 1975 (Final)
7.	Period of Grace:	6 years
8.	Term of Loan:	25 years
9.	Interest Rate:	6½ p.a.
10.	Commitment Charge:	3/4% p.a.
11.	Amortization:	Half yearly, October 15, 1974 - October 15, 1993
12.	Exchange Rate:	Appraisal - US$ 1 = 40.1 NT$ Current - US$ 1 = 38.1 NT$ Average - US$ 1 = 39.1 NT$
13.	Appraisal Report No. and Date:	TO-667a, November 5, 1968
14.	Fiscal Year:	Calendar Year through 1971, January 1 - June 30 in 1972, and July 1 - June 30 thereafter.

COSTS

		US$ million
Appraisal Cost Estimate (includes Transmission element)	Foreign Exchange	50.0
	Local Currency	39.2
	Total	89.2
Appraisal Cost Estimate (excluding Transmission element)	Foreign Exchange	41.0
	Local Currency	35.6
	Total	76.6
Final Costs (excluding Transmission element)	Foreign Exchange	58.5
	Local Currency	72.3
	Total	130.8

2. Summary and Conclusions

2.01 The Tachien Dam Project was commissioned about 14 months later than originally envisaged. Reasons for this delay were:

i) civil contract awarded 7 months later than anticipated;

ii) difficulties with registration of the Civil Contractor's Branch Office in Taiwan accounted for a further delay of 3 months; and

iii) geological and construction difficulties and difficulties in the procurement of locally produced materials accounted for the balance of about 5 months.

Taipower is nevertheless satisfied with the performance of contractors, suppliers, and consultants.

2.02 Cost-overruns totalling about US$ 54 million (about 71% of the original estimate) were incurred on the Tachien Dam Project and of about US$ 30.0 million (about 120% of the original estimate) on the transmission and substation component partly financed from the proceeds of loans 574-CHA, and 671-CHA. For political reasons Taipower was unable to accept the successful bid for the transmission line. Subsequent rebidding and financing of this line by the US Exim Bank caused additional costs and delays.

2.03 The delay in commissioning Tachien and the transmission line could have been a contributing factor for Taipower's decision to commission a total of 532 MW of gas-turbine peaking capacity in 1974.

2.04 The total overrun of about US$ 84 million on Tachien, and transmission and substation elements can be attributable to:

Tachien	US$ millions
- Change in scope, design changes, increased quantities	12.3
- Devaluation of the US$	3.7
- Increased costs of engineering services and supervision due to longer construction period, design changes, difficult construction	4.8
- Increased Interest during construction due to longer construction period and need for local borrowings	5.5
- Cost increases (escalation), Civil Contractors Claim, etc.	20.6

- Customs duties increased	0.4	
- Site conditions (preliminary works etc.)	6.7	
Sub-total		54.0
Transmission and Substation Element		
- Local escalation, increased land costs	6.0	
- Non-international competitive bidding	8.6	
- Increased scope, design changes, effect of US$ devaluation	7.8	
- Increased customs duties	5.4	
- Increased Interest during Construction due to longer construction period and need for local borrowings	1.5	
- Increased Engineering services (net)	0.2	
Sub-total		29.5
TOTAL		83.5

2.05 One particular aspect that characterized execution of this project was the Civil Contractor's continued precarious financial situation. Through the provision of several substantial advances a default by the contractor was avoided. The reason for this situation may have been the contractor's inadequate experience with the type of contract (unit rates which include the cost of equipment, camp facilities), whereas contracts with which he was more familiar with provided for full and separate payment of construction equipment and camp facilities when moved to the site and installed. (Unit rates in this type of contract therefore only include materials, labor, O & M costs of operating equipment and camp facilities, overheads and profits).

2.06 Besides the 234 MW installed at Tachien, the reservoir (184 million m^3 (net) firmed up capacity of downstream plants and permitted the installation of additional peaking capacity. The contribution of Tachien to Taipower's system totalled 641.7 MW and 702.2 GWh/annum. It is estimated that the benefit/cost ratio for Tachien (excl. transmission) compared to a thermal alternative was 1.57 at the time of appraisal. This ratio, inspite of the cost overrun, increased to 1.79 primarily due to the drastic increase in the price of fuel oil. Originally estimated to cost US$ 149/kW of incremental peaking capability, actual costs amounted to US$ 233/kW.

2.07 Taipower's power market developed more rapidly than anticipated. Forecast to increase at an average annual growth rate of about 10% for the period 1967-1975, the actual growth rate experienced -- in spite of the adverse effects of the energy crisis and changed economic conditions (especially in 1974 and 1975) -- amounted to about 13%. Without the energy crisis an average annual growth rate of about 15% could have been achieved. In absolute terms, the difference between forecast maximum demand and actual demand that could have been achieved by end 1975 was nearly 1338 MW. Forecast demand for end 1975 was 3051 MW whilst actual demand reached 3765 MW, an increase of over 714 MW. It is estimated that the energy crisis reduced Taipower's peak demand end 1975 by 624 MW. This indicates the significant effect on a utility of drastic changes in economic conditions to which, because of the lead time required to implement projects, it cannot react to immediately.

2.08 Whilst Taipower took prompt action to increase its tariffs by about 100% in January 1974 to offset the increased fuel costs and thus maintained and met the financial target of at least a 10% rate of return, its massive construction program (6 nuclear units under construction) has strained its financial resources. For the period 1968-1975 the construction volume was estimated to total about NT$31 billion (US$ 815 million). Actual construction volume was more than doubled reaching a level of about NT$ 74 billion (US$ 1900 million). As a consequence borrowings increased from NT$ 17 billion to NT$ 49 billion, by about 190% whilst net internal cash generation including income tax and dividends reinvested also increased by about 200% NT$ 17 billion to NT$ 49 billion.

2.09 Taipower's financial situation at the end of FY 1975 is satisfactory, with a rate of return of 13.8%; and a debt/equity rate of 52/48. But its operating ratio has deteriorated from 65% achieved in 1970 to 76% in 1975. Debt service coverage on an annual basis was still a respectable 210% in 1975 but does not take into account debt incurred.

2.10 Taipower recognizes the implications and accordingly has amended its long range development program. Due to the escalating costs of imported energy (70% of total commercial energy) Taiwan's economic development plans are being re-evalued and restructured. Taipower has already taken steps to advance the construction of hydro and pump storage projects whilst deferring the installation of oil fired peaking thermal plants. Originally estimated to require an installed capacity of about 15,600 MW by the end of 1983, the first revision early 1974 reduced this to about 13,000 MW, and a second revision in early 1975 to about 10,300 MW, a reduction of about 5300 MW. The program will be continually reviewed and revised to meet changed economic conditions.

3. Project Location, Description and Scope

3.01 The Tachien Development is located on the Tachia River, which flows

west to the Formosa Straits, about 87 km from its mouth, about 100 km SSW of Taipei and about 200 km NNE of Kaohsiung, the major load centers in Taiwan. The site is a narrow gorge with canyon walls reaching to over 2000 m on the right and 1500 m on the left. The steepness of the drop from headwaters to discharge; the lack of vegetation in the upper catchment area; and the extremely heavy concentration of rainfall accompanying seasonal typhoon storms all combine to produce exaggerated variations in flow and sharply peaked floods. The geological conditions at the site leave much to be desired. The strata orientation at the gorge is nevertheless suited for an arch dam structure -- the optimum choice from alternatives available.

3.02 The Project was based on a May 1966 study prepared by Taipower, who in March 1967 engaged the services of Electroconsult (ELC) of Milano, Italy, which led to a final design.

3.03 The Project consists of:

(i) a double curvature concrete arch dam with a volume estimated at 430,000 m^3 (actual 456,000 m^3); a height of 180 m; a crest length of 290 m; with concrete thickness varying between 4.5 m (top) and 20.0 m (base); and with a maximum nominal retention level at 1408 m and an exceptional water level at 1409.5 m. The reservoir provided has a storage volume of 232 million m^3 of which 184 million m^3 are active;

(ii) a spillway system consisting of a free flow tunnel spillway on the left bank passing 3400 m^3/sec (50% of the design flood); a spillway over the dam discharging 1400 m^3/sec; and two emergency sluiceways through the dam with a capacity of 1600 m^3/sec;

(iii) an underground powerhouse with 3 x 78 MW = 234 MW installed. The underground solution was adopted to avoid construction interruptions and subsequent hazards due to falling rocks and potential landslides; and

(iv) a surface control building and switchyard located at the top of the left abutment of the dam above the powerhouse.

Also included in the original project description, but not covered in this report in detail were:

(v) 17 km of double circuit 161 kV transmission line -- Tachien-Kukuan;

(vi) 120 km of double circuit 345 kV transmission line from Tienlun (near Kukuan) to Panchiao (near Taipei) with one circuit strung;

(vii) 165 km of double circuit 345 kV transmission line from Tienlun to Kaohsiung with one circuit strung; and

(viii) 161 kV terminal facilities and 345/161 kV transformers located at Tienlun, Panchiao and Kaohsiung.

A layout of the project identifying the principal features is shown in Annex 1.

4. Project Amendments

4.01 The transmission facilities were subsequently excluded from the Project although provisions had been made in a subsequent loan -- 671 CHA -- to finance the second 345 kV circuit and substation expansion. The reason for exclusion of the transmission element from the Project was that Taipower for political reasons could not accept the lowest bid. (Prior to bid award, the bidder's home country had established diplomatic relations with Mainland China). Under the circumstances the Bank could not agree with Taipower's proposed award and the transmission element was removed from the list of goods to be financed by the two loans. Taipower subsequently received financing from the US Exim Bank and the contract was awarded to a US firm.

5. Effect of Project Amendments

5.01 Since this report does not cover in detail the transmission and substation aspects -- financing provided by two different loans (574-CHA and 671-CHA) plus bilateral financing and inadequate information -- it may nevertheless be useful to provide some cost information. Taipower's decision not to award the contract to the lowest responsive bidder resulted in i) higher costs; and ii) construction delay. A comparison of estimated and actual cost is given below:

	In US$ 1000				
	Estimate				
Transmission	Loan 574	Loan 671	Total	Provisional Actual	Increase over Estimate
Land, Right of Way, Clearing	250	-	250	2105	1855
Towers	950	-	950	4816	3866
Conductors	2500	1900	4400	5474	1074
Hardware	950	1700	2650	3000	350
Erection	1850	900	2750	6527	3777
Sub-total	6500	4500	11000	21922	10922
Substations					
Transformers, Switchgear, etc.	3300	3200	5500	13316	7816
Civil Works & Erection	500		1500	3947	2447
Sub-total	3800	3200	7000	17263	10263
Miscellaneous					
Interest during Construction Foreign	800	700	1500	2800	1300
Local	-	-	-	1526	1526
Customs Duties	-	2500	2500	7895	5395
Engineering	500	-	500	1132	632
Contingencies	1000	800	1800	1358	(442)
Sub-total	2300	4000	6300	14711	8411
TOTAL	12600	11700	24300	53896	29596
			100%	221.8%	121.8%

5.02 Because of the change in contracting and financing arrangements plus inadequate information the possible reasons for the increased costs as given below are tentative only and are made only in the hope of providing some explanation. They are:

	In thousands of US$
(i) Rise in local costs due to higher wages, increased land costs etc.	about 6000
(ii) Effect of non-international competitive bidding, changed financing arrangements	about 8600
(iii) Increased scope (switchgear), design changes, effect of US$ devaluation	about 7800
(iv) Increased Customs Duties due to	
a) increased value of imported equipment; and	
b) increased duty rate	about 5400
(v) Interest during construction. (Need to borrow local funds due to insufficient internal cash generation).	about 1500
(vi) Increased Engineering/Decreased Contingencies	about 300
TOTAL	29600

6. General Project Considerations

6.01 At the end of 1967 Taipower had an installed capacity of 1565 MW (thermal 844 MW; hydro 721 MW). Thermal capacity was concentrated in two plants, one in the North and the other in the South, and hydro capacity was located in the central and northern regions. System capability had frequently been inadequate to meet demand and industrial growth had outstripped Taipower's ability to plan, finance and construct new plants.

6.02 The generating plants and load centers were interconnected by an extensive 161 kV transmission network and Taipower's market was concentrated in two regions; Northern, including Taipei and Keelung, and Southern including Kaohsiung. By planning capacity additions in such a way as to minimize regional load/generation imbalances, the requirements for north-south transmission facilities was minimized.

6.03 A major capacity addition was completed in mid-1968 when the first 300 MW coal-fired conventional steam unit became operational at Linkou, southwest of Taipei. Under construction at that time was a 360 MW hydro installation at Lower Tachien just downstream of the Tachien Project and Taipower was committed to two 300 MW oil-fired steam units at Talin near Kaohsiung and was completing arrangements for a second coal fired steam unit at Linkou.

6.04 Tachien was to be the next system addition and beyond that the need for additional base load capacity was foreseen. Taipower at that time was also seriously considering the introduction of nuclear power. Concurrently with the expansion of generating facilities, transmission facilities had to be provided. By mid-1968 Taipower had concluded a planning and operating study of bulk transmission requirements which indicated the desirability to start an EHV Network in connection with Tachien. Given the increased system size larger thermal units could also be installed benefitting from economies of scale. Because of this Taipower's practice of installing capacity at the load centers started to create regional load/generation imbalances which could only be avoided by the provision of bulk transport facilities to minimize costs in total and to provide for a more flexible construction schedule.

6.05 The provision of a storage at Tachien would also firm up output at existing downstream plants and in addition would permit the installation of additional capacity at Lower Tachien (actual US$51/KW) and Tienlun. The Tienlun plant with 3 x 26.5 MW was operational in 1952; Kukuan with 4 x 45 MW in 1962 and Lower Tachien mentioned in paragraph 6.03 was commissioned in 1970 with 2 x 90 MW. Subsequently a further 2 units of 90 MW each were installed at Lower Tachien (Loan 671-CHA) and commissioned mid-1973 at a time the Tachien Dam Project should have been operational. A fourth 26.5 MW unit will be added at Tienlun in November 1977.

6.06 Before completion of the Tachien Dam Project, the Lower Tachien and Tienlun head ponds were suitable for daily operations only. Kukuan provided with a sizeable headpond and a lower reregulating pond allowed full 180 MW operation for a five hour period for five days. The lack of storage and the wide fluctuations of river flow created a complex water resources management problem. During the dry season these plants were operated at the top of the load curve during peak hours and during the wet season the plants were operated on base. Load despatching had also to be coordinated with water conditions in other watersheds and with scheduled maintenance of thermal plant.

6.07 The Tachien Reservoir now permits Taipower to operate the Tachia River Plants with greater freedom from restrictions imposed by natural flow conditions and to concentrate their production into the peak hours all the year. The installed Tachia River capacity now totals 880 MW of which over 800 MW are dependable peaking power. Of this total about 640 MW are attributable to the reservoir. Of the total average annual energy production of 2100 GWh, about 700 GWh are attributable to the storage. The Tachia River Development therefore operates at a 27% plant factor or about 6-7 hours/day.

6.08 The development strategy adopted by Taipower was correct. However, industrial growth in the late 1960's and early 1970's far exceeded expectations with the result that with energy requirements of 8412 GWh in 1967 forecast to increase to 18,338 GWh by the end of 1975 at an average annual growth rate of 10%, actual requirements at the end of 1975 are 22,894 GWh, 25% above the estimate, indicating an average annual growth rate of about 13.3%. It should be noted, however, that the "energy crisis" in 1974 and 1975 and particularly changed economic conditions in 1975 severely affected the growth rates 1974 and 1975. Faced with growth rates of 13.4% and 18.8% achieved in 1969 and 1970 Taipower reviewed its development plans. Accordingly the decision was made to immediately add additional oil thermal capacity at Talin (2 x 375 MW plus 1 x 500 MW) all of which plus the 600 MW mentioned in para. 6.03 are now in operation.

6.09 The addition of these large blocks of thermal power -- all in the South -- permitted Taipower to defer by 4 years the first nuclear plant originally scheduled to be operational in 1974 and the decision to construct the EHV transmission system made it possible to concentrate capacity at one site thus benefitting from common facilities with resulting economies. Incremental actual cost for Talin 4, 375 MW and Talin 5, 500 MW were about US$ 128/kW and about US$ 158 kW respectively.

6.10 The original plan estimated installed capacity at the end of 1975 at 4034 MW. Actual installed capacity -- Talin No. 5 instead of a nuclear unit -- by end 1975 is estimated at 5372 MW an increase of 1338 MW or 33%. This includes about 532 MW of gas-turbine peaking capacity (284 MW in the north, and 248 MW in the south) installed in 1974 - 1975 required because of the delay in commissioning Tachien (late 1974 instead of mid 1973) and the more rapid growth of peak demand.

6.11 Peak demand at the end of 1975 was estimated at 3051 MW. Thus with the installed capacity provided (4034 MW) gross reserves (dependable) was estimated at 716 MW and net at 216 MW (largest unit out of service). However, demand at the end of 1975 totalled 3765 MW and installed capacity 5372 MW. Thus gross reserves totalled a surprising 1607 MW and net about 1235 MW. This surprising result is attributable to the drastic drop in demand growth experienced in 1974 and 1975 as a result of the energy crisis and changed economic conditions. It would be incorrect to criticize Taipower's planning. What Taipower can do is to delay where possible commissioning of future plants or if advantageous to commission nuclear plants as scheduled and reduce oil fired thermal generation, which would be possible thanks to the existence of the N-S EHV system. Taipower has already taken steps by amending its long range development plans. The construction of hydro and pump storage projects

has been advanced and the installation of oil-fired peaking thermal plants deferred. Its 1973 development plan foresaw installed capacity by end 1983 totalling 15,464 MW. Its revised plans aim at the provision of 10,086 MW by that year a reduction of 5368 MW equivalent to about US$ 1000 million.

7. Project Execution

Principal Contractors and Suppliers

7.01 Principal contractors and suppliers associated with the Project are:

Supplier/Contractor	Item	Actual Payments US$
Torno-Kumagai (Italy/Japan)	Civil Works	74.7 million
Hitachi (Japan)	Turbines & Generators	5.7 "
Mitsubishi (Japan)	Transformers	0.7 "
Hitachi (Japan)	Crane	0.2 "
BICC (UK)	Power Cables	0.5 "
Brown Boveri (Switzerland)	Circuit Breakers	0.3 "
Abengoa S.A. (Spain)	Station Service Equipment	0.2 "
Electroconsult (Italy)	Consulting Services	1.8 "
TOTAL		84.1 million

Erection of electromechanical equipment was carried out by Taipower personnel and preliminary works by Taipower and local contractors.

7.02 Bids for the civil works were opened June 2, 1969 and a contract was signed with Torno-Kumagai, an Italian-Japanese Joint Venture (TK) on October 8, 1969. Work started on December 8, 1969. The work program prepared at that time anticipated completion for October 1, 1974. The actual completion date was September 29, 1974, commissioning date of the third unit. The appraisal report anticipated that the civil contract would be signed about May 1969 and completion was forseen for mid 1973 -- a construction period of 4 years. Early delays thus contributed substantially to the overall delay of 14 months.

7.03 Before TK started construction, Taipower utilizing its own funds, contracted with local contractors the construction of some temporary and permanent civil works in order to expedite construction and thus early commissioning. Preliminary works started in March 1968 and were completed by June 1969 and covered an access road, enlargement of a tunnel in the access road to the dam site, excavation of the powerhouse access tunnel and concreting of its portal, and excavation of adits for the spillway tunnel, grouting galleries etc.

7.04 Rock measurements were carried out by Taipower on both abutments to provide design data. These measurements covered horizontal deformation of the of the bed rock and internal stress.

Diversion Works

7.05 Construction started in March 1970 and was completed in July 1972. Inspite of two typhoons (September 1970 and July 1971) which caused damage to construction facilities, work progressed satisfactorily. The Tachia River was diverted through the diversion tunnels on March 5, 1971 and initial impoundment by closing the diversion tunnel inlet gate started on December 15, 1973.

Dam

7.06 Excavation of the right and left abutments started in June 1970 and February 1971 respectively and was completed in July 1972. An abrupt change in the rock strata on the right abutment was compensated by moving the dam axis 8m upstream. Stabilisation and protection works were carried out closely following excavation (prestressed anchors). Concrete was placed in a period of 25 months from May 1972 to and including May 1974. The total volume placed was 456,000 m^3 (430,000 m^3 estimated) with a maximum pouring rate of 30,628 m^3 achieved in May 1973. This gave an average daily production of about 1100 m^3 over 28 working days.

Intake and Pressure Shaft

7.07 Open-cut excavation of the intake was carried out at the same time as excavation of the left dam abutment. Concrete for the intake structure and hoistroom was poured from January 1972 to May 1974. Excavation of the steel-lined pressure shaft started in December 1970 from a construction adit and was completed in February 1972. Concrete backfilling and installation of the steel-lining was carried out between July 1972-July 1973.

Spillway

7.08 Open-cut excavation of the inlet was completed by the end of 1971. Concreting was finished by August 1974. The top heading method for the excavation of the sub-horizontal portion of the tunnel was utilized. Starting in July 1971 excavation of the arch and its concreting were completed by October 1972. The remaining excavation and concreting were completed by July 1974. To improve rock conditions in a fault zone consolidation grouting was carried out from an overhead rock treatment gallery before excavation reached this area. Contact and other consolidation grouting started in June 1972.

Powerhouse

7.09 Construction started in May 1970 and was essentially complete at the end of 1973. The work included excavation, concrete lining, structural concrete, drilling and grouting, access tunnel cable gallery, draft tubes, vertical shaft to the surface control building, etc.

Control Building and Switchyard

7.10 Located on the surface on Pitan ridge, excavation started in early June 1970 and covered a period of 30 months. Excavated material was used as concrete aggregate and the rate of excavation was coordinated with aggregate requirements. Construction of switchyard foundations and of the control building followed excavation and was completed in October 1973.

Reservoir Treatment

7.11 This was an important and significant item. To support the right flank of the Pitan ridge a buttress fill was considered essential. This work started in November 1970. A flood in August 1972 washed away 59,000 m^3 of fill when filling was about 84% complete. Reconstruction and additional filling was finally completed in early 1974. Excavation of grouting galleries and shafts started in December 1970 and was completed in September 1974. Curtain grouting and drilling drainage holes (dam and ridge) started in December 1972 (dam) and November 1973 (ridge). By the end of 1974 grouting was essentially complete.

Installation of Hydro-Mechanical Equipment

7.12 Dam

River Outlets	Installation period	April-Dec 1973
Sluiceways		Aug-June 1974
Crest Spillway		March-Sept 1974

Intake and Penstock

Intake Gates & Trashracks	May 1972-Dec 1973
Steel Penstock	May 1972-April 1974

Spillway Tunnel

Inlet (fixed parts), gates & hoists	Dec 1972-July 1974
Elbow steel-liner	Jan-July 1974
Outlet steel-liner	May-July 1973

Electro-Mechanical Equipment

7.13 Installation of permanent electrical and mechanical equipment by Taipower personnel (three turbo-generator units, unit transformers, power cables, control equipment, switchyard equipment, auxilliary equipment) covered a period of 27 months from July 1972 - September 1974. The installation of turbine-generators started after completion of most of the civil works. The initial synchronization of Unit No. 3 took place June 26, 1974 and Units No. 2 and No. 1

were placed in commercial operation on July 27 and September 29, 1974 respectively.

7.14 Annex 2 shows the construction program prepared when work started compared with actual achievements.

Miscellaneous

7.15 Principal quantities. The Project required:

- Excavation	1,553,000 m^3
- Concrete	682,000 m^3
- Cement	173,734 t
- Grout Drilling	93,000 m
- Steel reinforcements	13,707 t
- Explosives	494 t

7.16 Man-Power. The Civil Contractor, Torno-Kumagai spent a total effort of 88,974 man-months (December 1969 - September 1974) on the job. His average workforce amounted to 1534 men with a peak of 2350 in June 1973.

7.17 Safety. During the period June 1970 - September 1974, 307 accidents occured involving 307 injuries (289 TK and 18 Taipower) and 31 deaths (25 TK and 6 Taipower). This unfortunate record primarily reflects the hazardous and difficult construction conditions.

7.18 Taipower Project Organization. Taipower's Tachien Project office had a staff of 800 responsible for supervision and installation activities at Tachien and Lower Tachien. This office under a Director supported by three Deputies (Administration, Civil Works and E & M Works) was responsible for contract administration, procurement, cost accounting, welfare, surveying and geology, materials testing, inspection, O & M of construction power and communications systems, installation of E & M equipment and inspection of E & M equipment.

7.19 Actual Financing Arrangements. The Tachien Dam Project was financed as follows:

	Local NT$ 1000	Foreign US$ 1000	Total NT$ 1000
IBRD	-	43,510	1,720,691
US Exim Bank	-	60	2.286
SAED	867,000	-	867,000
Taipower Funds	1,959,518	14,982	2,531,690
TOTAL	2,826,518	58,552	5,121,667

7.20 Quarterly Disbursements (Taipower Data) to October 31, 1975 amounted to:

		IBRD US$ 1000	SAED NT$ 1000	Taipower NT$ 1000	Total NT$ 1000
1968	2	-	-	22,216	22,216
	3	-	-	17,583	17,583
	4	-	-	7,244	7,244
1969	1	-	-	19,228	19,228
	2	-	-	11,025	11,025
	3	108	-	7,765	12,102
	4	287	-	30,635	42,152
1970	1	2,438	-	54,528	152,308
	2	214	1,849	65,547	75,959
	3	1,030	51,101	(26,349)	66,041
	4	563	4,419	44,245	71,232
1971	1	1,201	-	54,946	103,124
	2	1,002	-	57,688	97,866
	3	942	16,135	46,046	99,950
	4	1,688	44,264	38,286	150,243
1972	1	2,228	29,203	30,266	148,814
	2	5,791	44,504	85,262	361,997
	3	1,668	41,409	91,704	200,004
	4	2,213	67,560	38,621	194,922
1973	1	6,791	76,039	25,691	374,017
	2	2,369	64,020	77,297	230,906
	3	2,134	120,180	30,948	232,425
	4	5,045	159,472	120,501	472,177

1974	1	2,509	145,184	137,854	378,624
	2	1,611	1,661	193,269	256,299
	3	1	-	211,934	211,940
	4	351	-	427,871	441,125
1975	1	400	-	64,919	78,316
	2	(66)	-	197,102	194,580
	3	1	-	30,521	30,551
	October	16	-	5,469	6,074
TOTAL		42,535	867,000	2,219,862	4,761,044
Balance Remaining					357,984
GRAND TOTAL					5,119,028

Tachien Dam Project Costs

8.01 The Project was originally estimated to cost US$ 76.6 million equivalent. Actual recorded costs totalled US$ 130.6 million equivalent representing an increase of US$ 54.0 million or about 71%. Annex 3 gives a detailed comparison between originally estimated costs and actual costs. The cost overruns can be summarized as follows:

	US$ million	% increase
Preliminary Works	1.6	157
Dam & Reservoir	12.9	39
Power Facilities	3.1	52
Contractor's Claim	15.8	-
TOTAL CIVIL WORKS	33.4	83
Electro-Mechanical Equipment	10.3	76
Miscellaneous [1/]	1.2	21
Contingencies & Other	(2.6)	(23)
Interest During Construction	8.9	153
CHIHLOH Diversion [2/]	2.9	-
TOTAL PROJECT	54.0	70.5

1/ Engineering, Supervision and Administration
2/ Not included in original Project Description

8.02 Increased costs are attributable to:

i)	Change of Scope (Chihloh Diversion)	US$	2.9 million
ii)	Devaluation of the US$		3.7 million
iii)	Design Changes, Increased Quantities		12.3 million
iv)	Engineering Services & Supervision (longer construction and increased difficulties)		1.2 million
v)	Interest during Construction (longer construction) Foreign		2.7 million
	Interest during Construction (longer construction) Local		6.1 million
	(need to borrow local funds due to inadequate internal cash generation)		
vi)	Civil Contractor's Claim (see paragraph 8.03)		15.8 million
vii)	Site conditions (Preliminary works, under-estimation of difficulties to be encountered)		9.3 million
	TOTAL		54.0 million

Civil Contractor's Claims

8.03 In June 1973 Torno-Kumagi, the Civil Contractor, submitted a claim totalling about US$ 21.3 million equivalent as of that date. This claim was made up of 26 separate items covering increased quantities, new unit prices, geological conditions (increased supports, overbreak, etc), design changes, additional works, disagreement on measured quantities, finance charges for higher mobilization costs, additional construction plant and equipment, bureaucratic difficulties, communication difficulties, excessive taxation, idle work force, higher sub-contract costs, escalation, additional overheads and general expenses, etc.

8.04 Admittedly geological conditions were difficult and access to the site not easy. Nevertheless, the situation was well known to contractors and adequate geological information was available at the time of bid preparation. One of the reasons for the difficulties encountered by Torno-Kumagai was inadequate recognition of local conditions and Torno's lack of operational experience in Asia.

8.05 The major reason, however, that could have led to Torno-Kumagi's precarious financial condition -- inadequate working capital -- was unfamiliarity with the Anglo-Saxon form of unit rate contracts. In this type of contract mobilization costs -- camp facilities construction plant and equipment -- are not shown or paid for separately but their costs are included and recovered in the unit rates. Contractors therefore load unit rates of items destined for early execution (excavation for instance) and reduce unit rates of items for late execution (for instance concrete and erection of plant equipment) in such a manner that unit rate prices bear no relation to costs. This method ensures that the contractor can recover mobilization expenses early.

8.06 In a contract of this type (Tachien), mobilization costs account for about 30% of the total bid price. The European form of contract is split into

two parts:

Part 1 Camp Facilities;
Construction Plant; and
Construction Equipment; and
Part 2 Unit Rate Contract (covering labor, materials
O & M costs of equipment and plant,
and overheads and profit).

8.07 The contractor receives 90% of the quoted price of Part 1 once the facilities, plant or equipment are on site and operational and the balance of 10% when the facilities are either no longer required or are removed. This greatly eases the contractor's cash flow situation and should reduce the cost to the owner, because the financial charges incurred (IDC) are generally smaller than financial charges incurred by the contractor and passed on to the owner via the unit rates.

8.08 Based on the above observations it could prove advantageous to change current bidding procedures to those outlined in paragraph 8.06 above. One particular advantage resulting from such a change is that unit rates would be cost related thus prices would not change because of increased or decreased quantities and costs for additional work can be more easily negotiated. The cost effect of the recommended procedure if applied to Tachien cannot be determined, in fact any attempt to do this would be speculative.

8.09 Torno-Kumagi's claim was subsequently reviewed by Taipower and settled for about US$ 16.0 million equivalent.

9. Taipower's comments on difficulties encountered

9.01 Difficulties affecting the completion of the project were:

i) Registration of TK's Branch office which delayed construction begin;
ii) Geological conditions retarded progress;
iii) Changes in design increased quantities;
iv) Floods and landslides adversely affected performance; and
v) the abrupt increase in the oil price caused price increases of locally procured construction materials.

Displacement of the Dam Axis

9.02 Excavation of the dam abutments was made along two planes: rock bedding and joints. When excavation had progressed down to elevation 1390 it was found that the dip angle (the angle at which bedding planes fall) had changed abruptly. Faced with this situation the basic dam design and safety of the structure was reviewed and the decision taken to move the dam axis 8m upstream. This move resulted in a reduced excavation volume of 80,000 m^3 without an increase of concrete volume.

Design change of the Downstream Coffer Dam

9.03 Originally this structure was designed as a hollow concrete dam but changed to an arch gravity dam in April 1971 for the following reasons:

i) reduction of dam foundation excavation, simplification of the structure to reduce the construction period by eliminating time-consuming formwork, and difficulty of completing an adequate portion of the work in a dry season so that the partially finished structure would not be destroyed during the following wet season;

ii) stresses in the arch dam could be borne by the abutments;

iii) provision of an adequate flood impact zone (stilling basin) between the main dam site and the tailrace outlet portal in the event of spill over the dam crest; and

iv) construction to an adequate height before the 1971 flood season, thus reducing any adverse effect on the normal operation of the downstream Lower Tachien head pond.

Adverse Effect of Increased Oil Prices

9.04 The abrupt increase in oil prices coincided with peak construction. As a result of this increase, prices of construction materials -- reinforcement steel bars, cement, metals, plastic products etc -- increased substantially. In fact some construction materials could not be procured in this critical period. Taipower assisted TK with procurement by coordinating between Government agencies and local suppliers.

Lack of Space at the Job Site

9.05 Because of the topography -- steep and narrow gorge -- and lack of suitable storage space about 1000 cases of electro-mechanical equipment with a total weight of 4000 t had to be stored at Lower Tachien, 15 km from the job site. This would have created no problems had not heavy rains, landslides, and earthquakes caused traffic interruptions.

10. Taipower's Assessment of the Performance of Suppliers, Contractors & Consultant

10.01 Due to delay in ordering and delivery of 161 kV power circuit breakers (BBC) some oil circuit breakers from the system were temporarily installed and used for initial power generation and on arrival of ordered equipment removed.

10.02 The technicians sent by the Suppliers of the turbine generators, main transformers and 15 kV power cables to assist in erection were competent and cooperative.

10.03 TK did not fully familiarize themselves with the Laws, Regulations and Orders of ROC. This caused delays in registering their Branch Office. TK's financial condition was not good and Taipower had to grant several advances to help them overcome their financial difficulty. TK however, was well organized and had good technical and administrative management. Staff was competent

and experienced and possessed the know-how of new technical methods. Construction was mechanized and efficient.

10.04 The Consultant, ELC, was responsible for basic design, supervision and inspection. Taipower is satisfied with design work considered to be sound, in compliance with safely requirements, technically adequate, and overall economic. ELC Engineers at the site were competent and cooperative. Timely and appropriate instructions were issued by them. The only aspect that Taipower criticizes were that too many design changes were issued after preparation of construction drawings. This resulted in new work items requiring "time and energy consuming negotiations" between Taipower and TK.

10.05 The turbine-generator units supplied by Hitachi, Japan were delivered as scheduled. However, draft tube vibration and cavitation problems arose and Hitachi has been requested to make the necessary improvements.

10.06 Because of late delivery of station service equipment (transformers and switchgear) supplied by Abengoa SA, Spain, temporary power supply had to be made to avoid a delay in commissioning.

10.07 With regard the Bank's involvement in procurement matters, Taipower states:

i) Procurement of equipment under the Bank Loan was satisfactory; and

ii) International competitive bidding increased competition providing Taipower with a wider selection.

However, 6 transformers and 19 air breakers for station service equipment supplied by Abengoa S.A. of Spain arrived with damaged parts due to poor packaging or with missing parts. Taipower suggests that some kind of penalty should be imposed on such defaults. This is a matter between the supplier and Taipower and should not involve the Bank.

11. Project Justification in Retrospect

11.01 In addition to the Tachien power plant with an installed capacity of 234 MW, the storage provided regulates run-off, firms up installed capacity of existing downstream installations, and permits the installation of additional units at existing plants at low costs. (Lower Tachien No. 3 & 4, actual costs US$9.115 million for 180 MW or about US$50/kW installed). Thus the power contribution of Tachien to the system totalled 641.7 MW as shown below:

	Installed Capacity (MW)	Incremental Dependable Peaking Capacity (MW)	Average Annual Incremental Output (GWh)
Tachien (3 x 78 MW)	234.0	207.0	399.0
Lower Tachien No. 1 & 2 (2 x 90 MW)	180.0	88.3)	
Lower Tachien No. 3 & 4 (2 x 90 MW)	180.0	180.0)	120.8
Kukuan No.1-4 (4 x 45 MW)	180.0	128.6	44.3
Tienlun No.1-4 1/ (4 x 26.5 MW)	106.0	37.8	138.1
Total	880.0	641.7	702.2

11.02 The central location of the Tachien River Development in respect to the load centers and existing and planned thermal capacity permits the operation of the Tachien facilities at the top of the load curve. The North-South EHV Transmission System originally conceived as a transfer avenue of Tachien peak power to the North and South has now assumed a different role as a result of the abrupt rise in fuel oil prices. In the South at Talin about 1850 MW of oil-fired thermal power are now operational plus about 248 MW of gas turbines whilst in the North about 1050 MW oil and coal fired thermal is operational plus about 284 MW of gas turbines. The balance of about 600 MW of thermal capacity is made up of diesel capacity, smaller coal-oil-fired steam plants and gas-turbines mainly located in the North or North-Central Regions. Taipower has under construction 6 nuclear units of which 4 in the North (operation: Unit 1, 636 MW, 1977; Unit 2, 636 MW, 1978; Unit 3, 985 MW, 1980; and Unit 4, 985 MW, 1981) and 2 in the South (operational: Unit 1, 951 MW, 1983; and Unit 2, 951 MW, 1984). When the northern nuclear units become operational, these together with existing coal-fired units will be operated on base and surplus base load energy transferred south thus permitting the southern oil-fired thermal units to operate higher on the load curve. Similarly on commissioning of the southern nuclear units surplus base load would be transferred north. Thus whilst the N-S EHV system will continue to be used for the transfer of peak Tachien Power it would be incorrect to fully allocate the cost of this line to the Tachien Projects since part of the cost could reasonably be allocated to the nuclear plants. However, because of the changing power flow it would be difficult to make a reasonable allocation and accordingly the re-evaluation of the justification of Tachien excludes consideration of transmission investments. For comparison purposes initial data available at the time of appraisal was utilized to determine a bench mark (excluding transmission). The results are shown in subsequent paragraphs.

11.03 Justification of Tachien (excluding Transmission) based on data available at the time of appraisal.

i) Investments

Tachien Project	US$ 76.6 million
Lower Tachien No. 3 & 4	US$ 9.5 million
Tienlun No. 4	US$ 9.4 million
TOTAL	US$ 95.5 million

1/ Unit 4 to be installed in 1977

ii) Reference Alternative Thermal Plant (300 MW size - Talin 2)

Investments	US$ 125/KW
Fuel Costs	US cents 50/10^6 BTU
Plant Heat Rate	9000 BTU/kWh

iii) Parameters

Hydro

Life	50 years
Interim replacement	0.41% of investments/annum
Tax & Insurance	0.11% of investments/annum
O & M Costs	Tachien (Full)
	Lower Tachien & Tienlun (Incremental)

Thermal

Life	25 years
Interim replacement	0.35% of investments/annum
Tax & Insurance	0.65% of investment/annum
O & M Costs	US$ 2.5/kW/annum
Fuel Stock	60 days

Interest Rate 10%

iv) Benefit/Cost Ratio Tachien 1.57

11.04 Justification of Tachien (excluding Transmission) based on actual data.

i) Investments (actual)

Tachien Project	US$ 130.6 million
Lower Tachien No.3 - 4	US$ 9.2 million
Tienlun No. 4	US$ 9.4 million
TOTAL	US$ 149.2 million

ii) Reference Alternative Thermal Plant (500 MW Talin No. 5) 1/

Investments	US$ 149.9/kW
Fuel Costs (January 27, 1974)	US cents 162/10^6 BTU
Plant Heat Rate	9000 BTU/kWhr

iii) Parameters

Hydro

Life	50 years
Interim Replacement	0.41% of investments/annum
Tax & Insurance	0.11% of investments/annum
O & M Costs	Tachien (Full)
	Lower Tachien & Tienlun Incremental

Thermal

Life	25 years
Interim Replacement	0.35% of investments/annum
Tax & Insurance	0.65% of investments/annum
O & M Costs	US$ 2.5/kW/annum
Fuel Stock	60 days

Interest Rate	10%

iv) Benefit/Cost Ratio Tachien 1.79

11.05 In spite of the substantial cost overrun of US$ 54.0 million (71%) the increased fuel costs have increased the value of the Tachia River Development for Taipower. Originally estimated to cost about US$ 149/kW of incremental peaking capability the final costs increased to about US$ 233/kW.

12. Development of the Power Market

Forecast

12.01 At the end of 1967 Taipower was serving a maximum demand of 1417 MW, with sales of 7470 GWh requiring generation of 8412 GWh. System losses amounted to 11.2% of total generation and the average annual load factor was 67.8%. Of its sales 21% was utilized for residential and commercial purposes and 79% by industries. For the end of 1975, the appraisal forecast maximum demand at 3051 MW,

1/ Operational June 1975.

sales at 16,229 GWh and generation at 18,338 GWh. For that year system losses were estimated at 11.5% of total generation and the average annual load factor at 68.6%. Of total sales 23.6% was forecast to be utilized for residential and commercial purposes and 76.4% by industries. The estimated average annual load growth 1967-1975 was about 10% for maximum demand, sales and generation. The appraisal report, however, states "In view of the present level of economic activity in Taiwan, and the almost universal failure of past market forecasts to anticipate real growth achieved, it is likely the current projections understate future demand."

12.02 By end 1975 Taipower's maximum demand had reached 3765 MW, sales 21,217 GWh and generation 22,894 GWh. Of total sales 24% were utilized for residential and commercial purposes and 76% by industries. System losses had decreased to about 7% of total generation and the average annual load factor was about 69%. The average annual growth rates 1967-1975 were about 13.0% for maximum demand; 13.3% for generation; and 13.9% for sales. Annex 4 shows a comparison of forecast and actual power market.

12.03 The oil crisis (end 1973) and subsequent changed economic conditions greatly affected Taipower's market in 1974 and 1975. Growth rates achieved 1967-1973 were about 15% p.a. far in excess of the 10% forecast at the time of appraisal. In 1974, however, growth dropped substantially with sales increasing at only 5.3% over the previous year, generation increased at 3.7% only (reduced losses) whilst maximum demand increased at 10.1% accompanied by a drop in load factor -- 72.1% in 1973 to 67.9% in 1974. This drop in load factor is primarily the effect of production cutbacks in industry (reduction in the number of work shifts).

12.04 Faced with substantially higher than forecast growth rates 1969 through 1972 (18.8% for generation in 1970 for instance), resultant difficulties to meet demand (load curtailments in 1970 and 1971) and criticism by the Government, Taipower in early 1973 revised its long range market forecast which forms the basis for its investment program. Their forecast based on accepted methodology may, however, have been unduly influenced by past events. The forecast is summarized below:

	Sales (GWh)	Generation (GWh)	Maximum Demand (MW)	L.F. %
1972 (Actual)	16081	17449	2734	72.9
1975	24572	26680	4389	69.4
1982	62737	67860	11228	69.0
Average Annual Growth Rate				
1972-1982	14.6%	14.7%	15.0%	-

12.05 If we assume the short-term forecast 1972-1975 to be correct, the effect of the oil crisis and subsequent changed economic conditions on the power market could be as follows:

	1975		
	Forecast	Actual	Difference
Maximum demand (MW)	4389	3765	624
Sales (GWh)	24572	21217	3355
Generation (GWh)	26680	22894	3786

Thus the effect of the oil crisis apparently resulted in a demand decrease of about 620 MW.

12.06 The late 1973 supervision mission queried the load forecast on the grounds that forecast generation divided by forecast GNP (kWh/US$ GNP) increased from 3.0 kWh/$ in 1973 to 4.8 kWh/$ in 1982 and that incremental generation divided by incremental GNP showed an increase from 2.8 kWh/$ in 1973 to 7.6 kWh/$ in 1982. The mission estimated that the forecast could lead to an over-investment of 2500-3000 MW equivalent to US$750-900 million by 1982.

12.07 In early 1974 Taipower revised its forecast which resulted in a reduction of maximum demand for 1982 previously forecast at 11,228 MW to about 9750 MW a reduction of nearly 1500 MW. Because of the effect of the oil crisis and drastically changed economic conditions Taipower again in the middle of 1975 revised its load forecast. The reasons for this renewed revision were the following factors:

i) Economic Growth

	Economic Growth Rates (%)					
	1970	1971	1972	1973	1974	1975
GNP	10.8	11.7	12.0	11.9	0.6	2.8
Industries	20.3	24.1	21.0	19.2	(1.5)	5.8
Agriculture	6.0	2.1	1.9	3.6	0.9	(2.0)

Taiwan's economy is largely foreign-trade oriented with nearly half of its production exported each year. The slowdown resulted in production cutbacks, particularly in the plywood, textiles, petrochemicals, and electronic industries. As from spring of 1976 with general economic recovery, conditions became favourable again in Taiwan.

ii) Electricity Growth Rates

	Electricity Growth Rates (%)					
	1970	1971	1972	1973	1974	1975
Generation	18.8	14.8	15.0	13.5	3.7	11.5
Sales	19.0	15.6	16.2	11.5	5.3	12.4

iii) Power Use Growth Rates of Industries

	Growth Rates in %					
	1970	1971	1972	1973	1974	1975
Textiles	37.1	34.7	21.4	16.5	4.7	23.2
Petrochemicals	19.3	20.9	29.7	17.7	6.6	20.6
Metal	29.7	17.9	15.5	13.5	9.1	12.4
Machinery	24.1	26.5	32.4	29.6	(1.9)	1.3
Paper	21.7	13.1	14.3	12.2	(2.7)	11.4
Food	10.3	6.7	18.0	14.1	(0.8)	9.7
Fertilizer	(3.8)	(10.2)	(3.6)	(6.3)	3.5	(14.0)
Mining	0.4	(0.3)	7.3	(0.7)	5.5	2.4

Unfortunately absolute consumption figures are not available, however, the growth rates of total industrial sales were as follows:

Total Industries	18.7	15.6	17.1	10.7	4.9	10.8

iv) Forecast GNP Growth Rates

	Growth Rate in %				
	1975	1976	1977	1978	1979-1982
Pre Oil Crisis	9.3	9.0	8.5	8.5	8.5
Mid-1975 Estimate	3.3	6.4	8.2	7.8	8.0

12.08 Based on the above data Taipower now forecasts its market as follows: (data taken from a graph).

	MW			
	Maximum Demand	Installed Capacity	Firm Capacity	Excess Capacity
1975	3700	5500	3900	200
1976	4000	5530	3900	-100
1977	4300	6500	5000	700
1978	4600	7700	5900	1300
1979	5000	7700	5900	900
1980	5500	8500	6800	1300

1981	6000	9600	7600	1600
1982	6600	9700	7700	1100
1983	7300	10300	8300	1000
1984	8100	11234[1/]	9200	1100
1985	9000	11300	9300	300
1986	9900	11600	9300	-600

1/ Nuclear 5144 MW; thermal 4627 MW; hydro 1463 MW

12.09 For 1986 Taipower now forecasts sales of 55,100 GWh which represents an average annual growth rate 1975-1986 of 9.3%. It estimates losses at about 8% and the annual load factor at 68.5%. Thus maximum demand in 1986 is estimated at 9900 MW. Because of its heavy nuclear committment, six units totalling 5144 MW under construction, Taipower is faced with excess capacity reaching a peak of about 1600 in 1981.

12.10 Taipower's committed investment program and thus apparent resultant overinvestment raises interesting questions. For instance commissioning and requirements for nuclear capacity is as follows:

	Anticipated Commissioning Date	Date required to meet demand
Nuclear Unit 1	early 1977	early 1979
Unit 2	early 1978	early 1984
Unit 3	early 1980	early 1982
Unit 4	early 1981	early 1984
Unit 5	early 1983	early 1985
Unit 6	early 1984	early 1986

assuming other investments unchanged. The nuclear units are therefore operational 2-4 years too early. There are, however, three points that Taipower can take into consideration.

(i) the cost to Taipower of early commissioning represents 2-3 year interest at say 9%, which is offset by 2-3 years escalation. As long as annual escalation is higher than the interest rate, Taipower benefits directly;

(ii) Taipower can operate nuclear plants on base and thanks to the availability of the N-S EHV 345 kV double circuit transmission line can operate oil-fired steam generating plants higher on the load curve thus saving fuel. Nuclear fuel costs about US mills 5/kWh compared to about US mills 15/kWh for an oil-fired plant; and

iii) early availability of nuclear capacity will ensure that nuclear plants when required will have been debugged and will be fully reliable.

12.11 The difference between increased interest charges on the nuclear plants will be more than offset by potential fuel savings. The financial gain to Taipower would therefore be at least 2-3 years escalation on each nuclear unit, a not insignificant amount. Given the circumstances it would not be advisable for Taipower to cancel its contracts for the nuclear units 5 & 6 or to unreasonably extend the construction time of units 1 thru 4.

13. Finances

13.01 Taipower's financial targets agreed with the Bank required the achievement of an annual rate of return of 9.5% for FY 1970 and 10% for FY 1971 and thereafter. This rate of return was defined as the ratio between operating income (after taxes) and average net fixed assets plus 2.5%, plus 11.5% of cash operating expenses. The table below shows Taipower's actual performance compared with forecast results:

	Rate of Return %	
Year	Forecast (Calendar)	Actual (FY)
1968	8.8	8.3
1969	8.1	10.4
1970	9.5	12.5
1971	10.0	10.9
1972	10.7	5.4 (half year)
1973	10.9	10.8
1974	10.4	13.3
1975	11.5	13.8

The achieved performance can be considered satisfactory. In spite of this Taipower finds itself in financial difficulties.

13.02 Annex 5 compared forecast income statements with actuals. Because of the change in fiscal year in 1972, the results are not directly comparable but the following general comments can be made. With the exception of 1969 and 1970 the operating ratio was higher than forecast in spite of higher than forecast sales and revenues attributable to increased fuel costs in 1974 and 1975, generally higher O & M costs (increase in plant in service), increased depreciation charges (increased assets) and higher than estimated taxes.

13.03 Following the drastic increase in oil prices at the end of 1973 Taipower reacted with surprising speed virtually doubling tariffs in January 1974. Some consumers (industries) were faced with a 140% tariff increase and other consumers (low residential) with a 60% increase. As a result average revenue for kWh sold increased from NT$ 0.569/kWh (1.49 US cents/kWh) in 1973 to NT$ 1.08 (US cents 2.83/kWh) in 1975.

13.04 Annex 6 compares forecast and actual balance sheets. Gross assets in service at the end of calender 1975 were estimated at NT$ 43482.7 million with work in progress of NT$ 10447.8 million. By mid 1975 gross assets in service had achieved a level of NT$ 63811.2 million whilst work in progress (nuclear plants) amounted to NT$ 34,590.5 million. As a result total fixed assets by mid 1975 were more than double the estimate.

13.05 Faced with a substantial investment program financed to a greater extent by borrowings, both foreign and local, Taipower's long-term debt more than doubled from NT$ 17,306.1 million forecast for 1975 to NT$ 39,272.0 million. To meet short-term requirements Taipower also had to resort to utilization of bank overdrafts which by mid 1975 had reached nearly NT$ 1100 million (US$ 28 million).

13.06 As a consequence the debt/equity ratio in 1975, although still a favorable 52/48 compares unfavorably with the forecast 39/61.

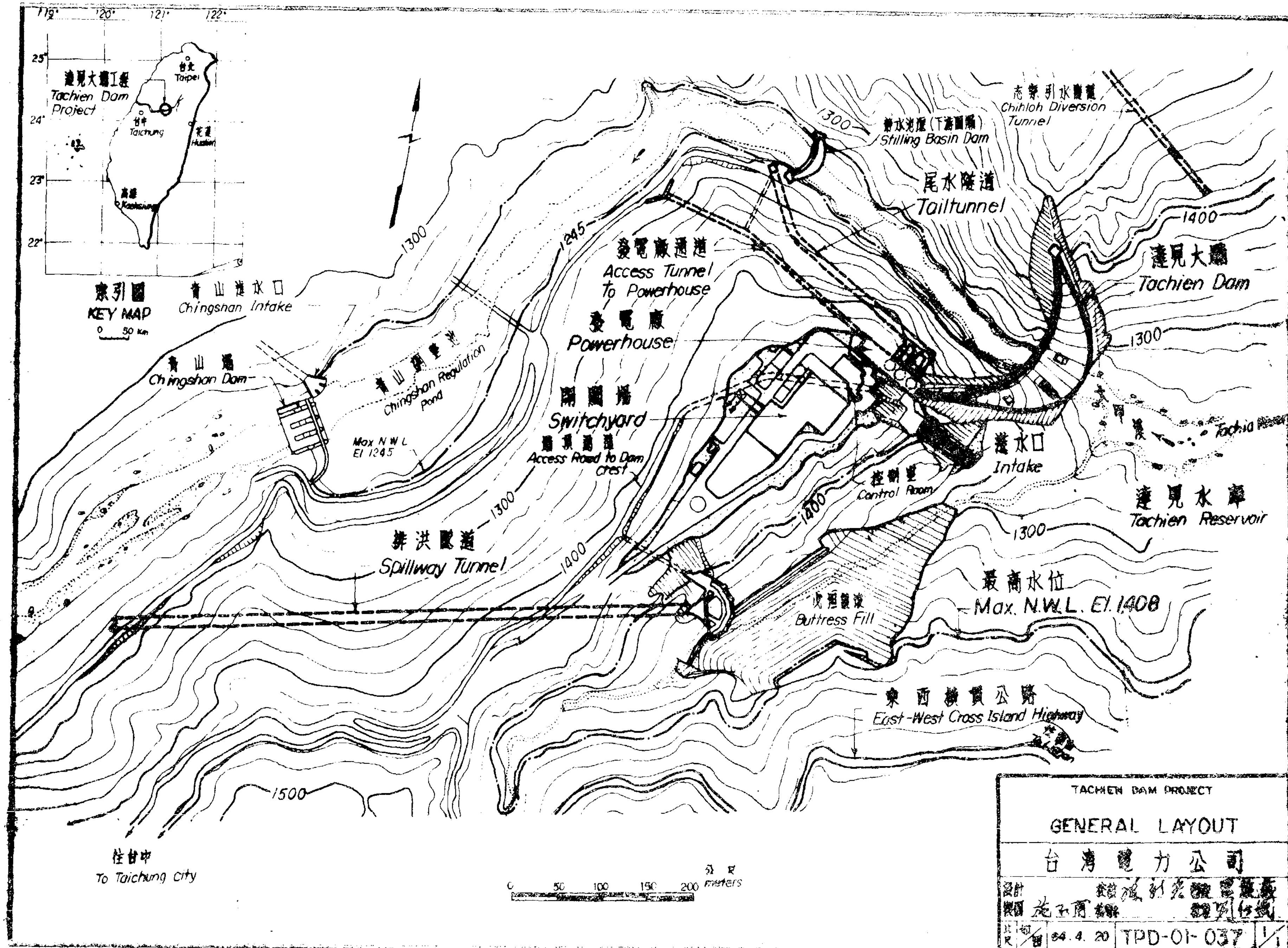
13.07 Taipower's financial situation is reflected in the summarized sources and application of funds statement below:

	In million of NT$			
	Forecast 1968-1975		Actual 1968-mid 1975	
SOURCES				
Internal Cash Generation	27,699.0		33,044.0	
Less Debt Service	(16,129.1)		(17,563.0)	
Dividends	(342.1)		(780.0)	
Net Internal Cash Generation	11,227.8	37.2%	14,701.0	21.1%
Capacity				
Income Tax Reinvested	2,481.1		366.0	
Stock	634.8		571.0	
	3,115.9	10.3%	937.0	1.3%
Contribution to Construction	802.2	2.7%	3,442.0	4.9%
Salvage Retired Assets	978.8	3.2%	2,367.0	3.3%
Borrowings	17,564.5	58.2%	48,765.0	69.5%
Total Sources	33,689.2	111.6%	70,212.0	100.1%
APPLICATIONS				
Construction	30,180.3	100%	70,127.0	100%
Change in Working Capital	3,508.9	11.6%	85.0	0.1%
Total Applications	33,689.2	111.6%	70,212.0	100.1%

13.08 1) Construction more than doubled.
2) Contribution from Internal Cash Generation towards construction dropped from 37% to 21% and
3) Borrowings nearly tripled.

13.09 Although not as favorable as forecast Taipower's present financial situation can still be termed as satisfactory. However, there are indications of a deteriorating trend be it operating ratio, self-financing level or current ratio. Increased and particular attention will need to be given to the load forecast and thus future investment requirements.

East Asia and Pacific Regional Office
August 9, 1976



達見大壩工程
Tachien Dam Project
Taipei
Taichung
Hualien
Kaohsiung
索引圖
KEY MAP
0 50 Km
青山進水口
Chingshan Intake
青山壩
Chingshan Dam
青山調整池
Chingshan Regulation Pond
Max N.W.L
El 1245
排洪隧道
Spillway Tunnel
發電廠通道
Access Tunnel To Powerhouse
發電廠
Powerhouse
開關場
Switchyard
壩頂通道
Access Road to Dam Crest
消力池壩(下游圍堰)
Stilling Basin Dam
志樂引水隧道
Chihloh Diversion Tunnel
尾水隧道
Tailtunnel
達見大壩
Tachien Dam
進水口
Intake
控制室
Control Room
達見水庫
Tachien Reservoir
最高水位
Max. N.W.L. El.1408
Buttress Fill
東西橫貫公路
East-West Cross Island Highway
往台中
To Taichung city
0 50 100 150 200
公尺
Meters
1245
1300
1400
1500
TACHIEN DAM PROJECT
GENERAL LAYOUT
台灣電力公司
64. 4. 20
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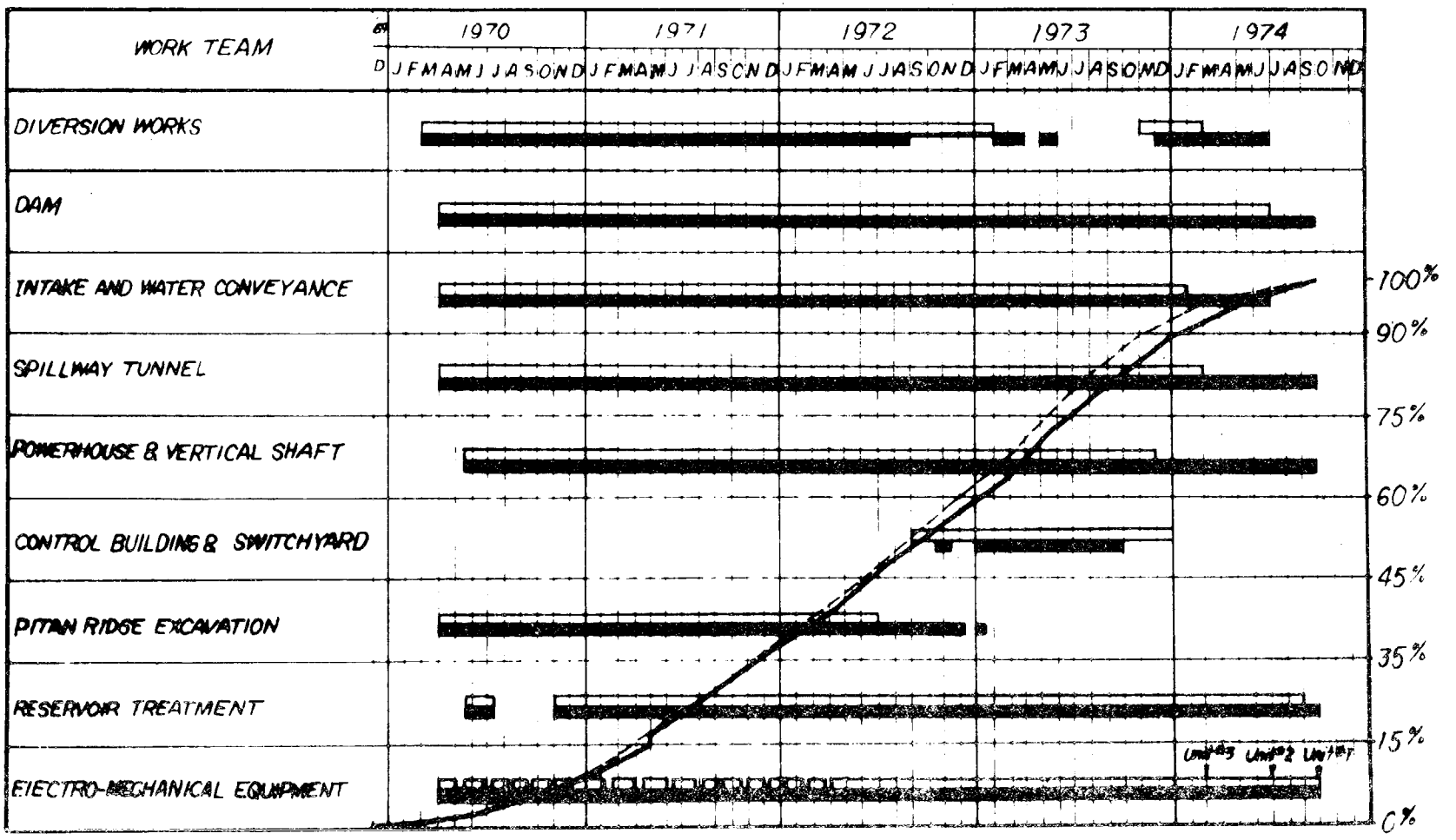
TACHIEN DAM PROJECT
CONSTRUCTION SCHEDULE AND PROGRESS



Annex 2

CHINA
TAIWAN POWER COMPANY
COMPLETION REPORT LOAN 574-CHA TACHIEN DAM PROJECT
COMPARISON ORIGINAL/ACTUAL COST ESTIMATE

(IN THOUSANDS OF US$)

	ORIGINAL ESTIMATE			ACTUAL COSTS			DIFFERENCES BETWEEN ESTIMATED AND ACTUAL COSTS INCREASE (DECREASE)		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
CIVIL WORKS									
Preliminary Works									
Access Roads	445	325	770	435	0	435	(10)	(325)	(335)
Camps	212	-	212	1056	0	1056	844	0	844
Site Preparation	50	-	50	1158	0	1158	1108	0	1108
SUB-TOTAL	707	325	1032	2649	0	2649	1942	325	1617
Dam & Reservoir									
Diversion Works	1604	1046	2650	1760	1335	3095	156	289	445
Pitan Ridge Excavation	1437	2948	4385	1054	1147	2201	(383)	(1801)	(2184)
Dam	6608	6738	13346	11511	9707	21218	4903	2969	7872
Foundations etc.	3122	2530	5652	3528	2511	6039	406	(19)	387
Spillway Tunnel	3295	2978	6273	5633	3958	9591	2338	980	3318
Reservoir Treatment	401	399	800	2323	1504	3827	1922	1105	3027
SUB-TOTAL	16467	16639	33106	25809	20162	45971	9342	3523	12865
Power Facilities									
Access Tunnel	378	219	597	891	600	1491	513	381	894
Intake	471	325	796	893	1013	1906	422	688	1110
Penstock	223	191	414	279	259	538	56	68	124
Powerhouse	2160	1402	3562	2055	1656	3711	(105)	254	149
Tailrace	128	75	203	407	222	629	279	147	426
Switchyard Control Building	400	100	500	572	358	930	172	258	430
SUB-TOTAL	3760	2312	6072	5097	4108	9205	1337	1796	3133
CONTRACTORS CLAIM SETTLEMENT	-	-	-	6337	9505	15840	6337	9505	15842
TOTAL CIVIL WORKS	20934	19276	40210	39892	33775	73667	18958	14499	33457
ELECTRO-MECHANICAL EQUIPMENT									
Dam & Spillway	417	975	1392	985	2198	3183	568	1223	1791
Intake & Penstock	608	1218	1826	735	1712	2447	127	494	621
Powerhouse & Switchyard	3590	6610	10200	7480	10562	18042	3890	3952	7842
TOTAL E & M	4615	8803	13418	9200	14472	23672	4585	5669	10254
MISCELLANEOUS									
Engineering Services	100	1400	1500	1296	1444	2740	1196	44	1240
Tests	235	85	320	235	85	320	-	-	-
Supervision & Administration	3760	-	3760	3684	-	3684	(76)	-	(76)
SUB-TOTAL	4095	1485	5580	5215	1529	6744	1120	44	1164
CONTINGENCIES + OTHER	5956	5636	11592	8978	-	8978	3022	(5636)	(2614)
INTEREST DURING CONSTRUCTION	-	5800	5800	6144	8504	14648	6144	2704	8848
CHIHLOH DIVERSION	-	-	-	2879	-	2879	2879	-	2879
TOTAL	35600	41000	76600	72308	58280	130588	36708	17280	53988

Annex 5

CHINA
TAIWAN POWER COMPANY
COMPLETION REPORT LOAN 574-CHA TACHIEN DAM PROJECT
COMPARISON OF FORECAST/ACTUAL GENERATION, MAXIMUM DEMAND, SALES 1968-1975

Calender Year	1967 Base Year	1968 Forecast	1968 Actual	1969 Forecast	1969 Actual	1970 Forecast	1970 Actual	1971 Forecast	1971 Actual	1972 Forecast	1972 Actual	1973 Forecast	1973 Actual	1974 Forecast	1974 Actual	1975 Forecast	1975 Actual Estimated
INSTALLED CAPACITY (MW)																	
Hydro	721.1	721	721	721	721	901	901	901	901	901	901	1081	1131	1415	1365	1415	1365
Thermal	858.4	1219	1219	1519	1524	1819	1819	2119	1873	2119	2618	2119	2993	2619	2993	2619	3935
TOTAL	1579.5	1940	1940	2240	2245	2720	2720	3020	2774	3020	3519	3200	4124	4034	4358	4034	5300
GENERATION (GWh)																	
Hydro	2469	n.a.	3569	n.a.	2835	n.a.	2639	n.a.	2870	n.a.	3415	n.a.	3207	n.a.	4190	n.a.	4642
Thermal	5771	n.a.	5928	n.a.	8060	n.a.	10365	n.a.	12094	n.a.	13824	n.a.	16425	n.a.	15849	n.a.	17659
Purchased	172	n.a.	305	n.a.	224	n.a.	209	n.a.	207	n.a.	210	n.a.	173	n.a.	495	n.a.	593
TOTAL	8412	9824	9802	10660	11119	11787	13213	12950	15171	14126	17449	15441	19805	16815	20534 *	18338	22894 *
		+ 16.8%	+ 16.5%	+ 8.5%	+ 13.4%	+ 10.6%	+ 18.8%	+ 9.9%	+ 14.8%	+ 9.1%	+ 15.0%	+ 9.3%	+ 13.5%	+ 8.9%	+ 3.7%	+ 9.1%	+ 11.4%
MAXIMUM DEMAND (MW)	1417	1630	1616	1771	1848	1959	2131	2151	2399	2341	2734	2570	3134	2799	3452 *	3051	3765 *
		+ 15.0%	+ 14.0%	+ 8.7%	+ 14.4%	+ 10.6%	+ 15.3%	+ 9.8%	+ 12.6%	+ 8.8%	+ 14.0%	+ 9.8%	+ 14.6%	+ 8.9%	+ 10.1%	+ 9.0%	+ 9.1%
AVERAGE ANNUAL LOAD FACTOR (%)	67.8%	68.8%	69.2%	68.7%	68.7%	68.7%	70.8%	68.7%	72.2%	68.9%	72.7%	68.6%	72.1%	68.6%	67.9%*	68.6%	69.4%*
SALES (GWh)																	
Lighting	1563	1762	1881	1915	2267	2164	2722	2437	3148	2737	3566	3065	4084	3427	4350	3825	5122
Power	5907	6989	6881	7508	7784	8244	9242	8985	10688	9750	13515	10569	13854	11454	14531	12404	16095
TOTAL	7470	8751	8762	9423	10051	10408	11964	11422	13836	12487	16081	13634	17938	14881	18881	16229	21217
		+ 17.1%	+ 17.3%	+ 7.7%	+ 14.7%	+ 10.5%	+ 19.0%	+ 9.7%	+ 15.6%	+ 9.3%	+ 16.2%	+ 9.2%	+ 11.5%	+ 9.1%	+ 5.3%	+ 9.1%	+ 12.4%
LOSSES (GWh)	942	1073	1040	1237	1068	1379	1197	1528	1291	1639	1328	1807	1822	1934	1609 *	2109	1625 *
As % of Generation	11.2%	10.9%	10.6%	11.6%	9.6%	11.7%	9.1%	11.8%	8.5%	11.6%	7.6%	11.7%	9.2 %	11.5%	7.8%	11.5%	7.1%*
CONSUMERS (Number)																	
Industrial	73000	n.a.	79000	n.a.	86000	n.a.	91000	n.a.	96000	n.a.	103000	n.a.	115000	n.a.	120000	n.a.	122846
Lighting	1786000	n.a.	1908000	n.a.	2049000	n.a.	2174000	n.a.	2314000	n.a.	2457000	n.a.	2614000	n.a.	2818000	n.a.	3016754
TOTAL	1859000	n.a.	1987000	n.a.	2135000	n.a.	2265000	n.a.	2410000	n.a.	2560000	n.a.	2729000	n.a.	2938000	n.a.	3139600
			+ 6.9%		+ 7.4%		+ 6.1%		+ 6.4%		+ 6.2%		+ 6.6%		+ 7.7%		+ 6.8%
EMPLOYEES (Number)	10336	n.a.	10594	n.a.	10526	n.a.	11402	n.a.	11919	n.a.	12623	n.a.	12956	n.a.	13241	n.a.	13970
CONSUMERS/EMPLOYEE (Number)	180	n.a.	188	n.a.	203	n.a.	199	n.a.	202	n.a.	203	n.a.	211	n.a.	222	n.a.	225
CONSUMPTION/CONSUMER (KWh)	4018	n.a.	4410	n.a.	4708	n.a.	5282	n.a.	5741	n.a.	6282	n.a.	6573	n.a.	6426	n.a.	6758
			+ 9.7%		+ 6.8%		+ 12.2%		+ 8.7%		+ 9.4%		+ 4.6%		- 2.2%		5.2%

* Estimated

Annex 4

CHINA
TAIWAN POWER COMPANY
COMPLETION REPORT LOAN 574-CHA TACHIEN DAM PROJECT
COMPARISON OF FORECAST/ACTUAL INCOME STATEMENTS 1968-1975
in millions NT$

Exchange Rate at Appraisal 1 US$= NT$ 40.1 Exchange Rate:Current 1 US$= NT$ 38.1 FY ends December 31, 1968-1971 FY ends June 30, 1972-1975	1968		1969		1970		1971		1972		1973		1974		1975	
	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast Calender 12 months	Actual 6 months	Forecast Calender	Actual FY	Forecast Calender	Actual FY	Forecast Calender	Actual FY
Sales of Energy (GWh)	8751	8762	9423	10051	10408	11964	11422	13836	12487	7609	13634	16786	14881	18676	16229	19439
Average Revenue/kWh in NT$	0.49	0.50	0.51	0.537	0.54	0.565	0.56	0.567	0.56	0.562	0.56	0.569	0.56	0.769	0.56	1.080
OPERATING REVENUES																
Sales of Electricity	4325.5	4381.2	4832.0	5394.8	5572.0	6755.6	6417.6	7849.6	7013.0	4279.1	7651.3	9546.4	8344.3	14357.0	9094.1	20993.9
Other	175.4	176.2	191.9	203.4	207.8	230.6	224.4	370.2	241.6	183.5	259.4	413.3	278.0	529.5	297.0	1065.1
TOTAL REVENUES	4500.9	4557.4	5023.9	5598.2	5779.8	6986.2	6642.0	8219.8	7254.6	4462.6	7910.7	9959.7	8622.3	14886.5	9391.1	22059.0
OPERATING EXPENSES																
Salaries, Wages, Welfare	427.5)	2040.9	448.0)	2271.5	465.4)	2513.2	483.2)	3253.7	499.8)	1796.6	517.8)	4390.4	541.7)	7124.1	562.3)	11344.1
Fuel	1399.1)		1659.4)		1519.4)		1565.8)		1746.8)		1954.0)		2136.1)		2067.0)	
Maintenance	208.5	174.7	264.0	259.0	308.5	309.7	355.5	354.7	382.6	202.1	416.2	439.2	466.9	566.2	500.6	751.4
Taxes (excl. Income Tax)	92.6	114.6	98.5	133.2	112.7	161.9	124.1	182.4	132.6	102.4	146.8	219.5	161.5	283.4	171.5	397.2
Income Tax	141.0	133.2	145.2	176.0	246.7	331.5	304.6	455.3	361.0	194.0	381.7	395.7	413.4	483.8	487.5	754.6
Other	290.7	185.5	304.6	178.2	317.4	185.6	335.6	350.2	343.5	221.4	426.0	233.4	442.7	329.8	481.9	857.1
Depreciation	648.4	668.5	737.1	800.5	884.6	1026.5	1015.3	1152.5	1113.4	659.6	1159.8	1507.7	1324.0	2291.1	1461.7	2759.1
TOTAL EXPENSES	3207.8	3317.4	3656.8	3818.4	3854.7	4528.4	4284.1	5748.8	4579.7	3176.1	5002.3	7185.9	5486.3	11078.4	5732.5	16863.5
OPERATING INCOME	1293.1	1240.0	1367.1	1779.8	1925.1	2457.8	2357.9	2471.0	2674.9	1286.5	2908.4	2773.8	3136.0	3808.1	3658.6	5195.5
Interest	615.9	625.5	810.7	716.9	882.9	775.7	983.5	815.8	1003.7	541.2	1053.3	1324.9	1115.7	1822.5	1145.1	2509.4
Less: Capitalized Interest	(148.8)	(142.5)	(240.0)	(175.3)	(303.0)	(175.4)	(286.0)	(114.3)	(297.0)	(118.9)	(226.0)	(542.9)	(233.0)	(996.7)	(114.0)	(1286.4)
Interest on Government Advances	70.0	71.2	-	209.1	-	153.9	-	13.7	-	0.7	-	8.4	-	58.9	-	129.7
TOTAL INTEREST	537.1	554.2	570.7	750.7	579.9	754.2	697.5	714.8	706.7	423.0	827.3	790.4	882.7	884.7	1001.1	1352.7
NET INCOME	756.0	685.8	796.4	1029.1	1345.2	1703.6	1660.4	1756.2	1968.2	863.5	2081.1	1983.4	2253.3	2923.4	2657.5	3842.8
Net fixed Assets in Operation																
Year Start	12983.7	12934.8	15066.4	15549.4	17278.1	17211.1	21615.6	20499.3	23927.1	22895.4	24024.2	23357.5	27470.6	25656.2	30693.0	28466.9
Year End	15066.4	15549.4	17278.1	17211.1	21615.6	20499.3	23927.1	22895.4	24024.2	23357.5	27470.6	25656.2	30693.0	28466.9	30356.2	41963.6
Average Net fixed Assets in Service	14025.0	14883.0	16172.0	17138.0	19447.0	19730.0	22771.0	22770.0	23976.0	23994.0	25747.0	25773.0	29082.0	28750.0	30525.0	37718.0
Rate of Return (%) (After Taxes)	8.8	8.3	8.1	10.4	9.5	12.5	10.0	10.9	10.7	5.4	10.9	10.8	10.4	13.3	11.5	13.8
Operating Ratio	0.71	0.73	0.73	0.68	0.67	0.65	0.65	0.70	0.63	0.72	0.63	0.72	0.64	0.74	0.61	0.76

Annex 5

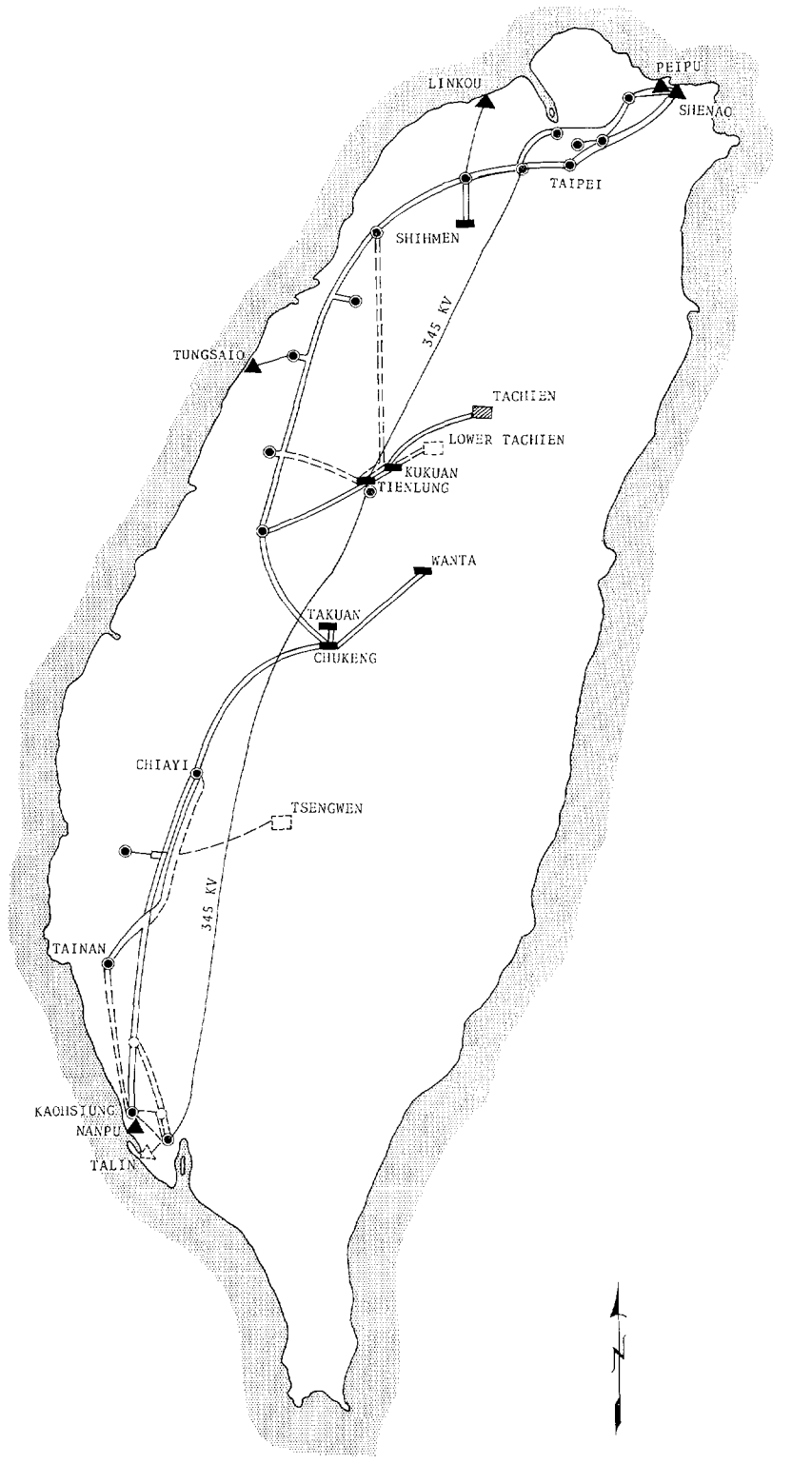
CHINA
TAIWAN POWER COMPANY
COMPLETION REPORT LOAN 574-CHA TACHIEN DAM PROJECT
COMPARISON OF FORECAST/ACTUAL BALANCE SHEETS 1968-1975
IN MILLIONS OF NT$

FY ends December 31 1968-1971 FY ends June 30 1972-1975	1968		1969		1970		1971		1972		1973		1974		1975	
	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast	Actual	Forecast 12 months	Actual 6 months	Forecast Calender	Actual FY	Forecast Calender	Actual FY	Forecast Calender	Actual FY
ASSETS																
Fixed Assets																
Fixed Assets in Service	22057.5	22731.7	24897.9	25195.5	29980.1	29465.8	33119.4	32964.0	34104.4	34022.1	38464.6	37663.7	42710.2	42561.0	43482.7	63811.2
Less: Depreciation	(5836.5)	(5919.2)	(6368.5)	(6492.8)	(7104.5)	(7264.2)	(7742.3)	(8100.1)	(8530.4)	(8556.9)	(9344.3)	(9504.1)	(10268.0)	(10855.5)	(11278.8)	(17346.5)
Consumer Contributions	(1154.6)	1263.1	(1251.3)	1491.6	(1350.0)	1702.3	(1450.0)	1968.5	(1549.8)	2107.7	(1649.7)	2503.4	(1749.2)	3238.6	(1847.7)	4501.7
Net Fixed Assets	15066.4	15549.4	17278.1	17211.1	21526.6	20499.3	23927.1	22895.4	20024.2	23357.5	27470.6	25656.2	30693.0	28466.9	30356.2	41963.0
Work in Progress	6126.5	5067.1	7255.8	5628.9	5621.0	4577.6	5840.4	6936.4	8423.4	9607.1	8216.6	14929.1	7919.0	25045.8	10447.8	34590.5
Total Fixed Assets	21192.9	20616.5	24533.9	22840.0	27236.6	25076.9	29767.5	29831.8	32447.6	32964.6	35687.2	40585.3	38612.0	53512.7	40804.0	76553.5
Other Assets	151.0	285.2	151.0	281.3	151.0	310.0	151.0	273.1	151.0	243.7	151.0	303.7	151.0	507.4	151.0	412.9
Current Assets																
Cash	176.0	203.1	216.4	151.8	203.8	211.7	335.6	172.0	828.0	446.1	1302.2	436.7	1962.2	479.9	2833.6	832.3
Accounts Receivable (Net)	242.8	204.5	304.4	255.1	352.7	316.8	386.7	345.5	422.3	386.0	460.6	470.1	502.2	691.8	547.2	799.2
Fuel	105.0)	809.7	110.0)	1056.8	125.0)	1183.5	135.0)	945.5	140.0)	995.8	160.0)	1145.9	170.0)	1977.7	180.0)	2772.3
Materials & Supplies	712.5)		815.0)		909.2)		1004.5)		1076.3)		1180.5)		1275.0)		1357.5)	
Prepayments	300.0	275.8	300.0	322.1	300.0	405.1	300.0	449.1	300.0	314.1	300.0	318.7	300.0	579.5	300.0	380.1
Other	60.0	105.7	60.0	79.9	60.0	96.0	60.0	129.3	60.0	119.2	60.0	137.6	60.0	198.2	60.0	124.4
Total Current Assets	1596.3	1598.8	1805.8	1865.7	1950.7	2213.1	2221.8	2041.4	2826.6	2261.2	3463.3	2509.0	4269.4	3927.1	5278.3	4908.3
Deferred Debts	55.0	43.0	55.0	22.3	55.0	10.0	55.0	48.3	55.0	20.3	55.0	7.7	55.0	46.1	55.0	47.3
TOTAL ASSETS	22995.2	22543.5	26545.7	25009.3	29393.3	27610.0	32195.3	32194.6	35480.2	35489.8	39356.5	43405.7	43087.4	57993.3	46288.3	81922.0
LIABILITIES																
Equity																
Capital stock	2000.0	2000.0	6360.5	2000.0	7256.5	7397.0	8303.5	9467.8	9514.8	9467.8	10868.9	10981.7	12391.9	10981.7	14145.2	13298.7
Advances to be converted to C.S.	3452.2	3484.7	-	3898.7	-	903.6	-	22.3	-	26.9	-	741.0	-	2517.4	-	3028.0
Retained Earnings & Reserves	4588.2	4979.7	4824.8	6011.4	5538.5	5277.4	6473.2	5952.9	7611.0	5339.3	8740.6	6537.3	9907.0	7636.6	11325.3	18288.9
Depreciation of unrecorded Appreciation of Plant	291.6	283.9	368.5	343.9	461.9	439.4	573.7	532.9	704.5	598.1	850.0	818.2	1023.7	1688.0	1222.5	1292.3
Total Equity	10332.0	10748.3	11553.8	12254.0	13256.9	14017.4	15350.4	15975.9	17830.3	15432.1	20459.5	19078.2	23302.6	22823.7	26693.0	35907.9
Reserves Foreign Exchange Losses	-	-	-	-	-	-	-	92.9	-	212.1	-	299.6	-	446.0	-	586.3
Long-Term Debt	11263.9	10639.7	13243.2	11400.1	14213.1	11922.5	14932.8	13963.0	15800.0	15966.7	16896.9	20781.9	17507.3	29186.5	17306.1	39272.0
Liabilities Plant Improvement	-	16.9	-	61.4	-	18.6	-	149.3	-	186.8	-	276.9	-	769.8	-	676.5
Current Liabilities																
Accounts Payable	371.2	109.8	416.2	179.9	408.2	108.5	444.6	161.2	465.8	360.0	519.1	460.1	562.3	794.2	567.5	594.7
Accrued Interest	-	192.1	-	165.3	-	212.0	-	119.4	-	133.1	-	235.9	-	440.1	-	369.4
Other Accrued Expenses	-	42.4	-	32.8	-	109.7	-	164.8	-	125.4	-	153.7	-	225.0	-	313.4
Short Term Loans	-	-	100.0	-	200.0	0.8	100.0	245.1	-	63.4	-	214.1	-	905.4	-	1050.6
Long-Term Debt due	813.1	640.3	1017.5	800.4	1099.8	897.2	1152.5	989.0	1168.2	1207.7	1266.0	1414.0	1480.2	1914.9	1506.7	2496.2
Dividends & Taxes Payable	-	68.0	-	21.6	-	182.4	-	180.2	-	1692.2	-	260.3	-	383.5	-	538.4
Other	200.0	53.1	200.0	66.4	200.0	101.3	200.0	118.1	200.0	73.7	200.0	188.9	200.0	87.4	200.0	72.6
Total Current Liabilities	1384.3	1105.7	1733.7	1266.4	1908.3	1611.9	1897.1	1977.8	1834.0	3655.5	1985.1	2927.0	2242.5	4750.5	2274.2	5435.3
Deferred Credits	15.0	32.9	15.0	27.4	15.0	39.6	15.0	35.7	15.0	36.6	15.0	42.1	15.0	16.8	15.0	44.0
TOTAL LIABILITIES	22995.2	22543.5	26545.7	25009.3	29393.3	27610.0	32195.3	32194.6	35480.2	35489.8	39356.5	43405.7	43087.4	57993.3	46288.3	81922.0
Debt/Equity Ratio	52/48	50/50	53/47	48/52	52/48	46/54	49/51	47/53	47/53	51/49	45/55	52/48	43/57	56/44	39/61	52/48
Current Ratio	1.15	1.45	1.04	1.47	1.02	1.37	1.17	1.03	1.54	0.62	1.74	0.86	1.90	0.83	2.32	0.90

Annex 6

TAIWAN POWER COMPANY

PROPOSED TACHIEN HYDROELECTRIC AND EHV TRANSMISSION SYSTEM PROJECT



JULY 1968

IBRD 2351