Report No. 1447-TH

Thailand: Appraisal of the Pattani Hydro-Electric Project

July 25, 1977

Projects Department
East Asia & Pacific Regional Office

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Document of the World Bank

CURRENCY EQUIVALENTS

US$1	=	Baht 20.50
฿ 1	=	100 Stang = US cents 4.88
฿ 1 million	=	US$48,780

WEIGHTS AND MEASURES EQUIVALENTS

kW	=	Kilowatt (1000 W)
MW	=	Megawatt (1000 KW)
kwh	=	kilowatt hour
Gwh	=	Gigawatt hour (1 million kwh)
kV	=	kilovolt (1000 V)
KVA	=	kilovoltampere
MVA	=	Megavolt-ampere (1000 KVA)
m	=	meter = 3.281 feet
km	=	kilometer (1000 m) = 0.6214 miles
sq m	=	1.196 sq yds
sq km	=	0.3861 sq miles
cu m	=	1.308 cu yds
1 ha	=	10000 sq m = 2.471 acres
1 cu m/sec	=	35.31 cusec (cubic feet per second)

ACRONYMS AND ABBREVIATIONS

NEA	-	National Energy Administration
EGAT	-	Electricity Generating Authority of Thailand
MEA	-	Metropolitan Electricity Authority
PEA	-	Provincial Electricity Authority
RID	-	Royal Irrigation Department
OFO	-	Oil Fuel Organization of Thailand
SPI	-	Sverdrup & Parcel International, Inc.
SEATEC	-	Southeast Asia Technology Co. Ltd.
EDL	-	Electricite de Laos
KFAED	-	Kuwait Fund for Arab Economic Development
CIDA	-	Canadian International Development Agency
OPEC	-	Organization of Petroleum Exporting Countries
OECF	-	Overseas Economic Cooperation Fund (Japan)
ADB	-	Asian Development Bank

FISCAL YEAR

The Thai Fiscal Year runs from October 1 - September 30

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

APPRAISAL OF THE PATTANI HYDRO-ELECTRIC PROJECT

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Map No. IBRD 10402R

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

APPRAISAL OF THE PATTANI HYDRO-ELECTRIC PROJECT

SUMMARY AND CONCLUSIONS

i. The Pattani Hydro-Electric Project for the Electricity Generating Authority of Thailand (EGAT) consists of the Pattani development (3 x 20 MW), expansion of the transmission system and consulting services. The Pattani hydro-electric development is located in Southern Thailand, an area which has its own power grid that is not yet connected to the main EGAT grid. The power generated will meet demand growth in the South and support the Provincial Electricity Authority's (PEA) rural electrification program which treats Southern Thailand as a priority area. The transmission lines and substations would be built in various parts of the country to support the Provincial Electricity Authority's rural electrification program, a slice of which is proposed for Bank financing in FY78. A study would be carried out of costs of supply on a marginal cost basis of the whole power sector; the report would recommend new tariff schedules.

ii. EGAT has received an aggregate of US$232 million in seven loans from the Bank since 1957. These have helped finance the expansion of the generation and main transmission system in Thailand. Although the proposed loan will be the eighth Bank project with EGAT and its predecessor, the grid has not yet reached all areas of Thailand. Continued Bank assistance is therefore desirable. The projects under the previous loans have all been satisfactorily completed or are now under construction and no significant problems have arisen during the period of the Bank's association with EGAT.

iii. The total financing requirement of the proposed project is estimated at US$159.7 million equivalent, including a foreign exchange component of US$86.2 million. Project costs would be financed by: a Bank loan of US$50 million, including US$9.6 million for interest during construction; a loan of US$20 million from the Kuwait Fund for Arab Economic Development (KFAED); and a loan of US$20 million from commercial banks. The balance of about US$69.7 equivalent would be financed by government equity and by EGAT from internal cash generation.

iv. The proposed Bank loan would be applied against the foreign exchange cost of the main civil works and related engineering services of the Pattani hydro-electric development; expansion of EGAT's transmission system; consulting services for a tariff study; and interest during construction. Procurement on the basis of international competitive bidding would be in accordance with the Bank's Procurement Guidelines.

v. Economic growth was substantial in the 1960's, the increase in GDP averaging 8% per year; it slowed to 6.5% for the six years through 1976. Demand for power grew in line with the expansion of the economy.

vi. Responsibility for the power sector in Thailand rests with three organizations: EGAT is responsible for generation and transmission; PEA is responsible for distribution in the provincial areas including some diesel generation; and the Metropolitan Electricity Authority (MEA) is responsible for distribution in the Metropolitan Bangkok area.

vii. EGAT is wholly Government owned and is organized as a modern public utility. It is efficient both in its day-to-day operations, future planning and project construction. Its financial history is good and the current financial position is sound. There are no major staff recruitment or training problems.

viii. EGAT's expansion program required to meet the forecast growth FY 77-83, is estimated to cost US$2.2 billion at escalated prices; the proposed project would account for 7.2% of this amount. The Pattani project as proposed, forms part of the least cost development program for EGAT's southern Thailand grid at discount rates up to 12% when compared with an alternative program which provides thermal power initially, instead of the hydro-electric development.

ix. The project is suitable for a Bank Loan of US$50 million for a term of 20 years including a grace period of 5 years with the guarantee of the Kingdom of Thailand.

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

APPRAISAL OF THE PATTANI HYDRO-ELECTRIC PROJECT

I. INTRODUCTION

1.01 This report covers the appraisal of the Pattani Hydro-Electric Project for the Electricity Generating Authority of Thailand (EGAT) for the provision of hydro-generation facilities at Pattani in Southern Thailand, expansion of the transmission system and the undertaking of a tariff study.

1.02 Total financing requirements of the project are estimated at ฿ 3273 million (US$159.7 million). The Bank has been asked to finance part of the foreign exchange component in an amount of ฿ 828 million (US$40.4 million), interest during construction amounting to ฿ 197 million (US$9.6 million) would also be financed. The Kuwait Fund has agreed to provide a loan of about ฿ 410 million (US$20 million) equivalent, to finance the foreign costs of equipment, associated transmission facilities and related engineering services. The commercial banks would finance about ฿ 219 million (US$10.7 million) in foreign exchange and ฿ 191 million (US$9.3 million) in local currency for the main civil works. The balance of about ฿ 1428 million (US$69.7 million) would be financed from government equity and EGAT's internal cash generation.

1.03 This would be the Bank's eighth loan to EGAT and its predecessor. Projects financed under the first six loans have been completed and are all operating satisfactorily. The Ban Chao Nen hydro-project financed under Loan 977-TH of March 1974 is under construction and is progressing well.

1.04 The first project performance audit report was made in April 1976 for Loan 655-TH (2-125 MW units at Sirikit hydro station and 1-300 MW unit at South Bangkok thermal station). It indicated that the financial performance of EGAT was satisfactory for the period 1968-74. The rate of return on average net fixed assets in operation was close to the projected level up to 1972. From 1972 onward, it was below the appraisal estimate due to high operation and maintenance, administration and fuel costs. EGAT's earnings covenant with the Bank requires a 30% contribution to construction costs from internal cash generation. The covenant has always been met.

1.05 The project now proposed is to assist EGAT in expanding its generation and transmission facilities and to continue the Bank's role in maintaining EGAT's financial position through tariff increases and the introduction of a fuel adjustment clause in EGAT's tariff schedule.

1.06 This report was based on a feasibility report prepared by EGAT's consultants, Sverdrup and Parcel International, Inc., of USA and on information gathered by Bank missions to Thailand in January and October, 1976.

II. THE COUNTRY, THE ECONOMY AND THE SECTOR

The Country and the Economy

2.01 The Kingdom of Thailand is 514,000 sq km in area and had a population of 42.4 million in 1975, which was growing at a rate of about 2.7% per year. Per capita GNP was about US$340 in 1975. Economic growth was substantial in the 1960's, the increase in real GDP averaging 8% per year. Growth slowed to 6.5% during the period 1970-75 largely due to weak export demand in 1970-71, a drought in 1972 which severely restricted agricultural production and the slowdown in economic activity following the world energy crisis and recession in 1974. The rate of growth of real GDP rose from 4.6% in 1974 to 5.5% in 1975, and a growth rate of about 6.5% is estimated for 1976. The Government's draft Fourth Five-Year Plan (1977-81) establishes a target growth of 7% per annum.

2.02 Thailand is well endowed with land and water resources for agricultural production. Agriculture is the major economic activity, contributing about 31% of GDP, employing 80% of the labor force and providing about 67% of merchandise export earnings in 1975. The manufacturing sector is small, contributing about 17% of GDP, 14% of merchandise exports and 4% of employment, but growing fairly rapidly at about 10% p.a. on average (1970-75). Significant tourism development is also taking place, and tourism is now a major source (8%) of foreign exchange.

The Power Sector

General

2.03 The power sector consists of three state enterprises and 53 private franchises (at end-FY75). The state enterprises are the Electricity Generating Authority of Thailand (EGAT), the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA).

The Electricity Generating Authority of Thailand (EGAT)

2.04 EGAT was established in 1968 by the merger of three public electricity authorities: the Yanhee Electricity Authority; the Northeast Electricity Authority; and the Lignite Authority. The Yanhee Electricity Authority had been established in 1957 as a condition of the first power loan to Thailand. The purpose of the merger was to increase the efficiency of electricity supply throughout the country and to coordinate the generation and transmission systems.

2.05 EGAT is now responsible for most of the generation and transmission in the public sector. It accounted for 92.6% (8212 Gwh) of all electrical energy (8866 Gwh) generated in Thailand in FY75, the balance being generated by other utilities (2.6%) and by self-generating industries (4.8%). EGAT sells energy in bulk to MEA, PEA, and to large industrial consumers.

The Metropolitan Electricity Authority (MEA)

2.06 MEA, a state enterprise, was established in 1958 with the objective of supplying electricity to the Bangkok Metropolitan Area encompassing Bangkok, Thonburi, Nonthaburi and Samut Prakon. In FY76 MEA was serving nearly 541,000 consumers with a peak demand of about 934 MW and sales of about 5,291 Gwh (65% of the national total).

The Provincial Electricity Authority (PEA)

2.07 PEA was established in September 1960 as a wholly Government-owned Corporation with the responsibility of providing and distributing electricity in all provinces of the country except in the area served by the Metropolitan Electricity Authority. US$3.6 million of a US$21.0 million Bank loan to Thailand in 1976 (Loan 1198T-TH) was onlent to PEA to help finance its rural electrification (RE) program in selected villages in 10 provinces in the northeast region. The Bank has also recently appraised a more comprehensive slice of PEA's RE program covering 20 provinces for possible joint financing with the Canadian International Development Agency (CIDA) and the OPEC Special Fund. PEA purchases most of its energy in bulk from EGAT but also generates electricity in areas not yet connected to the grid. In FY76, PEA served about 931,000 consumers with a peak demand of about 601 MW and sales of about 2,582 Gwh. Ninety-two percent of its energy requirements were purchased from EGAT representing 30% of EGAT's sales, and 8% were locally generated. Twenty-four percent of the energy sold was used by residential consumers, 45% by industrial consumers, 30% by commercial consumers, and about 1% for street lighting. (Highlights of the operations of MEA, PEA and EGAT are given in Annex 1.)

Private Franchises

2.08 The 53 private franchises at end FY75 had an installed capacity of 5.7 MW in diesel plant and sold 211 Gwh. About 30 franchise holders purchased their power needs in bulk from PEA and the remainder generated their requirements. Low profitability following the fuel crisis has caused most of the self-generating franchises to ask to be taken over by PEA. The takeover is scheduled to be completed by end-FY77 at a total estimated cost of ฿ 220 million (US$10.7 million) in compensation; individual amounts of compensation which will be negotiated on a willing-buyer, willing-seller basis, have yet to be agreed.

Government Agencies

2.09 The power sector has been poorly coordinated in the past at the policy-making level; the three state enterprises have followed separate policies within their jurisdictions having different tariffs, consumer contributions and connection criteria. The situation has been aggravated by EGAT reporting to the Prime Minister's Office and MEA and PEA to the Ministry of the Interior, although each of the two organizations reports to different officials.

2.10 Several Government agencies also have a direct interest in the power sector in addition to the departments to which the utilities report. These are:

- Tariff Rate Committee;
- National Economic and Social Development Board;
- Ministry of Finance;
- Budget Bureau;
- National Energy Administration; and
- Rural Electrification Board.

These agencies consider and approve: tariff recommendations for submission to the Council of Ministers; capital project proposals and budgets; annual financial performances; and Government equity and loans. None of them has overall policy responsibility, decisions on the sector being arrived at after all the agencies including the state enterprises reach a consensus. However, a major step towards remedying the situation has been taken by the formation of a sector policy committee during the latter half of 1976 made up of the above Government agencies and the three utilities with the object of agreeing coordinated policy for the sector.

2.11 The system has worked well to ensure that sector capital expenditures are rigidly controlled, but the fiscal emphasis of the approval process has constrained sector development to some extent. Financial yields have formed the basis for connections and consequent grid extensions rather than long term economic gains. Village connections by both PEA and MEA could have been accelerated and EGAT could have provided more main transmission lines and substations to extend the grid, if longer term economic considerations had governed sector development.

Energy Requirements and Resources

2.12 Total energy consumption in the 1956-75 period increased from about 1 million tons of oil equivalent to nearly 9 million tons, at an average annual growth rate of 11%. As a percentage of total energy requirements (expressed in heating value), consumption in 1975 was as follows:

	Percent
Petroleum	79.2
Hydro	11.0
Coal	2.2
Charcoal and Wood	0.7
Paddy Husk and Bagasse	6.9
Total	100.0

2.13 Thailand's energy resources consist of hydro-power, limited petroleum and coal, large but as yet uneconomical oil shale deposits, charcoal, wood, paddy husk, and bagasse. Its hydro potential totals about 11,000 MW and 40,000 Gwh (excluding the potential on two international rivers, the Mekong and the Salween) of which only 909 MW or 8.8 percent are presently exploited. Coal deposits are estimated at about 150 million tons of which about 75 million tons can be commercially exploited. Following the oil crisis, EGAT converted one oil-fired generating unit (75 MW) at North Bangkok to lignite and now has two 75 MW lignite burning units under construction at Mae Moh. Proven reserves of petroleum total about 2.5 million barrels (consumption of petroleum products in 1975 was 76 million barrels) but exploration is being carried out in the Northeast and in the Gulf of Thailand. Preliminary results indicate an off-shore gas deposit which could generate about 1,000 MW over a 30-year period. Oil shale deposits are estimated at about 2,700 million barrels which, if economically exploitable, could meet Thailand's domestic requirements at the current rate of consumption for about 50 years.

2.14 A future potential source of power for EGAT could be from hydro facilities on the Mekong River. The hydro-electric potential of this river and its tributaries is substantial. The first phase of the 135 MW Nam Ngum project on a tributary of the Mekong in Laos was completed in early 1972 and EGAT has been receiving energy from it since. The Pa Mong project on the Mekong River about 18 miles from Vientiane, where it forms the border between Thailand and Laos, has a potential of 2,800 - 4,800 MW. However, the earliest date by which Pa Mong power could be available is in the late 1980's but political and resettlement problems cloud the possible development of this site.

Demand and Supply of Electric Power

2.15 In FY75, total generating capacity was 2,754 MW, of which 2,537 MW were owned by the state enterprises, 6 MW by the private sector and 211 MW by the self-generating industries. Out of 2,754 MW, 909 MW were hydro; 1,479 MW, steam; 201 MW, diesel; and 165 MW, gas turbine. Total energy generation in FY75 was 8,866 Gwh, of which 8,430 Gwh were generated by the state enterprises, 10 Gwh by the private sector and 426 Gwh by self-generating industries. Hydroelectric plants produced 3,399 Gwh; steam power plants, 5,197 Gwh; diesel units, 239 Gwh; and gas turbines, 31 Gwh. Generation per capita was 209 kwh in FY75.

2.16 Despite the restraint on sector growth, expansion has been considerable. Since 1966, total energy sold has grown from 1496 Gwh to 7468 Gwh in 1975, a growth rate of 19%.

2.17 The household connection rate 1/ achieved in the country at end-FY75 was 22% as shown below:

1/ Households Connected ÷ Total Households x 100

	FY75 (000)
Population	42,391
Total Households	6,056
Households Connected	1,317
Households Connected (%)	22
Consumption (Gwh)	7,468

2.18 Thailand's per capita consumption of power in FY75 was 176 kwh compared to 229 kwh in the Philippines, 490 kwh in Korea and 30 kwh in Indonesia. Regional imbalances currently exist and the Southern Region, which the proposed project would serve, has barely 20% of households connected compared to nearly 40% in the wealthier Central Region (including Bangkok). Access to electrification by regions is shown in Annex 2.

2.19 EGAT's development strategy has been to utilize available hydro resources and supplement these with thermal plants based on the least cost solution. The major hydro plants are associated with multipurpose reservoirs. The mixed hydro-thermal system has served EGAT well and has enabled it to utilize fully the available hydro capability while giving irrigation demand priority. MEA's development strategy is to expand and improve the distribution system to provide a reliable and adequate supply to meet consumer demand and to give every household in its service area access to electricity by 1981. PEA's development strategy is to extend its system as quickly as possible and to promote electrification in the rural areas. Up to the end of FY76, 11,000 villages out of a total of 48,000, had been electrified.

2.20 For the FY70-76 period, total sector investment was about US$755 million with EGAT's share US$510 million or 67%; MEA, 16% and PEA, 17%. Investment in the power sector averaged about 1% of GDP and about 17% of public investment annually.

III. THE BORROWER

3.01 The Borrower would be EGAT, established in 1968 by a merger of three generation and transmission authorities. EGAT is a financially sound, well organized and operated utility. The Guarantor would be the Kingdom of Thailand.

Organization and Management

3.02 EGAT is organized and functions as a modern public utility with a considerable degree of autonomy, charged with the operation of the power generation and transmission installations under its jurisdiction and the establishment of such new facilities as may be required for the Thai power

grid including all generation facilities and transmission down to 69 kV. It does not have responsibility for isolated diesel generation or for transmission and distribution below 69 kV.

3.03 The Board of Directors consists of a Chairman and not more than ten other members, including the General Manager. The Chairman and other members of the Board are appointed by the Council of Ministers. All Board members act in a part-time capacity with the exception of the General Manager.

3.04 EGAT had a total of 14,302 employees at end-FY76. The management and staff are able and well qualified: 1456 are university graduates; 1547 have diplomas and higher professional education; and 2412 higher vocational education. (See Annex 3 for Organization Chart.)

Training

3.05 EGAT operates a training school to assist in upgrading its staff. It also provides opportunities for attendance at courses and seminars both inside and outside Thailand to enable staff to keep abreast of up-to-date techniques and methods appropriate to their work. EGAT has no training problems and no difficulties in recruitment.

Accounting and Audit

3.06 EGAT follows the "Uniform System of Accounts" of the US Federal Power Commission. The accounting system is well operated and administered by a competent staff. Annual accounts are prepared within the time limit of 90 days after the end of the fiscal year imposed by the EGAT Act. Accounting has been computerized over the past two years, and the system is working efficiently.

3.07 Audit of the accounts is carried out by the National Audit Council, the Government organization responsible for auditing all State enterprises in the country. Since the early 1960's the international accounting firm, Coopers and Lybrand of London, has been retained as financial consultants by EGAT and its predecessor to assist the Audit Council and issue a separate report on the annual accounts each year. EGAT is satisfied with this arrangement and during negotiations agreed to continue using financial consultants.

Tariffs

3.08 EGAT's tariffs are the standard two-part type which charges consumers separately for their demand (kw) and energy (kwh); they are appropriate for a supplier of bulk power.

3.09 Periodic reductions in the tariffs of EGAT, MEA and PEA were made during the decade up to FY74 due to economies of scale and consequent reductions in unit costs. During FY74, EGAT's tariffs were increased by about 50 percent to compensate for increased fuel prices following the fuel crisis.

3.10 During FY75, PEA's residential tariffs were reduced to equate with MEA's and to promote rural electrification. With this reduction, PEA's revenues no longer covered its costs but about 2/3 of the shortfall was covered by

increased tariffs to MEA's and EGAT's industrial consumers with EGAT channeling funds from MEA to PEA by charging PEA lower tariff levels for bulk power than MEA, based on 1975 load factors. Sector costs of operation and construction have substantially increased and a tariff increase for all three entities is necessary to maintain the sector's financial position. The current position requires an increase of a minimum of 29% to contribute to the funds required for construction through FY78 when the results of a tariff study to be carried out under the project (para 3.12) would be implemented. Concurrently, the funds channeled from MEA to PEA require review annually to ensure that both authorities are supplied with the funds needed to continue their expansion programs. The Council of Ministers has recently approved a sector tariff increase of 29%, to be implemented by August 1, 1977.

3.11 Government and EGAT covenanted in the agreement for Loan 977-TH that a fuel adjustment clause would be included in EGAT's tariff schedules to increase or decrease the basic energy charge to compensate for changes in the cost of fuel to EGAT. The mid-1974 deadline for meeting this covenant was extended at the Government's request because it was then reviewing the implications of its power sector tariff policies on its rural electrification program. Subsequently, the Government adopted a policy of subsidizing the cost of fuel to the sector, which lessened the urgency for a fuel adjustment. The policy of subsidizing fuel was discontinued, at the Bank's urging, in early 1977. The fuel adjustment clause has now been introduced in EGAT's tariff schedules; in accordance with Government policy, this clause includes provision for approval by the Council of Ministers of any adjustment required.

3.12 A Bank mission made a study of Thailand's power tariffs in 1974 and produced a research working paper (P.U. Report No. RDS4 of December 1974). The report confirmed the basic soundness of EGAT's financial policies and position and, to further strengthen financial performance in the power sector, recommended, inter alia, that a thorough investigation of the levels and structure of marginal costs and of load characteristics be carried out. In addition, staff studies suggested that the Government's rural electrification program will require to be cross-financed within a rationalized tariff structure for the whole of Thailand. The Bank staff has recommended, and the Government leans toward the same view, that subsidies of all kinds, including equity, soft local loans, corporate tax exemptions and excise duty exemptions, be discontinued. Government and EGAT have agreed to carry out a tariff study of the entire power sector on a marginal cost basis using a team from the various agencies and utilities that cover the power sector. The loan and guarantee agreements include appropriate undertakings for completion of the study; cover the employment of consultants if the Bank considers them necessary, the estimated cost of which is provided for in the loan; and provide for the recommendations which are agreed with the Bank, to be implemented by the end of FY78. Draft terms of reference are given in Annex 4.

Existing Facilities

3.13 EGAT had a total of 2437 MW in service at the end of FY76 made up of 909 MW hydro; 1334 MW steam; 165 MW gas turbines; and 29 MW diesel. Three voltage levels are used for transmission lines: 230 kV, 115 kV and 69 kV, with a total length of 7943 km at end-76. Eighty-eight substations were in service with an installed capacity of 3347 MVA. EGAT's system is modern and efficient; plant is well operated and maintenance is of a high standard.

3.14 Three additional generating plants are under construction with a total installed capacity of 810 MW (360 MW hydro and 450 MW thermal including

150 MW to be fired by lignite). Annexes 5 and 6 give additional details and the map attached shows the location of generating plants and the transmission lines.

Future Development

3.15 EGAT has prepared a program covering the period FY77-83 to meet the demand and energy requirements based on forecasts prepared by MEA and PEA. The forecast for MEA's area is based on demand arising from normal economic expansion and income growth in the Bangkok Metropolitan area. In the case of PEA's area, the demand forecast is based on the increase in demand in the existing system and the demand arising from the system expansion projects scheduled for completion, including the electrification of about 20,000 villages over the seven-year period. Financial considerations have led in the past to EGAT refusing to build transmission lines and substations to meet PEA's needs; however, EGAT's obligation to contribute an adequate contribution (20%) to construction from internal cash generation, and the tariff adjustments this requires, should ensure that sufficient funds and consequently facilities will be available to meet all economic demand.

3.16 Capital investment in EGAT's development program FY77-83 totals about ฿ 35 billion (US$1.7 billion) at 1976 prices, including interest during construction. Incremental costs per kW on an escalated basis are about US$675 which is a reasonable figure in view of the fact that the transmission element is small during this period and escalation factors used for Thailand are low compared to other countries because inflation is comparatively low. Annex 7 shows EGAT's power development program as a graph; Annex 8 shows a tabulation of system generation requirements and available capability.

3.17 The existing system is divided into four regions as shown on the attached map. All regions are interconnected with the exception of Region 3 located in Southern Thailand on the Malay Peninsula. An interconnecting link for which ADB is considering a loan, is scheduled for completion in FY79. This will increase operational flexibility and form a good complement to the Pattani development in the southern system.

IV. THE PROJECT

4.01 The proposed project will comprise: (a) the Pattani hydro-electric development, including resettlement; (b) the expansion of EGAT's transmission system in support of the rural electrification program; and (c) a tariff study.

Pattani Hydro-electric Development

4.02 The Pattani hydro-electric development, located about 825 km south of Bangkok in the extreme south of Peninsular Thailand, will include an 85 m high and 422 m long rock-filled dam with a total volume of about 2.9 million cu m. The reservoir will have an effective storage capacity of 995 million cu m, about 70% of average annual inflow. An open channel chute-type spillway controlled by 2 radial gates will be located in the right abutment. The intake will be built in a combined structure with the spillway. It will be provided with a semi-circular trashrack and a fixed wheel type gate. It will feed into

an underground power conduit of welded steel pipe embedded in concrete. The powerhouse will be a surface type reinforced concrete structure, located below the dam. It is designed to house 3 units of 20 MW each. The switchyard is located on the southeast end of the powerhouse and equipped with step-up transformers, switching and protection equipment. A 115 kV double circuit line will transmit the power to the Yala substation about 40 km away. (Annex 9 provides project details.)

Transmission System Expansion

4.03 The existing transmission system and substations of EGAT have to be expanded to meet the increasing load requirements. Included in this project is a part of EGAT's Transmission System Expansion Project No. 3 (1977-1981) specifically designed to support the rural electrification program of PEA in the following areas:

Northern Area

1. 115 kv Phayao-Chiangrai Line and Substations, 90 km long.

Northeastern Area

2. 115 kv Udonthani-Loei Line and Substations, 140 km long;

3. 115 kv Phon-Chaiyaphum Line and Substations, 65 km long;

4. 115 kv Ubon Ratchathani-Sisaket Line and Substations, 62 km long;

5. Buriram Substation; and

6. Phang Khon Substation.

Southern Area

7. 115 kv Yala-Narathiwat Line and Substations, 70 km long.

Tariff Study

4.04 A tariff study will be carried out to ascertain the marginal costs of supplying power to consumers at different voltage levels. The study report would be expected to recommend a single tariff schedule for application to consumers of both MEA and PEA with the object of eliminating all capital and operating subsidies from the sector and assessing the effect of taxation on the sector. The report would also recommend the manner of transferring cash to PEA (provincial areas) from MEA (Bangkok area), possibly by EGAT continuing to charge PEA a lower price for bulk power than that charged MEA; tariff schedules for EGAT's bulk power would be recommended accordingly. The draft terms of reference are given in Annex 4 (also see para 3.12).

Cost Estimate

4.05 The following table summarizes the project cost based on end-1976 price levels:

	In millions of Baht			In millions of US$			% of
	Foreign	Local	Total	Foreign	Local	Total	Total
A. PATTANI HYDRO DEVELOPMENT							
1. Preliminary works	-	314.0	314.0	-	15.3	15.3	10.6
2. Resettlement & Land Acquisition	27.0	273.0	300.0	1.3	13.3	14.6	10.1
3. Civil Works	527.7	350.5	878.2	25.7	17.1	42.8	29.6
4. Associated Hydro-mechanical Equipment	37.0	4.0	41.0	1.8	0.2	2.0	1.4
5. Electro-Mechanical Equipment	211.0	24.0	235.0	10.4	1.2	11.6	8.0
6. Associated Transmission	22.5	27.0	49.5	1.1	1.3	2.4	1.7
7. Engineering & Supervision	77.5	15.0	92.5	3.8	0.7	4.5	3.1
8. Administration & Overhead	-	55.0	55.0	-	2.7	2.7	1.9
9. Duties & Taxes	-	43.0	43.0	-	2.1	2.1	1.4
BASE COST	902.7	1,105.5	2,008.2	44.1	53.9	98.0	
10. Contingencies							
Physical:	78.5	40.0	118.5	3.8	2.0	5.8	4.0
Price:	238.4	133.7	372.1	11.7	6.5	18.2	12.6
SUBTOTAL	1,219.6	1,279.2	2,498.8	59.6	62.4	122.0	84.4
B. TRANSMISSION SYSTEM EXPANSION							
1. Transmission Lines	92.3	86.5	178.8	4.5	4.2	8.7	
2. Substations	56.8	38.4	95.2	2.7	1.9	4.6	
3. Communication System	9.7	1.9	11.6	0.5	0.1	0.6	
4. Engineering & Supervision	-	16.9	16.9	-	0.8	0.8	
5. Duties and Taxes	-	27.5	27.5	-	1.3	1.3	
BASE COST	158.8	171.2	330.0	7.7	8.3	16.0	
6. Contingencies							
Physical	8.1	7.2	15.3	0.4	0.4	0.8	
Price	64.2	47.1	111.3	3.1	2.3	5.4	
SUBTOTAL	231.1	225.5	456.6	11.2	11.0	22.2	15.3
C. CONSULTING SERVICES FOR TARIFF STUDY	6.3	2.3	8.6	0.3	0.1	0.4	0.3
TOTAL PROJECT COST	1,457.0	1,507.0	2,964.0	71.1	73.5	144.6	100.0
D. INTEREST DURING CONSTRUCTION							
1. IBRD Loan	196.5	-	196.5	9.6	-	9.6	
2. Kuwait Loan	30.8	-	30.8	1.5	-	1.5	
3. Commercial bank loan	82.0	-	82.0	4.0	-	4.0	
SUBTOTAL	309.3	-	309.3	15.1	-	15.1	
TOTAL FINANCING REQUIRED	1,766.3	1,507.0	3,273.3	86.2	73.5	159.7	

4.06 The physical contingency on civil works is estimated to be 10.5% of basic cost. This is adequate after taking into account design changes recommended by the International Consulting Board which are now being reviewed by EGAT (para. 4.10). On electrical and mechanical equipment and transmission facilities, the physical contingencies average 8% and 5% respectively. The price contingencies for foreign and local costs were derived by applying the following rates of escalation: for civil works, 9% in 1977-79, and 8% thereafter; for equipment and transmission lines, 7.5% in 1977-79 and 7% thereafter. A detailed cost estimate of the Pattani hydroelectric development is given in Annex 10 and that of the transmission system expansion in Annex 11.

Financial Arrangements

4.07 The proposed Bank loan of US$50.0 million would finance part of the foreign exchange cost of main civil works and the total foreign exchange cost of (i) construction equipment required by EGAT to carry out resettlement; (ii) related engineering services of the Pattani project on main civil works; (iii) expansion of EGAT's transmission system to support rural electrification; (iv) consulting services for a tariff study; and (v) interest during construction on the Bank loan. The foreign exchange cost of equipment (gates and hoists, turbines, generators, transformers, cranes) associated transmission facilities and related engineering services, amounting in total to about US$20 million would be financed from the Kuwait Fund. A group of commercial banks led by the Bank of Tokyo would finance US$20.0 million of the foreign and local costs of the main civil works. The balance of the local costs and interest during construction on the Kuwait and commercial bank loans would be financed by government equity and EGAT's internal cash generation.

4.08 The proposed financing arrangements are as follows:

Financing Parties		Items to be Financed	(US$ Million) Foreign	Local	Total
IBRD	1.	Resettlement, civil works, and related engineering services for Pattani hydroelectric development.	28.9		
	2.	Expansion of EGAT's transmission system	11.2		
	3.	Consulting services	0.3		
	4.	Interest during construction	9.6		
		Sub-total	50.0	-	50.0
Kuwait Fund	5.	Associated hydro-mechanical and electro-mechanical equipment	17.5		
	6.	Associated transmission facilities	1.3		
	7.	Related Engineering services	1.2		
		Sub-total	20.0	-	20.0
Commercial Banks	8.	Civil works for Pattani hydroelectric development	10.7	9.3	20.0
Government Equity	9.	Local costs	-	29.3	29.3
EGAT's Funds	10.	Local costs and IDC	5.5	34.9	40.4
TOTAL			86.2	73.5	159.7

Procurement

4.09 All civil works, materials and equipment financed under the proposed Bank loan will be procured on the basis of international competitive bidding in accordance with the Bank's Procurement Guidelines. The Bank's usual preference of 15% (or the custom duties, whichever is less) will be granted to local manufacturers. Construction for preliminary works and resettlement will be carried out by EGAT's work force, supplemented by local contractors. Items financed by the Kuwait Fund will follow KFAED procurement guidelines.

Disbursement

4.10 Disbursements for construction equipment for resettlement and substation equipment would be made against the c.i.f. cost of directly imported equipment and materials, or 100 percent of total expenditures ex-factory for equipment and materials manufactured locally, and 65 percent of total expenditures for imported equipment and materials procured locally. Disbursements on the main civil works and transmission lines would be at 42% and 50%, respectively, of total expenditures. For the consulting and engineering services, disbursements would be 100% of the foreign exchange costs. A disbursement schedule is given in Annex 12.

Engineering Services

4.11 The feasibility study and the preliminary design report of the Pattani project were prepared by Sverdrup & Parcel International, Inc. (SPI) of San Francisco in 1969 and 1974 respectively. Additional studies were undertaken during 1976 based on the recommendations of the Bank's consultant on dam construction. EGAT has also engaged SPI for the design, preparation of tender documents and evaluation of bids for the main civil works and equipment. EGAT intends to continue the services of SPI for the detailed design and construction supervision of the project. The Bank has no objection to this arrangement. An amount equal to about 4% of the estimated cost of the Pattani development has been included, equivalent to about 600 man-months at US$5,500/man-month. The importance of the work makes additional consulting opinion desirable and EGAT has retained the services of the International Consulting Board for the Ban Chao Nen Project for the Pattani Project as well.

Implementation Schedule

4.12 Specifications and tender documents for the civil works contract were issued with Bank approval in December 1976. Bids were opened in April 1977 and are now under evaluation by EGAT. This should allow the contract to be awarded by September 1977, after expected loan approval and signing. For equipment contracts, tenders will be issued in mid-1977 and contracts awarded in early 1978. Civil works construction will start in late 1977 and be completed by early 1981. Filling of the reservoir would commence in the wet season of 1980 and all three units are scheduled to be commissioned before the end of 1981. Total construction time is about 4-1/2 years. A detailed implementation schedule is shown in Annex 13. Specifications and tender documents for the transmission system expansion will be issued in early 1978 and awarded before end-1978. All lines and substations are scheduled for completion before end-1981.

Hydrology

4.13 Hydrology is based on a fifteen-year record period (1962-1976). A correlation study was made between rainfall and runoff to establish the long-term runoff at the dam site. The probable maximum flood, using well recognized methods, gives a peak discharge of about 6700 cu m /sec and a volume of about 1800 million cu m . The freeboard provided is adequate to accomodate the flood and also for the abnormal condition when one of the spillway gates is out of operation during a 1000-year flood.

4.14 Based on the suspended sediment rating curve at the dam site, the annual sediment load is estimated at about 500,000 tons a year. The dead storage of 210 million cu m is adequate to take care of the sediment inflow over the life of the project. (Further details are provided in Annex 14.)

Geology

4.15 The geological investigation of the project consisted of 54 drill holes with a total length of 1882 m, 49 wash holes, 93 test pits, 3 adits and 2 trenches. EGAT is currently driving a pilot tunnel along the alignment of the diversion tunnel and stripping both abutments at the dam site in order to provide additional information for detailed design.

4.16 Although there are limestone deposits upstream of the dam-site they are all located at higher elevations, well above the reservoir. No reservoir leakage is anticipated. The possibility of landslides in the reservoir area is also small as the slope of the banks is gentle and the vegetation cover extremely good.

4.17 In general, although the geomorphology of the site is not the best, it is feasible to construct a dam using sound engineering practice and care - particularly in foundation treatment. (Details are given in Annex 15.)

Ecology

4.18 In 1975, EGAT engaged the Southeast Asia Technology Co. Ltd. (SEATEC) in association with the National Institute of Development Administration (NIDA) and Mahidol University to carry out an Environmental and Ecological Investigation of the Pattani Multipurpose Project. The study covers the following disciplines: land and water resources; forestry; fisheries; mining; aquatic plants; wildlife; archaeology; health; socio-economic aspect; and resettlement. The draft of the Summary Report (Vol. 1) was made available to the Bank in November 1976 with the understanding that the whole report will be completed in 1977.

4.19 The summary report concludes that (i) the project will have no significantly adverse effects upon the climatic conditions of the Pattani river basin; (ii) the mineral deposits in the Pattani reservoir are scarce and there are no operating mines in the catchment area, accordingly the effect on mineral resources is negligible; (iii) no significant items of archaeological, historical or cultural importance will be lost due to inundation; (iv) the total

volume of marketable timber in the reservoir area was found to be very small and will be harvested before reservoir impounding; (v) the forest at elevations higher than the reservoir full supply level will be kept undisturbed in order to provide home ranges for various species of wildlife; (vi) malaria and diarrhea are the most dangerous diseases in the project area, followed by malnutrition and parasitic diseases. Adequate health and malaria control facilities would be provided at the construction site. In short, there is no single ecological consequence or combination of consequences, which is so significantly important as to preclude construction of the project. The report also made recommendations for further monitoring, both on a short-term and a long-term basis. EGAT intends to follow these recommendations in carrying out the project and assurances to this effect were obtained during negotiations.

4.20 The total area to be flooded is about 5744 hectares of which about 2010 ha are forest; 3200 ha, rubber plantations; 460 ha, mixed orchards; 60 ha, residential houses; and 14 ha, rice paddies and coconuts.

4.21 A total number of 3,256 inhabitants will need to be resettled and EGAT will provide a sum of ฿ 300 million (US$14.6 million) or 10% of total construction expenditures for this purpose. This is equivalent to US$4,500 per inhabitant, about 6 times the amount provided for the Ban Chao Nen project. This is because of the high compensation costs for the rubber plantations which account for 40% of the cost of the resettlement program. About 90% of the villagers own their land; there are no large holdings. EGAT has been carrying out a successful resettlement program for the Ban Chao Nen Project. EGAT organized a visit to Ban Chao Nen of people living in the reservoir area and their only additional request was to have the land (EGAT will provide about 3.2 hectares for each family) cleared for them. EGAT also agreed to employ the local villagers in project construction as much as practicable (Annex 16).

4.22 During negotiations, Government agreed to guarantee that (i) a resettlement coordinating committee would be established by September 30, 1977; (ii) a detailed resettlement plan would be submitted to the Bank for approval by March 31, 1978; (iii) the Committee would be made responsible for the implementation of the plan and EGAT for construction; and (iv) the Government would provide any funds needed in excess of ฿ 300 million should this amount prove inadequate for the purpose.

Risks

4.23 EGAT has minimized the risks to the project to the extent possible. As mentioned above, the Authority has engaged an International Consulting Board whose advice will be sought if any unusual technical problems arise. To preclude the possibility of uneconomically high bid prices for the main civil works due to the political instability of the area, tenders have already been called and opened. To minimize potential problems during project execution, EGAT has gathered the support of area residents, developing a mutually satisfactory resettlement scheme and offering them employment during the construction period. The fact that EGAT has been on site since April 1976 without incident suggests that the project is welcomed as part of the Government's increased effort to speed development of this relatively neglected region. Remaining risks are not judged to be great enough to preclude proceeding with the project.

V. PROJECT JUSTIFICATION

The Overall Power Market

5.01 The power market in Thailand comprises the Greater Metropolitan area of Bangkok served by MEA; the provincial areas served by PEA; and bulk supplies made by EGAT to industries and to Electricite de Laos (EDL). The distribution of peak demand and energy sales in FY76 was as follows:

	Peak Demand (MW)		Energy Sales (Gwh)	
MEA	955.6	58.0%	5,594.1	64.3%
PEA	607.2	36.9%	2,655.3	30.5%
INDUSTRIES & EDL	89.3	5.1%	446.3	5.2%
TOTAL	1,652.1	100.0%	8,695.7	100.0%

5.02 At the end of FY66, EGAT's predecessors served a peak demand of 318 MW and generated 1515 Gwh; the average annual load factor was 54.4%. Ten years later peak demand had increased to 1652 MW, generation to 9414 Gwh and the annual load factor had improved to 65%. In the ten-year period, there was a four-fold increase in power requirements. Average annual growth rates were 18% for peak demand and 20% for energy, respectively. Early stimulants were rapidly rising investments, favorable world rice markets, and services to the U.S. military. As a result of the oil crisis and world economic recession, the low point was reached in FY74 when demand and energy requirements increased by only 4.8% and 5.6% respectively. However, system growth recovered in FY76 to 17.4% and 14.6% respectively (Annex 17).

5.03 The load forecast made by EGAT was based on the consolidation of the MEA and PEA forecasts and industries supplied directly. MEA based its forecast on the assumption that its service area would be fully electrified by FY81 and PEA took into account the natural growth of the existing system and its plan for developing new extensions into the rural areas. Peak demand to be served by EGAT in FY86 is forecast at about 4,192 MW and generation at 24,966 Gwh. This arises from an average annual growth rate of about 11.2% for FY77-81 and 8.5% for FY82-86. The forecast is considered to be an acceptable basis for the power development program.

Power Development Program

5.04 EGAT, following its past policies, has developed a power program based on least cost solutions to provide adequate operational flexibility and diversify primary energy resources. Projects included in its FY77-86 program are listed below (Annexes 7 and 8).

Project	Unit #	Installed Capacity (MW)	Type	Commissioning Year	Status
(a) New Mae Moh	1	75	Thermal lignite	1977	Under construction
	2	75	" "	1978	"
(b) South Bangkok	5	300	Thermal, oil	1978	"
(c) Ban Chao Nen	1, 2	240	Hydro	1979	"
	3	120	Hydro	1980	"
(d) Ban Tha Thung Na	1, 2	38	Hydro	1980	Under planning
(e) Bhumibol	7	100	Hydro	1981	"
(f) Pattani	1, 2, 3	60	Hydro	1981	"
(g) New Mae Moh	3,	150	Thermal, Lignite	1981	"
(h) New Thermal	1	500	Thermal, oil	1982	"
(i) Lang Suan	1, 2, 3	80	Hydro	1983	"
(j) New Thermal	2	500	Thermal, oil	1984	"
(k) Quae Noi	1, 2	290	Hydro	1984	"
(l) New Thermal	3	600/500	Nuclear/oil	1985	"

5.05 Total additions consist of 3128 MW made up of 928 MW of hydro, 300 MW of thermal fired with lignite, 1300 MW of thermal fired with oil and 600 MW of possible nuclear. The first three projects listed are currently under construction. The Ban Chao Nen hydro-electric project is being financed by the Bank (Loan 977-TH) and OECF; ADB is considering a loan for financing the 100 MW No. 7 unit at Bhumibol and the Central-South tie line; the Pattani Hydro-electric project will be the next project to be implemented. The program is therefore firm up to 1981, beyond which further studies to determine the optimum solutions will be required.

5.06 The justification of a 600 MW nuclear unit by 1985 is under review by EGAT based on the relative economy between conventional oil-fired thermal plant and a nuclear unit.

Regional Load Forecast

5.07 Load growth for the southern system (Region 3) has been 16.9% p.a. on average for peak demand and 14.1% p.a. for energy generation in the past five years. Peak demand in FY76 was 90.7 MW representing a 29.2% increase over the previous year. Annex 18 summarizes regional generation records since FY71 and the forecast of generation requirements from FY77-86. Growth rates average about 10.3% p.a. for peak demand and 11.7% for energy generation.

Regional Development

5.08 The electrical system in southern Thailand is at present isolated from the other regions; interconnection between the southern and central regions will not be realized until 1979 and then with a tie-line of only 40 MW capacity; and the power output of the Pattani hydro-electric development is small compared to the whole EGAT system. Therefore, the justification of the project was made on a regional basis.

5.09 The main generating facilities in the southern system consist of two 15 MW gas turbine units at Hat Yai, a 30 MW oil-fired thermal unit at Surat Thani, a 3 x 20 MW lignite plant at Krabi and diesel units at Phuket (4 x 2.65 MW) totaling 130.6 MW.

5.10 To meet the load requirements for Region 3, EGAT's proposed development program up to 1981 is as follows:

(a) installation of two 15 MW gas turbines at Hat Yai by 1977 and 1978 respectively;

(b) construction of a 115 kv tie line between the central and southern system for commissioning by 1979;

(c) construction of the Pattani hydro-electric development, 3 x 20 MW, for commissioning by 1981.

Least Cost Solution for the Pattani Hydro Development

5.11 The Lang Suan hydroelectric project is still in the investigation stage, it cannot be completed before 1983. The only possible alternative would be an oil-fired thermal unit of 30 MW capacity which would generate about the same amount of energy at a capacity factor of 75%.

5.12 The following two alternative programs were compared:

	Program A	Program B
1981	Pattani (3 x 20 MW)	Thermal (1 x 30 MW)
1983	Thermal (1 x 30 MW)	Pattani (3 x 20 MW)

5.13 The sum of total investment costs, operating costs and fuel costs of the two alternatives were compared on a present worth basis. Efficiency prices were used with foreign exchange costs shadow priced at a ratio of 1.1 and local costs at a weighted /1 ratio of 0.85 for the hydroelectric scheme and 0.95 for the thermal alternative. Program A with early Pattani was found to be the least cost solution for discount rates up to 12.0% (Annex 19).

/1 For unskilled laborers.

5.14 Since this is a multipurpose project, Government has agreed to contribute about ฿ 600 million (US$29.3 million) towards the cost of the dam for downstream irrigation and flood control benefits./1 This may be considered as the minimum capitalized value of downstream benefits. Taking this into account, the equalizing discount rate would be about 20%.

5.15 During negotiations, the Government agreed to prepare and furnish to the Bank for review and comment a program for the survey, design and construction of downstream irrigation works and implement such works in accordance with the program.

Return on Investment

5.16 The internal rate of return of the Pattani hydroelectric project or the discount rate at which the present worth of costs attributed to the project is equal to that of the benefits over its life, is about 11% in constant prices (Annex 20).

5.17 The benefit and cost streams of the downstream irrigation development are shown in Annex 21. By adding the irrigation component, the overall internal rate of return for the multipurpose development would be 13%.

Transmission System Expansion

5.18 A total of about 430 km of 115 kV sub-transmission lines is needed to meet increased load demands and to support PEA's rural electrification program. There are no other alternatives; the conductor sizes were optimized on the basis of least-cost solutions. No separate rate of return has been estimated as it is difficult to identify that portion of system revenues properly attributable to the expansion of the parts of the transmission system involved.

VI. FINANCIAL ASPECTS

Past Performance

6.01 The provisions of the Act governing EGAT's activities and the policies followed enabled the Authority's management to maintain a sound financial position until FY73 at which time it seemed that rising operating and construction costs would necessitate an increase in basic average tariffs. The fuel crisis temporarily dampened demand growth below that forecast in FY73. Consequent postponement of capital expenditures coupled with local borrowings, enabled EGAT to maintain its financial position without any tariff increase, except to meet increased fuel costs, until FY77. Over the past 7 years, rates of return on average net fixed assets in operation (not revalued) have varied between 7.4% (FY75) and 10.1% (FY71); for FY76 the rate of return was 9.8% due

/1 Based on a cost allocation by consultants, using the acceptable "separable cost - remaining benefit" method.

to abnormal rainfall increasing the water availability in EGAT's hydro-reservoirs, with consequent reduction in fuel oil costs for generation. Debt service coverage on an annual basis was greater than 1.8 times in 6 out of the past 7 years; self-financing has averaged 29 percent after covering all operating requirements including debt service and working capital; the self-financing covenant of 30% /1 as defined for Loan 977-TH, has been met every year; the debt/equity ratio of 58/42 at end-FY76 was satisfactory; and a current ratio of 1.7 /2 was adequate. Income, Funds Flow Statements and Balance Sheets FY70-76 are shown in Annex 22. A summary of EGAT's Balance Sheet at end FY76 is shown below:

Assets	฿ Millions	US$ Millions
Plant in Service	13,427	655
Less Depreciation	2,981	145
Net Fixed Assets	10,446	510
Work in Progress	3,678	179
Net Current Assets	912	44
	15,036	733
Financed By:		
Equity	6,319	308
Long-Term Debt	8,717	425
	15,036	733

Future Position

6.02 Economic expansion and the additional generating capacity required by Thailand's rural electrification program will cause EGAT to expand its asset base 2.5 times over the next seven years. Capital expenditures to

/1 Excluding provision for working capital.

/2 Excluding current maturities.

meet the required construction program will total ฿ 44.8 billion /1 (US$2.2 billion) at current prices including interest during construction. EGAT plans to borrow 63% abroad to cover foreign costs; 20% will be borrowed locally; and 17% would be self-financed on the assumption that tariffs will be fixed to cover the resulting finance gap. The financing plan based on the foregoing is shown as follows:

Financing Plan: FY 1977-83
(Billions of Baht and US Dollars)

	฿	US$	%
Internal Cash Generation	22.49	1.10	50
Less: Debt Service and Working Capital Needs	14.91	0.73	33
Internal Funds Available for Investment	7.58	0.37	17
Borrowings	37.20	1.81	83
	44.78	2.18	100

6.03 In the past EGAT has been free of taxation--exempt from corporation tax and refunded for excise taxes by Government equity; the Bank has recommended that the sector including EGAT should be subject to all forms of taxation. The financial forecasts therefore assume that EGAT will be subject to customs duties from the beginning of FY79 when the recommendations of the tariff study will be implemented. Continued exemption from corporation tax is forecast on the premise that the sector including EGAT will provide all the support necessary for the rural electrification program from the tariff structures; RE support and taxation may cause tariffs to rise to unacceptable levels but the effect of taxation on sector tariffs will be addressed during the tariff study. Given these assumptions, and the objective that EGAT would self finance 17% of its construction expenditures, EGAT's average tariff per kwh is forecast to increase:

- 28% from August 1, 1977;
- 15% for FY80;
- 2% for FY81;
- 5% for FY82; and
- 5% for FY83.

/1 Total construction expenditures ฿ 48.2 billion (US$2.4 billion) less ฿ 3.4 billion (US$166 million) for irrigation facilities included in hydro-projects, paid for by Government.

Level of Self-Financing

6.04 The tariff levels forecast will permit EGAT to generate an average of 17% of construction expenditures over the 7 years ending FY83, after covering operating costs, debt-service and working capital. The corresponding rates of return range from 3.4% in FY77 to 10.0% in FY80-83, calculated on revalued net fixed assets in operation. The agreement for Loan 977-TH provides that EGAT make a contribution to construction of 30%./1 Discussions took place during appraisal on changing to a rate of return covenant for the proposed and future loans, but the EGAT Act provides that a reasonable contribution to construction be made and management does not wish any ratio that implies "profits," as any such connotation attracts bad publicity in the media. However, to provide a fair basis for judging EGAT's financial performance in terms of rates of return, EGAT has agreed to revalue assets each year based on the fixed capital formation deflator used for public investment in the RTG accounts and beginning with FY70 as the base year.

6.05 It is proposed that a contribution to construction from internal cash generation of 15% in FY 78-79 and 20% thereafter, be earned. It is also proposed to amend the current complicated definition of "Contribution to Construction" to a simple form which reads:

(a) The Borrower shall from time to time take all such measures (including without limitation, adjustments of the structure or levels of its electricity tariffs) as shall be required to produce, for each of its fiscal years beginning on October 1, 1978, funds from internal sources equivalent to not less than 15% for fiscal years 1978 and 1979 and not less than 20% for fiscal year 1980 and thereafter, of the Borrower's average capital expenditures for electricity operations for three years comprising the test year, the next preceding year and (on the basis of estimates acceptable to the Bank) the next following year.

(b) For the purpose of this Section:

(i) The term "funds from internal sources" means the difference between:

(a) The sum of gross revenues from all sources related to electricity operations, cash consumer contributions in aid of construction, net non-operating income, and any other cash inflows other than funds for financing capital expenditures; and

(b) The sum of all expenses of operation, including maintenance and administration (excluding depreciation and other non-cash operating charges), interest and other charges on debt (excluding interest financed under a loan contract), repayment of loans (including sinking

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/1 The calculation was based on a complicated definition which has now been simplified. The contributions now proposed are equivalent to contributions greater than 30%, based on the previous definition (see Agreement for Loan 977-TH).

fund payments, if any), all taxes or payments in lieu of taxes, all cash dividends and other cash outflows other than capital expenditures related to electricity operations; and

(ii) The term "capital expenditures" means all expenditures incurred on account of fixed or capital assets, including interest charged to construction.

Future Operating Results

6.06 Energy sales are estimated to increase from 8696 Kwh in FY76 to 18,331 Gwh in FY83, an average growth rate of 11.3%. Based on the tariff increases detailed in para 6.03, revenues are forecast to increase from ฿ 3.8 billion (US$0.2 billion) in FY76 to ฿ 12.9 billion (US$0.6 billion) in FY83, an average growth rate of 19% per year; operating expenses after escalation at about 6% per annum (except fuel /1), are forecast to grow from ฿ 2.9 billion (US$0.1 billion) to ฿ 8.9 billion (US$0.4 billion), an average annual growth rate of 17.2%.

6.07 A downward trend from 86.6% (FY77) to 68.8% (FY83) in the operating ratio indicates that an increasing proportion of revenues is made available to help finance rapidly increasing construction expenditures.

6.08 EGAT's capital structure will remain satisfactory throughout the forecast period; the debt/equity ratio will vary between 43/57 (FY77) and 56/44 (FY83), a satisfactory position.

6.09 The current ratio has varied in the past between 1.3 (FY70) and 1.7 (FY76). Consumers receivables at end-FY76 were about 2.6 months billings, which is high for a bulk power supplier. However, EGAT's contracts with MEA and PEA provide for extended payment over about 2 months; energy receivables have been forecast at 3 months billing. Inventory levels are about 2.0% of gross plant and have been forecast at this level through FY83; payables have been forecast at about 40% of operating expenditures excluding depreciation, the end-FY76 level; year-end cash balances are adequate throughout the period of the forecast; the current ratio excluding current maturities, averages about 2.0, a satisfactory position. Estimated Income, Funds Flow Statements and Balance Sheets FY77-83 are shown in Annex 23.

/1 Fuel costs have been forecast at ฿ 1.66 per liter, the 1977 price. Any increase in fuel prices thereafter would be dealt with by the fuel adjustment clause.

Debt Control

6.10 Debt service coverage on an annual basis varies between 1.3 (FY77) and 2.5 (FY81), which is satisfactory. The latest loan agreement (Loan 977-TH) provides that EGAT cannot undertake any project costing US$50 million equivalent or more without the Bank having agreed to the financing plan covering the project. This covenant was agreed in 1974 before the full effect of inflation following the fuel crisis had been appreciated; given the magnitude of annual inflation since then, absolute number limits are no longer appropriate; inflation and the scale of EGAT's operations have increased each project's cost to a figure greater than US$50 million; and the Bank would require to be approached for every project to be undertaken by EGAT. This is unnecessary as the management of EGAT is able and conservative in its financial policies. What is needed in the circumstances is a covenant which would give adequate freedom to EGAT to manage its debt while providing for Bank review of borrowings when debt reaches a level that might prejudice the future of the Authority. The proposed loan agreement therefore contains a covenant that the Bank need only agree to the incurrence of any loan including medium term loans, when the debt/equity ratio exceeds 60/40.

6.11 Short-term debt, defined as obligations maturing within 5 years, was limited by the agreement for Loan 977-TH to an aggregate amount of US$50 million equivalent. The limit is now outdated because of inflation over the past few years and EGAT's ever-expanding scale of operations. It was therefore agreed that unless the Bank agrees otherwise medium-term debt be limited in the aggregate to a maximum of 15% of total debt. This figure will vary from ฿ 1,511 million (US$74 million) for FY77 to ฿ 5,998 million (US$293 million) in FY83. Medium-term debt is defined as obligations which when issued mature within 5 years, as EGAT has been raising its local borrowings in the form of 5-year bonds and is prohibited by Government regulations from incurring bank overdrafts.

Receivables

6.12 EGAT's receivables at end-FY76 were about 2.6 months outstanding mainly due to MEA being slightly in arrears in paying their EGAT bills due to their being short of cash. EGAT's contracts with MEA and PEA allow for payments by installments over about 2 months, after receipt of each month's bill --a long period for a supplier of bulk power. The supply contracts cannot be amended without negotiations between EGAT, MEA and PEA. The effect on tariffs of the lengthy outstanding period will be considered during the tariff study with a view to amending the supply contracts.

Interest During Construction

6.13 EGAT's policy is to capitalize during the construction period interest charges on loans taken up for a construction program (IDC); the 1977-83 financing plan (see para 6.02) includes the capitalization of interest amounting to ฿ 5271 (US$257) million on loans of ฿ 37.2 (US$1.81) billion to be taken up over that period. The capitalized interest includes ฿ 197 (US$9.6) million for interest on the proposed US$50 million Bank loan.

6.14 The execution of the sizable development program will require EGAT to mobilize all its available liquid resources and in order to meet the financial requirements over the construction period, EGAT is requesting all lenders to add IDC to their loans. In support of this request the financial forecasts indicate that even with the proposed tariff increases (see para. 6.03) EGAT would not have the liquid resources to meet, in addition to operational and program requirements, the interest during construction on the loans for the program. The figures given below are indicative of the situation.

Sept. 30	1977	1978	1979	1980	1981	1982	1983
	(฿ millions)						
Estimated Cash Balance /a	162	393	661	1,387	1,145	1,071	1,311
Estimated Minimum Cash Required /b	468	604	741	926	1,030	1,246	1,403
Margin	-306	-211	- 80	+461	+115	-175	- 92
IDC	159	251	416	752	1,081	1,050	1,562
Shortfall	465	462	496	291	966	1,225	1,654
IBRD financing of IDC (included in IDC above)	3	15	29	46	66	38	

/a After all charges except interest on loans for works in construction.

/b One month's cash operating expenses and debt service (excluding IDC) and 5% of the construction program.

The timing and size of EGAT's investment program is reasonable. The single investment decision which might affect the IDC computation above (for 1980 and thereafter) would be a change in the timing and size of the 600 MW plant to be commissioned in FY 85 (see para 5.05); however, any reduction in IDC arising from this decision would still not enable EGAT to pay IDC relating to the loans taken up for the program. The large shortfall is therefore a justification for the inclusion of IDC in the Bank loan.

VII. AGREEMENTS REACHED AND RECOMMENDATIONS

7.01 During negotiations, agreement was reached on the following points:

(a) fuel adjustment clause (para. 3.11);

(b) tariff study (para. 3.12);

(c) ₿ 600 million contribution by Government (paras. 4.08 and 5.14);

(d) ecology (para. 4.19);

(e) resettlement (para. 4.22);

(f) downstream irrigation works (para. 5.15);

(g) asset revaluation (para. 6.04);

(h) contribution to construction (para. 6.05);

(i) borrowing (para. 6.10); and

(j) medium-term debt (para. 6.11).

7.02 The proposed project is suitable for a Bank loan of US$50 million for a term of 20 years including a grace period of 5 years with the guarantee of the Kingdom of Thailand.

THAILAND
ELECTRICITY GENERATING AUTHORITY OF THAILAND
PATTANI HYDRO-ELECTRIC PROJECT
HIGHLIGHTS OF MEA, PEA, AND EGAT OPERATIONS

	1968	1975	Average annual growth rate in %	1976
1. MEA				
Maximum Demand (MW)	351	830	13.1	934
Energy Purchase (Gwh)	1,858	5,051	15.4	5,665
Energy Sales (Gwh)	1,736	4,794	15.6	5,291
Losses (Gwh)	122	257	-	374
Losses (as a percent of Purchases)(%)	6.6	5.1	-	6.6
Number of consumers (10^3)	315	506	7.0	541
Sales/consumer (kwh)	5,511	9,474	8.1	9,776
Residental sales % of total	19	17	13.7	-
Small business sales % of total	21	15	10.4	-
Medium & large business sales % of total	59	67	17.7	-
Street lighting % of total	1	1	12.4	-
Number of employees	5,766	8,569	8.3	-
Number of consumers/employee	62	61	-	-
2. PEA				
Maximum Demand (MW)	157	517	18.6	601
Energy purchased (Gwh)	439	2,199	-	2,695
Energy generated (Gwh)	110	110	-	130
Energy available (Gwh)	549	2,309	22.3	2,825
Energy sold (Gwh)	458	2,120	24.5	2,582
Losses in Gwh	91	189	-	243
Losses as percent of available (%)	16.6	8.2	-	8.6
Average annual load factor (%)	40.0	54.5	-	57.0
Consumers (10^3)	398	780	10.1	931
Average energy sales/consumer (kwh)	1,150	2,719	13.1	2,773
Residential sales % of total	35	26	-	24
Small business % of total	30	29	-	30
Medium & large business sales % of total	34	44	-	45
Street lighting % of total	1	1	-	1
Number of employees	5,678	7,502	7.0	8,028
Number of consumers/employee	85	102	-	116
3. EGAT				
Maximum Demand (MW)	505	1,407	15.8	1,652
Generation (Gwh)	2,654	8,212	17.5	9,414
Energy sold (Gwh)	2,475	7,642	17.5	8,696
Losses in Gwh	179	570	-	718
Losses as percent of available	6.7	6.9	-	7.6
Annual load factor	57.2%	66.6%	-	65.0
Number of employees		12,697	-	14,302

THAILAND

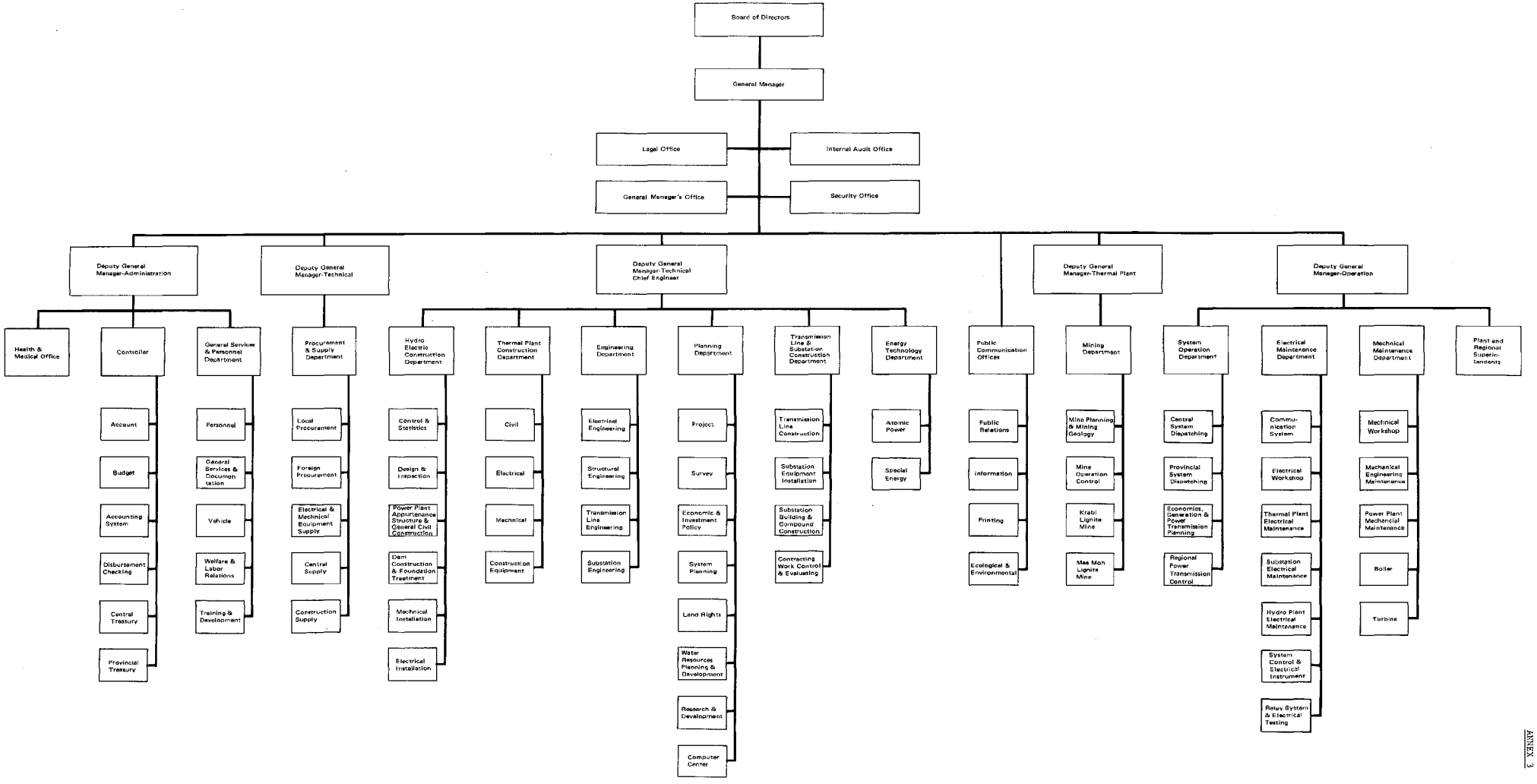
ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDROELECTRIC PROJECT

Access to Electricity by Regions

Region	Population	Population Electrified	% of Electrification
Northern	7,729,660	1,164,970	15.07
Northeastern	14,533,705	1,560,520	10.74
Central (including MEA service area)	14,902,425	5,531,977	37.12
Southern	5,225,656	1,022,163	19.56
Total	42,391,446	9,279,630	21.90

THAILAND
ELECTRICITY GENERATING AUTHORITY OF THAILAND
ORGANIZATION CHART



ANNEX 3

World Bank—16772

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDRO-ELECTRIC PROJECT

TARIFF STUDY - TERMS OF REFERENCE

General

Before decisions on policy can be taken by Government, the costs of supplying and distributing electric power should be known so that the consequences of any decisions made by the Government and EGAT are revealed.

Objective

The purpose of the study should be to derive a tariff structure which reflects as closely as possible the costs to the economy of meeting the demand for electricity, subject to any constraints imposed by the revenue requirements necessary to meet sector financial objectives and by any income distribution objectives (e.g., subsidizing poor consumers) which the electricity tariffs may be required to serve.

Analysis of Costs

(a) The relevant costs are not the financial costs to EGAT, MEA and PEA of expanding and operating their systems to meet the demand, but the incremental costs to the economy. Strictly speaking, therefore, shadow prices (for capital, labor and foreign exchange) rather than actual prices should be used as appropriate for measuring costs and any taxes on sector inputs should be deducted and subsidies added back. In this case, however, exclusion of taxes and subsidies from the costs already available within the sector will suffice, although it is suggested that the opportunity cost of capital should be taken as 14 percent.

(b) The first step would be to analyze the marginal costs of generating, transmitting and distributing electricity at different places, times and voltage levels to different consumers over the next few years, defined for this purpose as the period 1977-83. Due attention would be required to the daily and seasonal variations in forecast system demand, and to the extent possible, in forecast demands of various consumer classes. The basis for the estimates of marginal costs would be the development program for the period 1977-83 at constant prices, the proposed operating regime and proposals for subsequent expansion, all of which formed the basis of the forecasts used by the appraisal mission for the Pattani and ARE projects.

(c) For time periods when demand does not come up against the system capacity constraint (allowing for the reserve margins to maintain security of supply already agreed), marginal costs would be simply marginal costs grossed up to allow for losses at the different voltage levels. The relevant losses are incremental losses, even if they can be estimated only approximately, not average losses.

(d) At periods when an increase in generation would bring the system up against the security constraint, the marginal cost of meeting demand would be the addition to all system costs resulting from adding to generation capacity and/or storage, transmission and distribution, in order to provide the increased supply with an unchanged probability of failure.

(e) Incremental costs attributable to poor power factors should also be studied for those types of consumer (the larger ones) who can be expected to improve their power factor in response to suitable tariff incentives. The most important cost is the extra MVA capacity required to cater for these poor power factors.

Existing Tariffs

(f) The next step would be to examine the existing tariff structures and compare them with the structure of marginal costs of supply derived from the foregoing analysis. Large differences between the two may be an indication that the existing system is giving the wrong price signals to consumers. Examination of the existing system should pay particular attention to what types of tariffs are feasible. Other features to look for in examining the existing system are whether it is difficult to administer, conducive to disputes or conducive to fraud, since these will provide useful pointers to improvement in devising the new tariff structure.

(g) Examination of existing tariff structures would embrace the current levels of consumers contributions and whether the criteria used to assess these contributions is appropriate in view of the launching of the accelerated rural electrification program. All forms of consumer contributions should be studied including village contributions, charges for connection including housewiring, payments for service lines and security deposits.

New Tariff Proposals

(h) With the information thus collected, it should be possible to make a first set of proposals for changing the existing tariff system so that the incentives (and disincentives) it provides to consumers correspond more closely to the schedule of marginal costs derived. These proposals would consist of a classification of consumers and a tariff (or set of tariffs) for each class, together with any connection charges for reactive power which can be justified. Both Government and the authorities are then in a position to decide the tariff policies to be adopted. The tariffs can then be modified to take account of these policies and the following:

(i) Any strong arguments for slanting electricity tariffs because of price distortions (e.g., of substitutes for public electricity supply) elsewhere in the economy which are likely to affect electricity sales in the absence of such slanting;

(ii) The desirability of the three power authorities paying taxation on the same basis as any other commmercial entity;

(iii) The need for EGAT, MEA and PEA collectively, and private franchises individually, to generate sufficient funds to meet the demands in their areas without Government assistance. This would generally mean raising those elements of the proposed tariffs where price elasticity of demand is least, if the revenues based on marginal cost pricing are insufficient. Rates of return and contributions to construction levels should be considered within the study and should generally be fixed at levels which will provide revenues sufficient to cover:

- operating costs;
- debt and equity servicing;
- working capital requirements;
- a contribution to construction costs sufficient to bridge any gap between construction costs and possible consumers contributions, borrowings and additional equity.

(iv) Any income redistribution objectives to which electricity tariffs may be required to contribute in Thailand; and

(v) Practicality and cost. There is a trade-off between the cost of administering any tariff structure (which largely depends on the cost of metering and billing) and the extent to which it can reflect the structure of marginal costs. Complex metering, for example, is likely to be worthwhile only for larger consumers, since the response of small consumers to the extra incentives (or disincentives) it offers would not justify the expense.

(i) Modification of the strict "marginal cost" tariffs should be designed to cause the least possible disturbance to the incentives they offer to consumers in relation to the cost of supplying them.

(j) The new tariff schedules should provide for the automatic adjustment of rates in the event of increases in the price of fuel for thermal and diesel plants. The price level at which the fuel adjustment comes into effect should be defined.

(k) The tariff schedule should be a single set of tariffs for application to consumers of both MEA and PEA. Accordingly, recommendations should be made on the manner of passing to PEA the surplus funds accruing to MEA arising from the use of tariffs based on the overall cost of supply in both the provincial and metropolitan Bangkok areas. The study should also recommend the tariffs to be charged MEA, PEA and large industrial consumers by EGAT.

THAILAND
ELECTRICITY GENERATING AUTHORITY OF THAILAND
PATTANI HYDRO-ELECTRIC PROJECT
EXISTING GENERATING CAPACITY
(As of End 1976)

Plant Type	No. of Units	Capacity (MW) Installed	Capacity (MW) Ultimate	Average Energy Generation (Gwh/yr)
Hydroelectric Plant				
Bhumibol	6	420	560	1,550
Sirikit	3	375	500	965
Ubolratana	3	25		65
Sirindhorn	2	24	36	73
Chulabhorn	2	40		115
Nam Pung	2	6		15
Kang Krachan	1	19		70
Subtotal	19	909	1,186	2,853
Thermal Powerplant				
North Bangkok /a	3	237.50		1,900
South Bangkok	4	1,000	1,300	7,200
Surat Thani	1	30		210
Mae Moh /b	1	6.25		50
Krabi /b	3	60		300
Subtotal	12	1,333.75	1,633.75	9,660
Gas Turbine				
North Bangkok	2	30		26
South Bangkok	4	60		53
Bangkok Noi	1	15		13
Nakhon Ratchasima	1	15		13
Udon Thani	1	15		13
Hat Yai	2	30		26
Subtotal	11	165		144
Diesel Powerplant				
Mae Moh	9	9		8
Chiangmai	8	8		7
Phuket	4	10.60		9
Nakhon Si Thammarat	2	2		2
Subtotal	23	29.60		26
TOTAL	65	2,437.35		12,683

/a North Bangkok Unit 1 is designed for dual firing (oil and lignite).

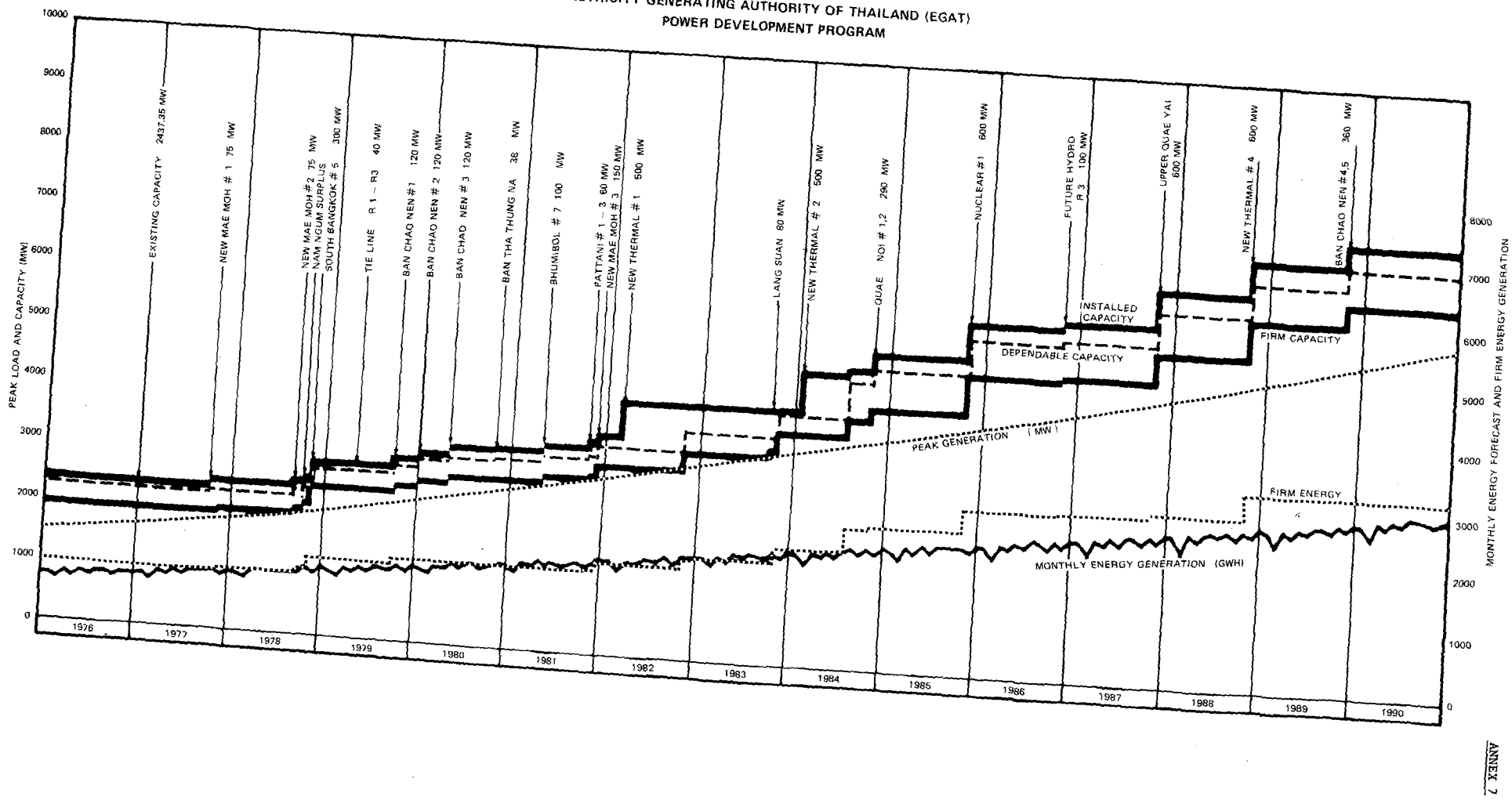
/b Lignite - fired.

THAILAND
ELECTRICITY GENERATING AUTHORITY OF THAILAND
PATTANI HYDRO-ELECTRIC PROJECT
EXISTING POWER TRANSMISSION LINES AND SUBSTATIONS (AS OF END 1976)

System Voltage	SUBSTATIONS		TRANSMISSION LINE (CIRCUIT-KILOMETERS)		
	Number	Installed Transformer Capacity* (MVA)	Double Circuit	Single Circuit	Total
REGION 1					
230 kV	6	1,954	748	18	766
115 kV	22	537	136	704	840
69 kV	8	107	-	288	288
TOTAL REGION 1	36	2,598	884	1,010	1,894
REGION 2					
115 kV	16	270	406	1,282	1,688
69 kV	6	22	-	356	356
TOTAL REGION 2	22	292	406	1,638	2,044
REGION 3					
115 kV	12	149	244	922	1,166
REGION 4					
230 kV	3	133	1,258	219	1,477
115 kV	6	69	359	623	982
69 kV	9	106	-	380	380
TOTAL REGION 4	18	308	1,617	1,222	2,839
ALL REGIONS					
230 kV	9	2,087	2,006	237	2,243
115 kV	56	1,025	1,145	3,531	4,676
69 kV	23	235	-	1,024	1,024
TOTAL EGAT	88	3,347	3,151	4,792	7,943

* Generator transformers and Station service transformer are excluded.

THAILAND
ELECTRICITY GENERATING AUTHORITY OF THAILAND (EGAT)
POWER DEVELOPMENT PROGRAM



ANNEX 7

World Bank—16773

THAILAND
ELECTRICITY GENERATING AUTHORITY OF THAILAND
PATTANI HYDRO-ELECTRIC PROJECT
SYSTEM GENERATION REQUIREMENT AND AVAILABLE CAPABILITY

Fiscal Year	REQUIREMENT					CAPABILITY AND RESERVE					
	Peak Generation		Energy Generation		Annual	Capacity - MW			Energy - Gwh		
	MW	%Incr	Gwh	%Incr	L.F.%	Installed	Dependable	Reserve	Average	Firm	Reserve
1976	1652.1	17.45	9414.5	14.65	65.05	2437.3	2271.3	619.2	13399.1	12275.1	2860.6
1977	1773.0	7.32	10306.0	9.48	67.75	2512.3	2346.3	573.3	13440.2	12316.2	2010.2
1978	1990.0	12.24	11642.0	12.96	67.95	2637.3	2471.3	481.3	14007.3	12883.3	1241.3
1979	2218.0	11.46	13023.0	11.86	68.01	3057.3	2879.6	661.6	17246.5	16095.8	3072.8
1980	2489.0	12.22	14752.0	13.28	68.47	3297.3	3096.2	607.2	18309.8	16865.8	2113.8
1981	2793.0	12.21	16558.0	12.24	68.31	3435.3	3200.2	407.2	18464.8	16865.8	307.8
1982	3057.0	9.45	18147.0	9.60	68.21	4145.3	3901.6	844.6	21867.7	20202.7	2055.7
1983	3333.0	9.03	19798.0	9.10	68.11	4225.3	3973.6	640.6	23617.3	21947.3	2149.3
1984	3614.0	8.43	21481.0	8.50	68.06	4725.3	4473.6	859.6	26191.8	24466.8	2985.8
1985	3900.0	7.91	23205.0	8.03	67.99	5015.3	4713.6	813.6	28640.3	26613.3	3408.3
1986	4192.0	7.49	24966.0	7.59	67.94	5715.3	5397.6	1205.6	33250.2	31199.2	6233.2

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDRO-ELECTRIC PROJECT

PROJECT DESCRIPTION

General

1. The Pattani River is located in the districts of Pattani and Yala, in the extreme south of Peninsular Thailand, adjacent to Malaysia. The general topography of the Peninsula is rolling to mountainous, with relatively small areas of flat land, except for the Suratthani and Songkhla plains on the eastern side. The Tenasserim mountain range divides the Peninsula from north to south. Most of the streams fall steeply and produce flash floods during periods of heavy rain.

2. The Pattani is one of the major rivers on the Peninsula's eastern slope. It rises in the mountains near the Malaysian border and flows northward for about 210 km through the Yala and Pattani districts to the Gulf of Thailand at the city of Pattani. The Pattani River basin can be described as mountainous upstream of the city of Yala, and as coastal plain from Yala to Pattani. The gradient above Yala averages 0.002, decreases abruptly at Yala to 0.00025 and flattens downsteam to the Gulf of Thailand at Pattani.

The Project

3. The proposed Project consists of a storage dam, a power plant and irrigation outlet, and associated transmission line and switchyard facilities. The storage dam, located slightly upstream of Ban Rang and downstream of the confluence of the Pattani and Hala rivers, is a rockfill type about 85 m high. Appurtenant facilities include two concrete-lined diversion tunnels, a chute spillway, a combined intake structure and conduit for power and irrigation releases. The power plant will be of the surface type, with three 20 MW units. The irrigation outlet will provide for release of irrigation water when power flows are insufficient. The transmission line of 115 kV will extend from the power plant switchyard to the substation at Yala about 40 km distant.

4. The Royal Irrigation Department has begun construction of irrigation and flood control works about 55 km downstream of the Pattani dam to take advantage of flow regulation provided by the reservoir. Annex 21 contains a description of the works and preliminary estimates of costs and benefits.

Dam

5. The dam to be built will be a rockfill structure with an impervious core, about 85 m in height and with a crest length of about 422 m. The crest elevation is 120 m with a normal full supply level of 115.0 m, a freeboard of 5 m. The total embamkment of the dam has an estimated volume of about 2.9 million cu m .

6. According to geological investigations it was found that the foundation rock at the dam site varies radically over the area. There are shales which would be subject to high deflection under heavy, concentrated loading, and quartzites which would be relatively insensitive to loading. Most of the rock is badly sheared and fractured, and there are many offsets in layers caused by faulting. Because of these factors, it was considered that a concrete dam would involve unacceptable risks. However, a rockfill dam --the base of which covers a wide area -- does not need the bearing strength required for a concrete dam and can be safely built provided that adequate precautions are taken.

7. The section and composition of the dam embankment, with a 2:1 upstream slope and a 1.8:1 downstream slope, will make full utilization of suitable materials generated from excavation, or made available from borrowpits or quarries within economical haul distances.

Spillway

8. The spillway of an open-channel chute type, will be located near the right abutment to take advantage of the most favorable prevailing foundation conditions. The complete spillway system includes the approach channel, an ogee-shaped intake structure, two radial type regulating gates (12.5 m x 17.5 m), gate hoists, a bridge located at dam crest elevation, a chute flip bucket, stilling basin and exit channel. The maximum spillway design capacity of 4600 cu m/sec has been determined from the predicted probable maximum flood. (see Annex 14).

Intake Structure

9. The intake will be built in a combined structure with the spillway. It will be provided with a semicircular trashrack and controlled by a fixed wheel type service gate. It will be designed for a minimum operating level of El. 83 m.

Power Conduit

10. The power conduit will be a welded steel pipe embedded in concrete. It will be 6.0 m in inside diameter with a total length of 183 m.

Powerhouse and Switchyard

11. The powerhouse consisting of the main machine room, control room, repair workshop, stores and station service unit is a conventional reinforced concrete structure about 26 m high, 14 m wide and 50 m long.

12. The switchyard is located on the southeast side of the powerhouse.

Generating Equipment

13. The turbines are vertical shaft Francis units each of 25,000 hp operating at 214.3 rpm and with a discharge of 45 cu m/sec at the rated head of 47 m.

14. The generators will be of a vertical shaft, umbrella type installed in a concrete barrel. Unit capacity is 23,500 KVA and the frequency is 50 cycles.

15. The transformers will be outdoor, three-phase, oil immersed with forced air cooling each of 27000 KVA capacity. Low voltage will be 13.2 kV whereas high voltage, 115 kV.

Transmission Line

16. The transmission line from the switchyard to the Yala substation will be 2 circuits of 115 kV, having a total length of 40 km. Steel tower construction will be used.

Implementation Schedule

17. The construction period will be approximately 4-1/2 years. The implementation schedule is outlined in Annex 13. It is anticipated that the contract for civil works would be awarded in September 1977. During calendar 1978 the principal activity will be concentrated on preliminary works and excavation of two diversion tunnels. By early 1979, it would be possible to divert the river. At the same time excavation for the dam will proceed as will excavation for the spillway, intake and power conduit. The fill for the main dam is expected to be started in mid-1979 and completed by early 1981. Reservoir impounding would commence in September 1980. Tenders for electromechanical equipment would be issued by mid-1977 and contracts awarded by early 1978. Erection of units would start in mid-1980 and commissioning is expected by mid-1981, September 1981 and end-1981 respectively.

Basic Data

18. The following table summarizes the principal features of the project:

1.	Location:	Located in the upstream reaches of the Pattani river	
2.	Catchment:	2080 sq km	
3.	Annual inflow:	about 1450 million cu m	
4.	Maximum flood	6734 cu m/sec	
5.	Reservoir:	Maximum flood level:	117.7 m
		Normal full supply level:	115.0 m
		Minimum operating level	83.0 m
		Total storage	1205 million cu m
		Effective storage:	995 million cu m
6.	Dam:	Type: Rockfill with impervious core	
		Crest elevation:	120.0 m
		Height:	85.0 m
		Crest length:	422.0 m
		Volume:	2.9 million cu m
7.	Spillway:	Type:	Open channel chute
		Capacity:	4600 cu m/sec
		Control gates:	2 radial gates (12.5 m x 17.5 m)
8.	Power intake and conduit	Combined single intake structure for power and irrigation controlled by 1 fixed wheel-gate; steel conduit of 6.0 m diameter embedded in concrete.	
9.	Powerhouse:	Reinforced concrete structure.	
10.	Generating Equipment:		
	Turbines:	Vertical shaft Francis Unit	
		Rated head	47 m
		Discharge	45 cu m/sec
		Output	25,000 hp

Generators:	Vertical umbrella type, enclosed air cooled.	
	Output:	23,500 KVA
	Voltage:	13.8 kV
	Frequency:	50 cycles
	Power factor:	0.85
Transformers:	Outdoor, 3 phase, oil immersed with forced air cooling	
	Capacity:	27,000 KVA
	Voltage:	13.8/115 kV
Transmission Line:	Length:	40 km
	Voltage:	115 kV
	Number of circuits	2

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDROELECTRIC PROJECT

Cost Estimate - Pattani Hydro Development

Items	Foreign	Local	Total	Foreign	Local	Total
	---- B million ----			---- US$ million ----		
1. Preliminary works						
EGAT's camp & service road	-	30.00	30.00	-	1.46	1.46
Reservoir clearing	-	9.00	9.00	-	0.44	0.44
Access road improvement	-	18.00	18.00	-	0.88	0.88
Reservoir road relocation	-	257.00	257.00	-	12.54	12.54
Total preliminary works	-	314.00	314.00	-	15.32	15.32
2. Resettlement and land acquisition	27.00	273.00	300.00	1.32	13.31	14.63
3. Civil works						
Construction facilities & mobilization	56.17	48.18	104.35	2.74	2.35	5.09
River diversion	5.12	3.90	9.02	0.25	0.19	0.44
Diversion tunnel approach channel	3.69	0.82	4.51	0.18	0.04	0.22
Diversion tunnels	57.40	21.73	79.13	2.80	1.06	3.86
Foundation treatment	29.52	15.37	44.89	1.44	0.75	2.19
Dam	174.25	115.82	290.07	8.50	5.65	14.15
Power intake & spillway	114.80	88.97	203.77	5.60	4.34	9.94
Power conduit & irrigation outlet	18.45	6.56	25.01	0.90	0.32	1.22
Stilling basin & exit channel	30.75	21.12	51.87	1.50	1.03	2.53
Powerhouse, tailrace & switchyard	37.52	28.08	65.60	1.83	1.37	3.20
Total civil works	527.67	350.55	878.22	25.74	17.10	42.84
4. Associated equipment						
Draft tube gate & monorail	1.50	-	1.50	0.07	-	0.07
Spillway radial gates & hoist	9.20	-	9.20	0.45	-	0.45
Roller train gates & hoist (power intake)	2.20	-	2.20	0.11	-	0.11
Bulkhead gates (power intake)	1.00	-	1.00	0.05	-	0.05
Trashrack (power intake)	1.00	-	1.00	0.05	-	0.05
Power conduit lining	18.60	-	18.60	0.91	-	0.91
Installation	3.50	4.00	7.50	0.17	0.19	0.36
Total associated equipment	37.00	4.00	41.00	1.81	0.19	2.00
5. Electromechanical equipment						
Turbines & generators	132.00	-	132.00	6.53	-	6.53
Transformers	27.00	-	27.00	1.32	-	1.32
Accessory equipment	27.00	-	27.00	1.32	-	1.32
Switchyard equipment	5.50	-	5.50	0.27	-	0.27
Shutoff valve & irrigation outlet	4.50	-	4.50	0.22	-	0.22
Installation	15.00	24.00	39.00	0.73	1.17	1.90
Total electromechanical equipment	211.00	24.00	235.00	10.39	1.17	11.56
6. Associated transmission						
Right-of-way	-	5.60	5.60	-	0.27	0.27
115 KV double circuit line	12.30	12.90	25.20	0.60	0.63	1.23
115 KV Yala substation	7.50	6.50	14.00	0.36	0.32	0.68
115 KV Temporary Pattani substation	0.70	1.50	2.20	0.04	0.07	0.11
Communication	2.00	0.50	2.50	0.10	0.02	0.12
Total associated transmission	22.50	27.00	49.50	1.10	1.31	2.41
7. Engineering consulting service	77.50	15.00	92.50	3.78	0.74	4.52
8. EGAT administration and overhead	-	55.00	55.00	-	2.68	2.68
9. Import duties and taxes	-	43.00	43.00	-	2.11	2.11
10. Contingencies						
Physical						
Preliminary works	-	-	-	-	-	-
Resettlement & land acquisition	-	-	-	-	-	-
Civil works	57.60	35.88	93.48	2.81	1.75	4.56
Associated equipment	1.43	-	1.43	0.07	-	0.07
Electromechanical equipment	18.05	3.07	21.12	0.88	0.15	1.03
Transmission system	1.43	1.03	2.46	0.07	0.05	0.12
Subtotal	78.51	39.98	118.49	3.83	1.95	5.78
Price						
Preliminary works	-	23.16	23.16	-	1.13	1.13
Resettlement & land acquisition	-	-	-	-	-	-
Civil works	145.55	98.40	243.95	7.10	4.80	11.90
Associated equipment	13.53	1.03	14.56	0.66	0.05	0.71
Electromechanical equipment	75.85	8.40	84.25	3.70	0.41	4.11
Transmission system	3.48	2.67	6.15	0.17	0.13	0.30
Subtotal	238.41	133.66	372.07	11.63	6.52	18.15
Total contingencies	316.92	173.64	490.56	15.46	8.47	23.93
TOTAL CONSTRUCTION COST	1,219.59	1,279.19	2,498.78	59.60	62.40	122.00

December 1976

THAILAND
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PATTANI HYDRO-ELECTRIC PROJECT
COST ESTIMATE - TRANSMISSION SYSTEM EXPANSION

Items	In millions of Baht Foreign	Local	Total	In millions of US$ Foreign	Local	Total
1. Transmission Lines						
115 kV Phayao-Chiang Rai	18.50	17.60	36.10	0.90	0.86	1.76
115 kV Udon Thani-Loei	29.80	28.40	58.20	1.45	1.39	2.84
115 kV Phon-chaiyaphum	17.70	15.50	33.20	0.86	0.76	1.62
115 kV Ubon Ratchathani-Sisaket	13.20	12.60	25.80	0.64	0.61	1.25
115 kV Yala-Warathiwat	13.10	12.40	25.50	0.64	0.60	1.24
Subtotal	92.30	86.50	178.80	4.49	4.22	8.71
2. Substations						
Chiang Rai & Phayao	10.70	7.10	17.80	0.52	0.35	0.87
Loei & Udon Thani	7.60	5.50	13.10	0.37	0.27	0.64
Chaiyaphum & Phon	9.90	6.50	16.40	0.48	0.32	0.80
Sisaket & Ubon Ratchthani	6.40	4.30	10.70	0.31	0.21	0.52
Buriram	6.60	4.60	11.20	0.32	0.22	0.54
Phang Khon	6.60	4.60	11.20	0.32	0.22	0.54
Narathiwat & Yala	9.00	5.80	14.80	0.44	0.28	0.72
Subtotal	56.80	38.40	95.20	2.76	1.87	4.63
3. Communication System	9.70	1.90	11.60	0.47	0.09	0.56
4. Engineering & Supervision	-	16.90	16.90	-	0.82	0.82
5. Duties and Taxes	-	27.50	27.50	-	1.34	1.34
Total base cost	158.80	171.20	330.00	7.72	8.34	16.06
6. Contingencies						
Physical	8.10	7.20	15.30	0.40	0.35	0.75
Price	64.20	47.10	111.30	3.10	2.30	5.40
Subtotal	72.30	54.30	126.60	3.50	2.65	6.15
TOTAL CONSTRUCTION COST	231.10	225.50	456.60	11.22	10.99	22.21

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DISBURSEMENT SCHEDULE

Fiscal Year and Quarter	Cumulative Disbursement at end of Quarter (thousands of US$)
1978	
September 30, 1977	-
December 31, 1977	4,000
March 31, 1978	4,700
June 30, 1978	6,000
1979	
September 30, 1978	8,400
December 31, 1978	10,800
March 31, 1979	13,400
June 30, 1979	16,000
1980	
September 30, 1979	18,700
December 31, 1979	21,600
March 31, 1980	25,100
June 30, 1980	28,600
1981	
September 30, 1980	32,100
December 31, 1980	35,600
March 31, 1981	38,100
June 30, 1981	40,600
1982	
September 30, 1981	42,900
December 31, 1981	45,200
March 31, 1982	47,100
June 30, 1982	48,400
1983	
September 30, 1982	49,200
December 31, 1982	50,000

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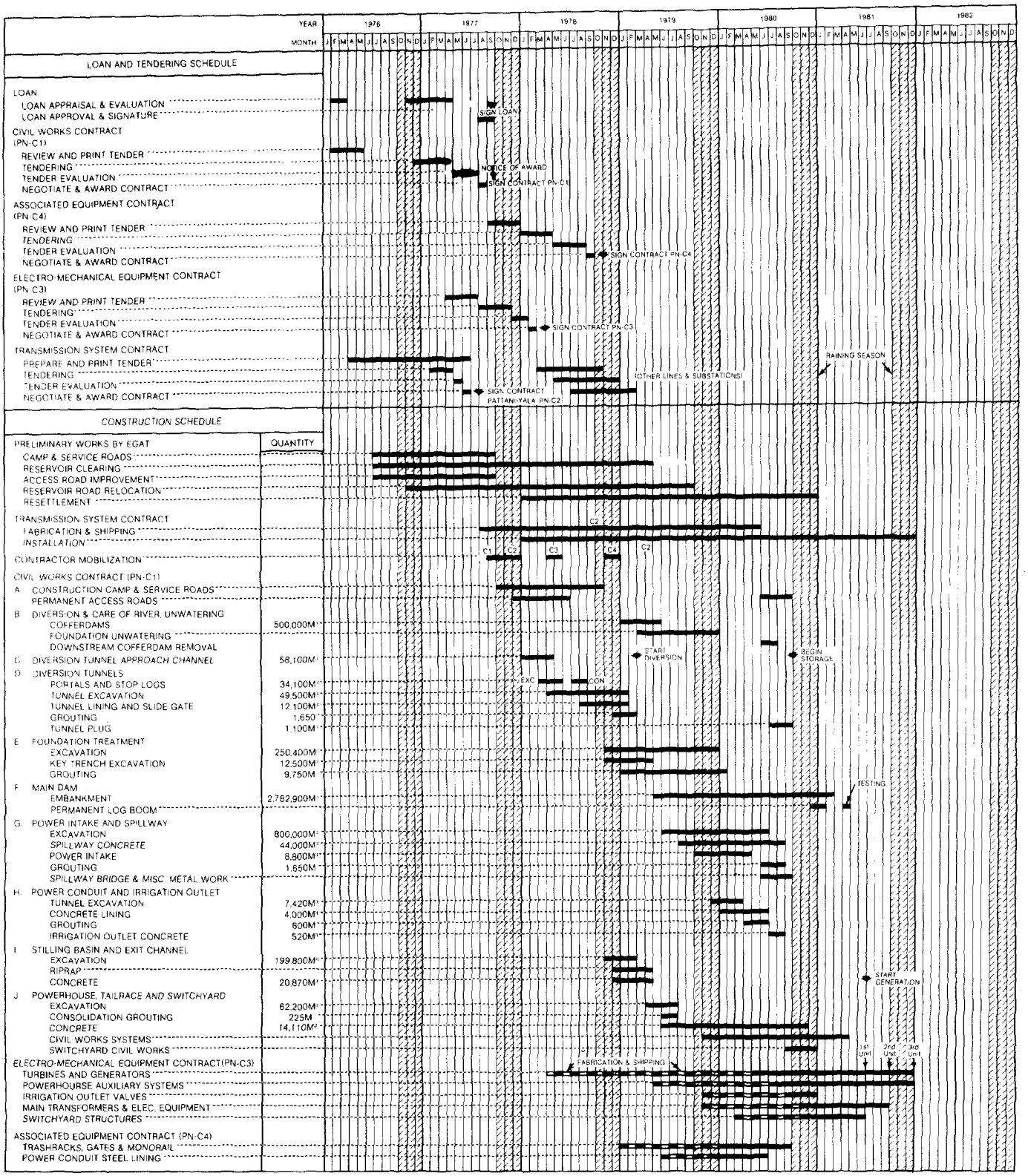
IMPLEMENTATION SCHEDULE

ANNEX 13



World Bank 16871

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDRO-ELECTRIC PROJECT

HYDROLOGY

Climate

1. The Pattani River Basin is located at the southernmost tip of the Peninsular Region of Thailand. The climate is tropical and seasons result from two major air movement systems, the northEAst and the southwest monsoons, each with its own weather characteristics. The northeast monsoon season is associated with the Northern Hemisphere winter and extends from October through January. During this period, the Peninsular Region is hot and humid, and rainfall is heavier and more frequent, while other parts of Thailand are comparatively cool and almost rainless. The southwest monsoon and the transition period bring lesser rainfall to the Peninsular area than the northeast monsoon. Unlike the major portion of Thailand, the Peninsular Region has no protective barrier to the east. Available records indicate that no storms of full typhoon intensity reach the area, however, tropical depressions and occasional tropical storms do cross the the Peninsula, bringing with them large volume and high intensity rainfall.

2. The monthly mean temperature at Pattani varies from about 26.1^{o}C in December to about 28.4^{o}C in May; and the extreme temperatures range from a minimum of 19^{o}C to a maximum of 38^{o}C. The mean relative humidity ranges from about 77 percent in January to about 84 percent in November.

3. Average annual rainfall varies from 1700 to 2400 mm over the basin. The average annual runoff at the damsite, embracing a catchment area of 2080 sq km, is estimated to be 46 cu m/sec or approximately 1,450 million cu m.

Hydrological Records

4. There are 14 rainfall and 5 stream flow gauging stations in the Pattani River basin. The duration of records and sponsoring agencies are summarized below:

	Station	Sponsored Agency	Period of Record	Guage Type
Rainfall	Pattani	Met. Dept.	1966-P, but intermittent	
	Yaring	"	1915-P, " "	
	Yarang	"	1922-P, " "	
	Mayan	"	1922-P, " "	
	Nong Chik	"	1906-P, " "	
	Yala	"	1907-P, " "	
		R.I.D.	1964-P,	
	Raman	Met. Dept.	1922-P,	
	Yaha	"	1922-P,	
	Bannang Sata	"	1922-P, " "	
	Ban To	N.E.A.	1962-P,	
	Ban Tan To	"	1962-P,	
	Storage Dam Site	N.E.A.	1963-P,	
Runoff	Decha Bridge	R.I.D.	1947-1960	Staff
	Ar Hoh Ru	"	1963-P	"
	Diversion dam Site	"	1968-P	"
	Yala	"	1964-P	Staff w/ rating
	Storage dam Site	N.E.A.	1962-P	"
		R.I.D.	1967-P	Recording
	Bannang Sata	"	1961-P	"
	Ban To	"	1961-P	"

River Runoff

5. Therefore, there were only twelve years of flow records at the dam site by the time of the last feasibility study in 1974 and 15 years up to present. It was necessary to extend the runoff records by correlation with rainfall. An analysis of the available rainfall records led to the selection of two periods, 1922-1958 and 1952-1965, as the basis of study. The double mass curve method was used to correlate rainfall with runoff, and to obtain the long-term monthly runoff at the dam site:

Month	Average Flow MCM	cu m/sec	%
January	40	15	2.7
February	52	23	4.2
March	50	19	3.4
April	51	19	3.4
May	72	28	4.9
June	101	38	6.9
July	210	79	14.4
August	276	106	19.0
September	271	101	18.7
October	149	56	10.2
November	68	28	4.7
December	110	41	7.5
Annual Total	1450	46	100.0

Flood Flow

6. Two methods were used in estimating the design floods, statistical and physical.

7. Statistical:

The annual flood peaks from 1962 through 1975 arranged in descending order were:

Annual Flood Peaks (cu m/sec)	Year
2075	1967
1420	1972
1240	1975
1005	1973
960	1965
885	1970
460	1974
398	1971
380	1962
377	1969
336	1966
250	1963
190	1964
110	1968

The results of the frequency analysis of annual flood peaks for various return periods were as follows:

Return Period, yrs.	Flood Discharge, cu m/sec By Foster Type III Distribution
20	1856
30	2100
50	2400
100	2793
1000	4326
10000	6114

A design flood corresponding to a return period of 30 years or about 2100 cms was adopted for the design of the diversion tunnel. In view of the short duration of flow records and a recorded flood of 2075 cu m/sec, this seems reasonable.

8. Physical:

The highest recorded storm in the southernmost region of Thailand and in the adjacent Kelantan state of West Malaysia occurred in the first week of January 1967. The center of this storm was Kota Bharu, where a total rainfall of 1319.7 mm was recorded for the period. This storm was first maximized by dew point temperature adjustment, then translocated to the project area by making further adjustments for the elevation difference.

Maximizing factor = 1.076

Maximized rainfall = 1419.2 mm

Maximized point rainfall for the project area = 0.85 x 1419.2 = 1206.4 mm
(Adjustment for distance from the source of moisture)

Maximized average basin rainfall = 0.83 x 1206.4 =1001.7 mm
This maximized storm was distributed over five days according to the pattern observed during the storm of January 1967. An amount of 5 mm per day was subtracted to account for the base flow of 100 cms and a runoff coefficient of 80% was adopted to calculate the effective rainfall. Basic unit hydrographs of past floods were developed out of seven storms chosen for anaysis. A 24-hour unit storm of 10 mm and unit hydrograph similar to the December 18, 1962 storm was adopted. The results of the studies were as follows:

Probable maximum flood	6734 cu m/sec
Probable maximum flood volume	1810 million cu m
Maximum spillway discharge	4600 cu m/sec
Maximum reservoir elevation at extreme flood	117.73 m
Freeboard available	2.27 m

Operation under Abnormal Condition

9. Assuming that one of the spillway gates does not function properly under the condition of a 1000-year flood of about 4400 cu m/sec, the reservoir will rise up to elevation 117.5 - 117.8 m depending upon the design of river outlet. The remaining freeboard will still be adequate to take care of wave action.

Reservoir Sedimentation

10. Based on the suspended sediment rating curve at the dam site, annual suspended load is estimated at about 500,000 tons/year, after allowing an additional 20% for bed load. The dead storage of 210 million cu m is adequate to take care of the sediment inflow over the life of the project.

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PATTANI HYDRO-ELECTRIC PROJECT

GEOLOGY

Reservoir Geology

1. The bedrocks in the reservoir area consist of quartzite, sandstone, shale, limestone and minor granitic and gnessic type rocks. Formations in which these rocks occur range in age from Cambrian to late Cretaceous, with the crystalline rock being the youngest. As a result, the limestone formation is located at high elevation above the reservoir levels, no reservoir leakage is expected.

2. The regional strike of the rock units in the reservoir area is to the north or northeast. The dip is to the west and northwest. This trend can be followed all the way to the crest of the regional folding located south of Betong (45 km in air distance south of the damsite). Upon crossing the border into Malaysia the rock units can be seen to dip to the west - southwest. Superimposed on the regional fold pattern are numerous local moderate to tight folds.

3. No extensive fault systems have been mapped in Southern Thailand. A study of the aerial photographs of the reservoir suggests an extensive fault-like feature of 1 to 3 km east and nearly parallel to the Pattani and Hala Rivers. There are many local faults within the damsite, and this prevalence should be considered normal for the entire region. The slope of banks is rather gentle and vegetation coverage extremely good. No massive slides are expected. However, bank erosion during the reservoir drawdown period is possible. A field survey for detecting slide areas should be carried out and proper measures be undertaken before impounding.

4. Four prominent joint systems have been mapped. Three of them appear to have quite an extensive distribution. Similar joint orientations have been mapped up to 10 km from dam site.

Damsite Geology

5. The rock underlying the damsite is of three major types: quartzite, sandstone and shale. These lie in beds of varying thickness and are modified by metamorphism and weathering, with the quartzite being the most intensively

metamorphised, and the hardest of the three. The sandstone is slightly coarser than the quartzite and has been leached to depths as great as 10 centimeters. It is not as hard as the quartzite and grades into the quartzite or the shales without distinct bedding planes. The shale is the least competent of the three rock types, having been sheared and deformed. These major rock members lie in various positions on each side of the damsite, reflecting the presence of folding and faulting.

6. The damsite area encompasses approximately 0.4 square km, and is bisected by the Pattani River. The rock on the right abutment generally strikes N 40° to 50° W and dips 45° to 55° NE. The rock on the left abutment strikes about N 65° E and dips generally 20° NW. The fault is nearly vertical or dips at a high angle to the northeast. Associated with this fault and nearly perpendicular to it are a series of normal faults.

7. There are primary and secondary joint systems in the foundation rock. The primary system is traceable for a considerable distance, but the secondary joints are localized. These have been filled, in part, with various natural cementing agents and sand, but many of them are partially open. Water losses during drilling varied, depending on the degree of filling of joints. The most prominent joint sets have the following attitudes: strike N 70° W, dip 50° to 70° SW; strike N 59° W, dip 70° NE; strike N 16° W, dip 60° NE and 70° SW. Dips of exposed joint surfaces vary extensively. Secondary joint attitudes are: strike N 60° to 70° E, dip 14° NW and about N 40° E, vertical to dipping about 50° SE. Most of the joints seen on the surface were open, some gapping up to one centimeter. Joint sets found in the rock cores were in varying stages of closure. Some were unfilled, some filled with sand, and some filled with cementing media such as iron oxide, manganese oxide, pyrite, or silica.

8. 49 wash borings, combined with previous drilling (39 holes) and test pits (93) indicated that overburden thicknesses are rather shallow beneath the upstream cofferdam site (less than 5 m) and the main dam foundation (3 to 10 m). The bedrock surface in the channel deepens abruptly downstream of the dam. This deepening coincides with a shear zone that obliquely crosses the channel in the tailrace area. the river has gouged out the easily eroded shales, clays, and broken rock within the shear zone, degrading the bedrock floor of the valley correspondingly. Subsequent drill hole data indicated that rock underneath the downstream toe of the dam is firm quartzite, thus stability of the dam itself would not be adversely affected by the shear zone. The alluvium underneath the downstream cofferdam area is about 20 m deep, thus a cut-off, possibly a slurry trench or cellular steel cofferdam, would be necessary.

9. The entire area underlying the main dam foundation will be stripped and cleared to a sound rock surface by removing all top soil, alluvial deposits, weathered and decomposed rock. In fractured, or faulted zones, all deleterious materials will be removed and backfilled with concrete. Special care will be taken in the foundation area underlying the impervious core of the dam to provide a sound, acceptable surface of contact. Consolidation and curtain grouting will be applied.

Spillway

10. Quartzites generally underlie the spillway crest structure and upper chute section whereas sandstones, shales and lenses of quartzites are found in the lower chute section and flip bucket area. A major fault trends roughly normal to the spillway chute about 40 m upstream of the flip bucket. Rock in the vicinity of the transverse fault will be highly fractured and deeply weathered but should provide an adequate base for the concrete lining. Drains and tie-down anchors should be provided to prevent uplift.

Power Conduit

11. Quartzite is the primary rock to be encountered throughout the area and is highly fractured and contains many small shear zones. Support will be required for the length of the tunnel. Ground water will not be a problem as the ground water table appears to lie below the invert of the power conduit.

Penstock

12. A major fault structure crosses the penstock alignment at an acute angle near the downstream edge of the anchor block. Between the power conduit and the anchor block, the penstock will be found on hard, fractured quartzites. Rock quality degenerates abruptly downstream from the anchor block. It would be advisable to move the anchor block slightly upstream to found the structure entirely on firm quartzites.

Powerhouse

13. Nine holes were drilled in the powerhouse area. Owing to the complex geological structure and the difficult drilling conditions which resulted in poor recovery, the foundation conditions are still not well defined. One of the major faults in the damsite area transverses the powerhouse site. Approximately 60 percent of the material to be removed is expected to be quartzite and quartzitic sandstone. The middle of the powerhouse will be resting on relatively soft shales and fractured rock. The quartzites are hard, but closely jointed and fractured, and should be capable of sustaining pressures well in excess of 60,000 psf. The shale and shear zones will have a lower supporting capacity but still adequate to support the powerhouse. They should be protected from further deterioration with gunite immediately after exposure.

Conclusions

14. The foundation exploration for the project was carried out in several stages: first by the Electric Power Development Company of Japan consisting of 18 drill holes, 36 test pits, 3 adits, and 2 trenches; then by Royal Irrigation Department consisting of 21 drill holes (1119 m in total) and 57 test pits; and finally by EGAT consisting of 49 wash holes and 15 drill holes (764 m in total).

15. EGAT is now carrying out a pilot tunnel of $2.5^{m} \times 2.5^{m}$ along the whole length of Diversion Tunnel No. 1 and surface stripping at both abutments of the dam in order to provide additional information for detailed design.

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PATTANI HYDRO-ELECTRIC PROJECT

RESETTLEMENT PROGRAM

1. Population Data

No. of villages	31
No. of households	722
No. of people	3,256

2. Land Classification in the Reservoir Area

	Rai /1	Hectares
Forest	12,559	2,010
Rubber plantation	20,000	3,200
Paddy field	72	12
Coconut farm	14	2
Mixed orchard	2,875	460
Residential	380	60
Total	35,900	5,744

3. Household economic data

Family size - 3 - 8 persons per family averaging about 5.5

Average size of rubber plantation - about 50 rai or 8 ha

Annual income land distribution - ฿ 20,000 per family
90% of the villagers have their own land; there are no large holdings

4. Compensation cost estimate

(a) Land plantation:

Rubber 20,000 rai @ ฿ 6,000 /2 ฿ 120,000,000

/1 1 hectare = 6.25 rai.

/2 Based on figures recommended by the Consultants for the environmental and and ecological investigation.

Orchard, coconut & Paddy fields	2961	rai	@ ฿ 3,000	8,883,000
Residential	380	rai	@ ฿ 7,500	2,850,000
Unused land	6280	rai	@ ฿ 1,250	7,850,000
			Sub-total	฿139,583,000

(b) Houses and buildings

public properties	4,159,000
private properties	19,289,000
Sub-total	฿ 23,448,000
Total	฿163,031,000

5. Outline of Resettlement plan

(a) Agricultural land allocated to the resettlers will be 20 rai per family including a 0.5 rai house plot;

(b) Rubber planting with new species is recommended for the resettlement area;

(c) Land will be cleared and graded by EGAT;

(d) Electricity, water supply, roads and service centers will be provided by EGAT;

(e) Resettlers will have to build their own houses from the compensation paid by EGAT; and

(f) For the first 5 years until the rubber trees reach maturity a subsistence allowance of ฿ 1000 per month per family will be paid by EGAT.

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Growth of EGAT Generating System

Fiscal year	Installed capacity (MW)	Peak generation MW	Peak generation % increase	Energy generation Gwh	Energy generation % increase	Energy sales Gwh	Energy sales % increase	Annual load factor %
Actual								
1965	383.4	235.0	32.02	1,111.0	43.35	1,009.05	39.9	53.90
1966	403.4	318.0	35.31	1,515.0	36.36	1,413.96	40.1	54.40
1967	546.4	397.0	24.84	2,042.0	34.78	1,900.19	34.4	58.70
1968	690.8	521.0	31.23	2,611.0	27.66	2,437.38	28.3	57.20
1969	892.3	635.0	21.88	3,376.0	29.29	3,151.32	29.3	60.70
1970	1,152.3	748.3	17.70	4,095.3	21.60	3,856.42	22.37	62.50
1971	1,167.3	872.7	16.62	4,792.9	17.03	4,475.83	16.06	62.70
1972	1,391.3	1,028.8	17.89	5,711.5	19.19	5,293.25	18.26	63.30
1973	1,448.9	1,199.3	16.57	6,872.8	20.34	6,399.75	20.90	64.40
1974	2,143.5	1,256.3	4.75	7,258.6	5.60	6,687.05	4.49	65.90
1975	2,437.3	1,406.6	11.96	8,211.6	13.13	7,589.97	13.50	66.60
1976	2,437.3	1,652.1	17.45	9,414.5	14.65	8,695.70	14.55	65.05
Forecast								
1977	2,512.3	1,773.0	7.32	10,306.0	9.48	9,542.0	9.74	67.7
1978	2,637.3	1,990.0	12.24	11,642.0	12.96	10,779.0	12.96	67.9
1979	3,057.3	2,218.0	11.46	13,023.0	11.86	12,059.0	11.87	68.0
1980	3,297.3	2,489.0	12.22	14,752.0	13.28	13,659.0	13.27	68.4
1981	3,435.3	2,793.0	12.21	16,558.0	12.24	15,332.0	12.25	68.3
1982	4,145.3	3,057.0	9.45	18,147.0	9.60	16,803.0	9.59	68.2
1983	4,225.3	3,333.0	9.03	19,798.0	9.10	18,331.0	9.09	68.1
1984	4,725.3	3,614.0	8.43	21,481.0	8.50	19,890.0	8.50	68.1
1985	5,015.3	3,900.0	7.91	23,205.0	8.03	21,486.0	8.02	68.0
1986	5,715.3	4,192.0	7.49	24,966.0	7.59	23,117.0	7.59	67.9

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LOAD FORECAST FOR SOUTHERN SYSTEM

Year	Peak Demand MW	% Increase	Energy Generation Gwh	% Increase	Annual Load Factor %
Actual					
1971	42.0	7.7	229.1	4.9	62.3
1972	44.5	6.0	240.3	4.9	61.6
1973	52.1	17.1	264.6	10.1	68.0
1974	61.1	17.3	298.2	12.7	55.7
1975	70.2	14.9	372.4	24.9	60.6
1976	90.7	29.2	439.2	17.9	55.3
Average	1971/76	16.9		14.1	
Forecast					
1977	105.0	15.7	551.9	25.7	60.0
1978	120.0	14.3	630.7	14.3	60.0
1979	137.0	14.2	720.1	14.2	60.0
1980	150.0	9.5	788.4	9.5	60.0
1981	167.0	11.3	885.1	12.3	60.5
1982	181.0	8.4	967.2	9.3	61.0
1983	196.0	8.3	1055.9	9.2	61.5
1984	210.0	7.1	1140.5	8.0	62.0
1985	225.0	7.1	1231.8	8.0	62.5
1986	241.0	7.1	1319.5	7.1	62.5
Average	1977/86	10.3		11.7	

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ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDRO-ELECTRIC PROJECT

THE LEAST COST SOLUTION

Alternatives to the Project

1. The least cost analysis was made on a program basis. Before 1981, there is no other alternative but to add gas turbines of 15 MW each in 1977 and 1978 respectively and a 132 KV tie line of 40 MW capacity in 1979. The Lang Suan hydroelectric project located in the northern part of Region 3 is still in the investigation stage and cannot be completed before 1983.

2. Two programs were chosen for comparison:

	Program A (Early Pattani)	Program B (Late Pattani)
1981	Pattani (3 x 20 MW)	Thermal, oil-fired (1 x 30 MW)
1983	Thermal, oil fired (1 x 30 MW)	Pattani (3 x 20 MW)

Each program was designed to meet the projected system demand with a reserve capacity of the largest unit in operation or loss of the tie line.

Capital Cost

3. All costs were based on end-1976 price level. Price contingencies were not included. Shadow prices were used as follows: (i) taxes and duties were excluded; (ii) foreign exchange costs were shadow priced by a factor of 1.1; (iii) local costs were adjusted by shadow pricing: the Pattani project at a factor of 0.85, made up of the labor content of the local cost estimate (30%) shadow priced at 0.5 plus the 70% of local costs remaining (30% x 0.5 + 70% = 0.85); and the thermal alternative at a factor of 0.95, made up of the labor content of the local cost estimate (10%) shadow priced at 0.5 plus the 90% of local costs remaining (10% x 0.5 + 90% = 0.95).

4. The cost of Pattani used for the discounted cash flow analysis is shown below with its phasing.

Year	W/O Shadow Pricing (M฿) F.C.	L.C.	Total	With Shadow pricing (M฿) F.C.	L.C.	Total
1	-	47.5	47.5	-	40.4	40.4
2	69.5	177.4	246.9	76.4	150.8	227.2
3	114.6	256.3	370.9	126.1	217.8	343.9
4	276.9	264.8	541.7	304.6	225.1	529.7
5	381.4	227.0	608.4	419.5	193.0	612.5
6	138.8	117.0	255.8	152.7	99.4	252.1
7	-	12.5	12.5	-	10.6	10.6
TOTAL	981.2	1,102.5	2,083.7	1,079.3	937.1	2,016.4

5. The cost of a 30 MW oil-fired thermal unit at end-1976 price level was estimated at US$600 per kW with its phasing shown below:

Year	W/O Shadow Pricing (M฿) F.C.	L.C.	Total	With Shadow pricing (M฿) F.C.	L.C.	Total
1	19.9	5.3	25.2	21.9	5.0	26.9
2	104.5	28.4	132.9	115.0	27.0	142.0
3	112.9	31.5	144.4	124.2	29.9	154.1
4	40.8	9.5	50.3	44.9	9.0	53.9
5	24.0	-	24.0	26.4	-	26.4
TOTAL	302.1	74.7	376.8	332.4	70.9	403.3

6. Associated transmission system expansion was assumed to be the same for the two alternative programs.

Operation and Maintenance Cost

7. Annual operation and maintenance costs at 1976 price level were estimated as follows:

	O & M (M฿)
Pattani Hydro	10.0
30 MW oil-fired Thermal Unit	8.0
Transmission Lines and Substations	4.0

Fuel Cost

8. The fuel consumptions of alternative programs were calculated by the principle of economic loading on the load duration curve. Fuel costs with shadow pricing used in the comparison were:

	Bulk supply from central network	30MW thermal unit	Gas turbine
Heat rate, btu/kwh	10,000	12,500	15,500
Fuel consumption, liter/kwh	0.265	0.326	0.463
Fuel cost ฿/liter	1.66	1.79	3.84
฿/kwh	0.47 /1	0.58	1.78
with shadow pricing	0.52	0.64	1.95

Results of Analysis

9. The present worths of alternative programs at different discount rates were:

Discount Rate	Program A	Program B
6%	4,005	4,138
8%	3,324	3,406
10%	2,854	2,892
12%	2,512	2,512
14%	2,251	2,218
16%	2,042	1,983

10. The equalizing discount rate between Program A and Program B is 12%. Program A with early Pattani is therefore the least cost solution for discount rates up to 12%, even after allocating all the costs of common facilities to power.

Sensitivity Tests

11. Sensitivity tests for variations in capital costs and fuel costs were made with the results shown below:

/1 Including transmission losses.

	Case 1 All Costs Allocated to Power	Case 2 ฿ 600 Million Allocated to Downstream Benefits
(a) On basic assumptions	12.0%	20.5%
(b) Pattani Cost increased by:		
5%	11.2%	18.8%
10%	10.5%	17.5%
(c) Fuel Cost increase by:		
10%	12.8%	21.5%
20%	13.5%	22.7%

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ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDROELECTRIC PROJECT

Rate of Return

General assumptions

(a)	Project data	
	Installed capacity	2 x 30 MW
	Annual capacity factor	38%
	Energy output	200 Gwh
	Peaking capability	60 MW
(b)	Project cost (end-1976 price level)	฿ million
	Total project cost (net of price escalation, duties and taxes)	2,084.0
(c)	Operation & maintenance costs	฿ million
	Pattani hydro plant	10.0 per year
	Transmission and substation	2.0 per year
(d)	Cost of fuel to EGAT in southern region	
	Thermal units (30 MW)	฿ 0.58/kwh
	Gas turbines (4 @ 15 MW)	฿ 1.78/kwh
(e)	EGAT's average tariffs (based on recently approved rates)	
	Demand charge ฿/kw/month	58.50
	Energy charge ฿/kwh, first 100 kwh/kw	0.48
	next 300 "	0.45
	over 400 "	0.41

Result of Analysis

(a) All project costs allocated to power

Pattani is the first hydroelectric plant in the southern system. The most economic operation of the system is to use Pattani to take the peak load and to replace existing gas turbines and thermal units when possible; the analysis is based on this this assumption.

Year	Cost Stream	Benefit Stream
	------in millions of Baht------	
1977	267	-
1978	344	-
1979	530	-
1980	612	-
1981	252	58
1982	91	196
1983	35	303
1984	71	361
1985	41	292
1986	12	370
1987	12	288
1988	12	369
1989-2026	12	296

Internal rate of return = 11%

(b) Multipurpose development including downstream irrigation

Year	Cost Streams		Benefit Streams	
	Power	Irrigation /1	Power	Irrigation /1
	in millions of Baht			
1977	267	-	-	-
1978	344	123	-	-
1979	530	185	-	-
1980	612	308	-	4
1981	252	350	58	12
1982	91	312	196	31
1983	35	195	303	62
1984	71	125	361	102
1985	41	60	292	156
1986	12	18	370	219
1987	12	18	288	291
1988	12	18	369	357
1989	12	18	296	457
1990	12	18	296	485
1991	12	18	296	502
1992	12	18	296	523
1993-2026	12	18	296	537

Internal rate of return = 13%

/1 See table 1 of Annex 21.

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ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDROELECTRIC PROJECT

Irrigation and Flood Control

Introduction

1. The Pattani Reservoir would create a potential for year-round irrigation of about 60,000 ha in the lower reaches of the Pattani River. The reservoir, although not specifically operated for flood control, has an effective storage of about 70% of the average annual inflow and would intercept a large volume of the monsoon runoff and thereby reduce considerably the magnitude and frequency of floods downstream of the dam.

Status of Irrigation

2. Proposals for irrigation development in the Pattani River Basin were presented in a 1969 feasibility report prepared by Sverdrup and Parcel International, Inc. (SPI) for the Royal Irrigation Department (RID), the agency responsible for all large-scale irrigation projects in Thailand. The study was updated in 1977 by SPI, assisted by Frederiksen, Kamine and Associates. RID has recently started construction of a diversion dam to serve a Stage I development of 41,500 ha. The diversion dam is about 55 km downstream from the proposed hydroelectric project. Other works constructed to date include the upper part of one of the main canals and about 40 km of main drains. However, the topographic surveys and detailed engineering of the project works have yet to be carried out and a firm timetable for the implementation of the project has so far not been prepared.

3. In 1976, a Bank mission reviewed the present status and future outlook for irrigation development in Thailand at the request of the Government. The mission's report /1 identified certain problems encountered in recent years in project implementation. In general, projects are constructed over too long a period of time and with more emphasis on major works such as dams and main canals, than on the tertiary systems needed to provide the farmers with a timely and reliable water supply.

4. To overcome these problems, the report recommended improvements in planning and programming with particular emphasis on preparation of implementation schedules. A typical schedule should specify all of the activities needed to achieve a working irrigation system, such as surveys, designs, construction of main canals, laterals, service roads, etc., on-farm development, and the establishment of effective operation and maintenance. Timetables should be prepared covering all major preconstruction activities which also identify the issues which remain to be resolved. Improved planning and

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/1 "Thailand, Irrigation Program Review," Report No. 1397A-TH, December 1976.

programming should also be combined with a system of regular progress reporting. This would help RID's management to overcome the delays sometimes experienced in project completion and the realization of project benefits. These recommendations should be adopted by RID in implementing the Pattani Project to ensure that the considerable irrigation potential created by the hydroelectric project are to be realized without delay.

The Project Area

5. The Stage I project has a gross area of 46,000 ha (41,500 ha net irrigable) in the shape of a triangle with its apex at the diversion dam and its base along the coast of the Gulf of Thailand. Virtually all of the project area is presently devoted to a single paddy crop grown during the wet season (September-January). Rainfall in the dry season is not enough to allow cultivation of field crops without irrigation. Paddy yields average about 1.5 ton/ha. Some improvement in rainfed rice yields would be possible with improved cultural practices and the use of good quality seeds, but the potential for higher yields is limited by droughts, in September and January, and floods in November/December. The higher land surrounding the project area is planted to rubber and numerous small plots of fruit and vegetables. The average farm holding in the project area is about 1.6 ha and most of the farmers own approximately an equal area of land planted to rubber and other crops. Virtually all the farmers own their land. The road system is adequate within the project area and is linked by paved roads to the nearby province capitals of Pattani and Yala.

Project Works and Cost Estimates

6. The principal features of the project are:

(a) a diversion dam consisting of a service spillway with seven 6 m wide radial gates, and an emergency spillway with a 1,600 m long overflow weir;

(b) three main canals with a combined length of 90 km;

(c) lateral canals with a total length of 570 km;

(d) on-farm development on 41,500 ha consisting of tertiary canals, drains and farm roads;

(e) about 150 km of main drains and 365 km of secondary drains and flood control works; and

(f) flood control works comprising about 30 km of flood embankments upstream of the diversion dam and 10 km of channel improvement in the lower reaches of the project area.

The estimated cost of the project, in January 1978 prices, is summarized below. Civil works costs, except for on-farm development, are taken from the 1977 update of the Feasibility Report (para. 2) and have been increased

by 10% to bring them to January 1978. On-farm development costs are based on a unit cost of $350/ha in line with recent contracts for similar work in Thailand. Engineering and administration, and physical contingencies are 10% and 15% of civil works costs respectively.

Cost Summary

	US$ million
Diversion dam	7.9
Canals and laterals	22.2
On-farm development	14.5
Drains	10.1
Flood control	8.1
Engineering and administration	6.2
Base cost estimate	69.0
Physical contingencies	9.4
Expected price increases	27.6
Total cost	106.0

Economic Justification

7. The provision of year-round irrigation coupled with reduction in flooding would permit the farmers to grow a double crop of rice. With projected paddy yields of 3.5 ton/ha and 4 ton/ha in the wet and dry seasons respectively and assuming an annual cropping intensity at full development of 170% (100% in the wet season and 70% in the dry season), paddy production would increase from 60,000 tons at present to 260,000 tons at full development seven years after completion of the project. The estimated rate of return is about 16% (see Table 1).

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ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDROELECTRIC PROJECT

Cost and Benefit Streams for Irrigation Development

Year	Costs /a	Benefits
	US$ million	
1978	6.0	-
79	9.0	-
80	15.0	0.2
81	17.1	0.6
82	15.2	1.5
83	9.5	3.0
84	6.1	5.0
85	2.9	7.6
86	0.9	10.7
87		14.2
88		17.4
89		22.3
90		23.7
91		24.5
92		25.5
93		26.2
1994-2026		26.2

Internal Rate of Return = 15.7%

/a Includes O&M costs of $0.9 million at full development phased in from 1981.

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INCOME STATEMENTS: FY 1970-76
(Millions of Baht)

Year Ending September 30	1970	1971	1972	1973	1974	1975	1976
Sales Increase %	-	15.5	18.3	18.5	6.8	13.5	14.6
Energy Sales (GWh)	3,865	4,465	5,283	6,260	6,687	7,589	8,696
Average Price (฿/kWh)	0.297	0.292	0.291	0.293	0.373	0.448	0.444
Revenues							
Energy Revenues	1,148	1,307	1,541	1,834	2,498	3,406	3,859
Other Revenues	9	8	7	6	11	8	9
Total Revenues	1,157	1,315	1,548	1,840	2,509	3,414	3,868
Operating Expenses							
Fuel	385	345	389	548	1,022	1,707	1,735
Operating	182	198	304	322	424	586	691
Depreciation	184	204	265	303	359	424	463
Total Expenses	751	747	958	1,173	1,805	2,717	2,889
Operating Income	406	568	590	667	704	697	979
Interest	190	220	256	320	365	446	489
- Charged Construction	35	48	63	108	131	135	124
- Charged Operations	155	172	193	212	234	311	365
Retained Earnings	251	396	397	455	470	386	614
Rate Base	5,162	5,639	6,272	7,040	8,490	9,465	9,950
Rate of Return %	7.9	10.1	9.4	9.5	8.3	7.4	9.8
Operating Ratio %	64.9	56.8	61.9	63.7	71.9	79.6	74.6
Revenue/Average Cross Plant %	19.1	19.6	20.4	21.3	24.0	28.9	29.8

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ELECTRICITY GENERATING AUTHORITY OF THAILAND

FUNDS FLOW STATEMENTS: FY 1970-76
(Millions of Baht)

Year Ending September 30	1970	1971	1972	1973	1974	1975	1976
Internal Sources of Funds							
Operating Income	406	568	590	667	704	697	979
Depreciation	184	204	265	303	359	424	463
Total Internal Funds	590	772	855	970	1,063	1,121	1,442
Operational Requirements							
Increase/Decrease Working Capital	2	52	5	36	41	213	-110
Interest Charged Operations	155	172	193	212	234	311	365
Debt Repayments	209	255	253	315	345	316	320
Total Operational Requirements	366	479	451	563	620	840	575
Internal Funds Available for Investment	224	293	404	407	443	281	867
Capital Investment							
Construction	649	854	1,534	1,862	1,244	1,716	1,937
Interest During Construction	35	48	63	109	132	135	124
Total Capital Investment	684	902	1,597	1,971	1,376	1,851	2,061
Balance to be Financed	460	609	1,193	1,564	933	1,570	1,194
Financed By							
Borrowings	448	656	969	1,269	903	1,249	1,422
Equity (Government Contribution)	30	33	194	345	86	159	306
Total Capital Sources	478	689	1,163	1,614	989	1,408	1,728
Cash Increase/Decrease	18	80	-30	50	56	-162	534
Cash at Beginning of Year	54	72	152	122	172	228	66
Cash at Year End	72	152	122	172	228	66	600
Debt Service Coverage	1.6	1.8	1.9	1.8	1.8	1.8	2.1
Contribution to Construction %	32.7	32.5	25.3	20.6	32.1	15.2	42.1

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ELECTRICITY GENERATING AUTHORITY OF THAILAND

BALANCE SHEETS: FY 1970-76
(Millions of Baht)

Year Ending September 30	1970	1971	1972	1973	1974	1975	1976
Assets							
Fixed Assets							
Plant in Service	6,286	7,146	8,031	9,266	11,585	11,972	13,427
Less Depreciation	975	1,180	1,454	1,762	2,109	2,519	2,981
Operating Plant	5,311	5,966	6,577	7,504	9,476	9,453	10,446
Work in Progress	1,116	1,154	1,865	2,594	1,630	3,075	3,678
Current Assets							
Cash	72	152	122	172	228	66	600
Inventories	92	114	132	149	187	305	314
Receivables	289	377	460	503	972	1,066	1,250
Total	453	643	714	824	1,387	1,437	2,164
TOTAL ASSETS	6,880	7,763	9,156	10,922	12,493	13,965	16,288
Equity and Liabilities							
Equity							
Paid in Capital	2,401	2,434	2,628	2,973	3,059	3,212	3,518
Retained Earnings	292	688	1,085	1,540	2,010	2,396	3,009
Revaluation Reserve	-	-	-105	-259	-142	-102	-208
Total Equity	2,693	3,122	3,608	4,254	4,927	5,506	6,319
Long-Term Debt							
Debt Due	3,844	4,245	5,066	6,175	6,616	7,510	8,717
Total Debt	3,844	4,245	5,066	6,175	6,616	7,510	8,717
Current Liabilities							
Payables	338	391	476	487	944	943	1,246
Total	338	391	476	487	944	943	1,246
Contributions	5	5	6	6	6	6	6
TOTAL EQUITY AND LIABILITIES	6,880	7,763	9,156	10,922	12,493	13,965	16,288
Average Gross Plant/GWh (000)	1,626	1,504	1,436	1,382	1,559	1,552	1,489
Increase in Gross Plant %	-	13.7	12.4	15.4	25.0	3.3	12.1
Debt/Net Plant %	72.4	71.1	77.0	82.3	69.8	79.4	83.4
Debt % of Debt and Equity	58.8	57.6	58.4	59.2	57.3	57.7	57.6
Current Ratio	1.3	1.6	1.5	1.7	1.5	1.6	1.7

THAILAND - EGAT

Forecast Income Statements
(B millions)

Years ending September 30	1977	1978	1979	1980	1981	1982	1983
Sales increase (%)	9.7	13.0	11.9	13.3	12.2	9.6	9.1
Energy sales (GWh)	9,542	10,779	12,059	13,659	15,332	16,803	18,331
Average price per kWh	0.47	0.56	0.55	0.63	0.64	0.67	0.70
Energy revenue	4,502	6,010	6,592	8,565	9,875	11,357	12,857
Other revenue	19	20	21	22	23	24	25
Total revenues	4,521	6,030	6,613	8,587	9,898	11,381	12,882
Operating expenses							
Fuel	2,596	3,393	3,715	4,200	4,839	5,104	5,619
Operations	773	815	1,013	1,112	1,255	1,422	1,566
Depreciation	544	684	811	932	1,089	1,461	1,684
Total expenses	3,913	4,892	5,539	6,244	7,183	7,987	8,869
Operating income	608	1,138	1,074	2,343	2,715	3,394	4,013
Net income before interest	608	1,138	1,074	2,343	2,715	3,394	4,013
Interest	455	546	608	711	812	1,444	1,563
Charged operations	455	546	608	711	812	1,444	1,563
Net income	153	592	466	1,632	1,903	1,950	2,450
Retained earnings	153	592	466	1,632	1,903	1,950	2,450
Rate base	17,645	19,673	21,039	23,999	27,109	33,945	40,211
Rate of return (%)	3.4	5.8	5.1	9.8	10.0	10.0	10.0
Operating ratio (%)	86.6	81.1	83.8	72.7	72.6	70.2	68.8
Revenue/average gross plant (%)	20.2	23.8	23.8	26.8	27.0	25.1	23.9

Report prepared June 14, 1977 for the period beginning October 1, 1976.

THAILAND - EGAT

Forecast Funds Flow Statements
(B millions)

Years ending September 30	1977	1978	1979	1980	1981	1982	1983	Total
Internal sources of funds								
Operating income	608	1,138	1,074	2,343	2,715	3,394	4,013	15,285
Depreciation	544	684	811	932	1,089	1,461	1,684	7,205
Total internal funds	1,152	1,822	1,885	3,275	3,804	4,855	5,697	22,490
Operating requirements								
Increase/decrease working capital	213	170	50	534	196	687	278	2,128
Interest charged operations	455	546	608	711	812	1,444	1,563	6,139
Debt repayments	426	625	681	740	739	1,309	1,408	5,928
Total operational requirements	1,094	1,341	1,339	1,985	1,747	3,440	3,249	14,195
Internal funds available for investment	58	481	546	1,290	2,057	1,415	2,448	8,295
Capital investment								
Construction	2,284	3,048	3,622	6,122	8,457	10,117	11,132	44,782
Total capital investment	2,284	3,048	3,622	6,122	8,457	10,117	11,132	44,782
Balance to be financed	2,226	2,567	3,076	4,832	6,400	8,702	8,684	36,487
Financed by								
Borrowing	1,788	2,798	3,344	5,558	6,158	8,628	8,924	37,198
Total capital sources	1,788	2,798	3,344	5,558	6,158	8,628	8,924	37,198
Cash increase/decrease	-438	231	268	726	-242	-74	240	711
Cash at beginning of year	600	162	393	661	1,387	1,145	1,071	1,071
Cash at year end	162	393	661	1,387	1,145	1,071	1,311	1,311
Debt service coverage	1.3	1.6	1.5	2.3	2.5	1.8	1.9	1.9
Annual contribution to construction	2.5	15.8	15.1	21.1	24.3	14.0	22.0	18.5
3-year average (%)	-	16.1	12.8	21.3	25.0	14.3	-	-

Report prepared June 14, 1977 for the period beginning October 1, 1976.

THAILAND - EGAT

Forecast Balance Sheets
(B millions)

	1977	1978	1979	1980	1981	1982	1983
ASSETS							
Fixed assets							
Plant in service	24,294	26,391	29,262	34,925	38,420	52,284	55,421
Less depreciation	5,081	6,070	7,245	8,612	10,218	12,292	14,714
Operating plant	19,213	20,321	22,017	26,313	28,202	39,992	40,707
Work in progress	3,335	5,744	8,078	10,293	17,351	15,909	27,041
Current assets							
Cash	162	393	661	1,387	1,145	1,071	1,311
Inventories	406	440	491	622	690	1,066	1,118
Receivables	1,441	1,923	2,109	2,741	3,160	3,634	4,114
Total	2,009	2,756	3,261	4,750	4,995	5,771	6,543
Total assets	24,557	28,821	33,356	41,356	50,548	61,672	74,291
EQUITY AND LIABILITIES							
Equity							
Paid-in capital	3,518	3,518	3,518	3,518	3,518	3,518	3,518
Retained earnings	3,162	3,754	4,220	5,852	7,755	9,705	12,155
Revaluation reserve	6,476	7,629	8,848	10,169	11,748	13,440	15,839
Total equity	13,156	14,901	16,586	19,539	23,021	26,663	31,512
Long-term debt							
Debt due	10,079	12,252	14,915	19,733	25,152	32,471	39,987
Total debt	10,079	12,252	14,915	19,733	25,152	32,471	39,987
Current liabilities							
Payables	1,316	1,662	1,849	2,078	2,369	2,532	2,786
Total	1,316	1,662	1,849	2,078	2,369	2,532	2,786
Contributions	6	6	6	6	6	6	6
Total equity and liabilities	24,557	28,821	33,356	41,356	50,548	61,672	74,291
Average gross plant/GWh (000)	2,344	2,351	2,308	2,350	2,392	2,699	2,938
Increase in gross plant (%)	18.8	8.6	10.9	19.4	10.0	36.1	6.0
Debt % of debt + equity	43.4	45.1	47.3	50.2	52.2	54.9	55.9
Current ratio	1.5	1.7	1.8	2.3	2.1	2.3	2.3

Report prepared June 14, 1977 for the period beginning October 1, 1976.

THAILAND

ELECTRICITY GENERATING AUTHORITY OF THAILAND

PATTANI HYDROELECTRIC PROJECT

Assumptions in Financial Forecasts

1. Revenues

Revenues have been forecast through FY79 without any increase in tariffs after the 28% increase from August 1, 1977. For FY80 to FY83, revenues have been increased to yield a rate of return on the revalued net fixed assets of 10% per annum.

2. Fuel

Fuel oil has been forecast at ฿ 1.66 per liter (US¢8.1) the July 1977 price.

3. Operating Surpluses

Operating expenses have been based on FY76 costs; for increases in plant capacity at the cost per MW of installed capacity; for increases in transmission lines at the cost per km for operating and maintenance. Escalation has been assumed at 6% per year.

4. Depreciation

Depreciation is based on the straight-line method at the following rates:

	%
Steam Plants	4.0
Diesel Generating Units	7.5
Hydro Plants:	
Dams, etc.	1.3
Electrical and Mechanical	4.0
Transmission Towers	2.5
Poles and Fixtures	4.0 - 20.0
Structures	4.0

5. Taxation

It has been assumed that EGAT will pay all import duties but will be exempt from income corporate taxes or any payments in lieu.

6. Borrowings

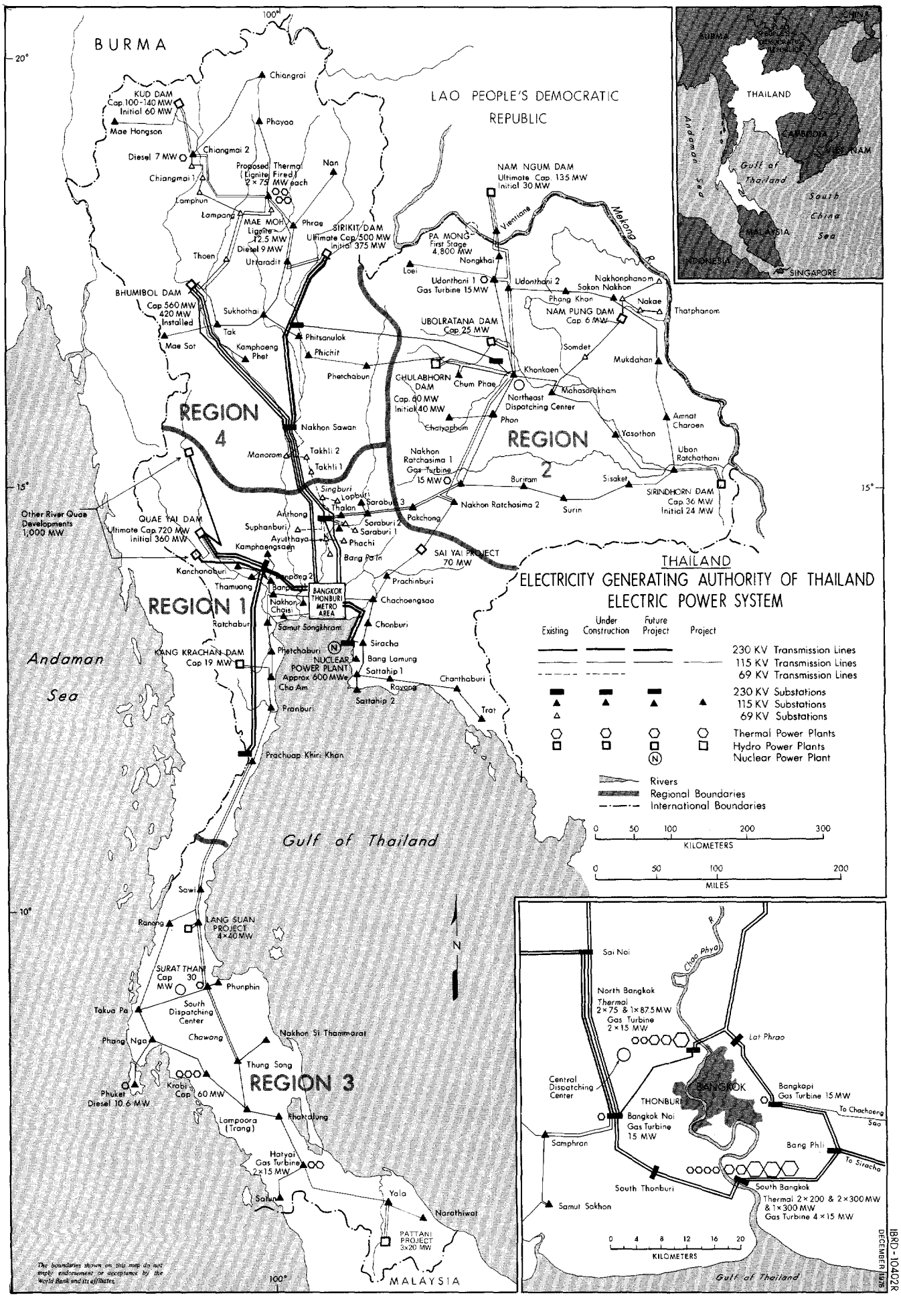
Foreign borrowings FY77-83 amounting to ฿ 27,912 million (US$1,361 million) have been partially arranged (฿ 8,625 million - US$421 million) or are assumed to come from IBRD, ADB or OECF at interest rates of 8.7%, 8.9%, or 4.5%, respectively, for terms of 20-25 years including 4-5 years grace. Local borrowings of ฿ 9,286 million (US$453 million) are assumed to come from Government for terms of 10 years including 5 years grace at interest rates of 10%.

7. Contributions from Government

฿ 3,400 million (US$166 million) has been assumed to come from Government for the cost of irrigation facilities in hydroelectric projects. The amounts have been deducted from construction expenditures and exlcuded from fixed assets.

8. Construction Costs

Construction costs are based on 1977 prices escalated at 6% per year.


BURMA
LAO PEOPLE'S DEMOCRATIC REPUBLIC
THAILAND
Andaman Sea
Gulf of Thailand
South China Sea
MALAYSIA
INDONESIA
SINGAPORE
CAMBODIA
VIETNAM
REGION 1
REGION 2
REGION 3
REGION 4
KUD DAM Cap.100-140 MW Initial 60 MW
Mae Hongson
Chiangrai
Phayao
Chiangmai 2
Diesel 7 MW
Chiangmai 1
Proposed Thermal (Lignite Fired) 2×75 MW each
Nan
Lamphun
Lampang
MAE MOH Lignite 12.5 MW Diesel 9 MW
Phrae
SIRIKIT DAM Ultimate Cap.500 MW Initial 375 MW
Thoen
Uttaradit
NAM NGUM DAM Ultimate Cap 135 MW Initial 30 MW
Vientiane
Mekong R.
PA MONG First Stage 4,800 MW
Nongkhai
Loei
Udonthani 1 Gas Turbine 15 MW
Udonthani 2
Nakhonphanom
Sakon Nakhon
Phong Khon
Nakae
Thatphanom
NAM PUNG DAM Cap 6 MW
BHUMIBOL DAM Cap.560 MW 420 MW Installed
Sukhothai
Tak
Mae Sot
Kamphaeng Phet
Phitsanulok
Phichit
UBOLRATANA DAM Cap.25 MW
Somdet
Mukdahan
Phetchabun
CHULABHORN DAM Cap. 40 MW Initial 40 MW
Chum Phae
Khonkaen
Mahasarakham
Northeast Dispatching Center
Chaiyaphum
Phon
Yasothon
Amnat Charoen
Nakhon Sawan
Manorom
Takhli 2
Takhli 1
Nakhon Ratchasima 1 Gas Turbine 15 MW
Buriram
Sisaket
Ubon Ratchathani
SIRINDHORN DAM Cap.36 MW Initial 24 MW
Singburi
Lopburi
Thalan
Saraburi 3
Nakhon Ratchasima 2
Surin
Other River Quae Developments 1,000 MW
QUAE YAI DAM Ultimate Cap.720 MW Initial 360 MW
Suphanburi
Anthong
Saraburi 2
Saraburi 1
Pakchong
Ayutthaya
Phachi
Kamphaengsaen
Bang Pa In
SAI YAI PROJECT 70 MW
Kanchanaburi
Thamuang
Bangpong 2
Bangpong 1
BANGKOK THONBURI METRO AREA
Nakhon Chaisi
Prachinburi
Chachoengsao
Ratchaburi
Samut Songkhram
Chonburi
Phetchaburi
Siracha
KANG KRACHAN DAM Cap 19 MW
NUCLEAR POWER PLANT Approx 600 MWe
Bang Lamung
Sattahip 1
Cha Am
Rayong
Chanthaburi
Sattahip 2
Trat
Pranburi
Prachuap Khiri Khan
Sawi
Ranong
LANG SUAN PROJECT 4×40 MW
SURAT THANI Cap 30 MW
Phunphin
Takua Pa
South Dispatching Center
Chawang
Nakhon Si Thammarat
Phang Nga
Thung Song
Phuket Diesel 10.6 MW
Krabi Cap. 60 MW
Khantalung
Lampoora (Trang)
Hatyai Gas Turbine 2×15 MW
Yala
Satun
Narathiwat
PATTANI PROJECT 3×20 MW
THAILAND
ELECTRICITY GENERATING AUTHORITY OF THAILAND
ELECTRIC POWER SYSTEM
Existing
Under Construction
Future Project
Project
230 KV Transmission Lines
115 KV Transmission Lines
69 KV Transmission Lines
230 KV Substations
115 KV Substations
69 KV Substations
Thermal Power Plants
Hydro Power Plants
Nuclear Power Plant
Rivers
Regional Boundaries
International Boundaries
0 50 100 200 300
KILOMETERS
0 50 100 200
MILES
N
Sai Noi
Chao Phya R.
North Bangkok Thermal 2×75 & 1×87.5 MW Gas Turbine 2×15 MW
Lat Phrao
Central Dispatching Center
BANGKOK
THONBURI
Bangkapi Gas Turbine 15 MW
To Chachoengsao
Bangkok Noi Gas Turbine 15 MW
Samphran
Bang Phli
To Siracha
South Thonburi
South Bangkok Thermal 2×200 & 2×300 MW & 1×300 MW Gas Turbine 4×15 MW
Samut Sakhon
0 4 8 12 16 20
KILOMETERS
Gulf of Thailand
The boundaries shown on this map do not imply endorsement or acceptance by the World Bank and its affiliates.
IBRD-10402R
DECEMBER 1978