KINGDOM OF THAILAND

FEASIBILITY STUDY
ON
NAM YUAM RIVER BASIN INTEGRATED HYDROELECTRIC DEVELOPMENT PROJECT

DECEMBER, 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Japanese Government decided to conduct a Study on Nam Yuam River Basin Integrated Hydroelectric Development Project and entrusted the Study to Japan International Cooperation Agency (JICA).

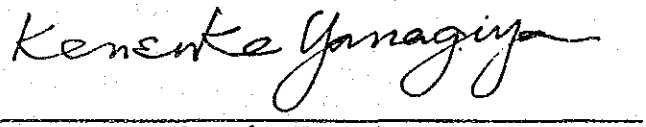
JICA sent to the Kingdom of Thailand a Study team headed by Mr. Tetsuo Nishigori of the Electric Power Development Co., Ltd., from February 1988 to October 1989.

The team exchanged views with the officials concerned of the Government of the Kingdom of Thailand and conducted a field Study. After the team returned to Japan, further studies were made and the present report was prepared.

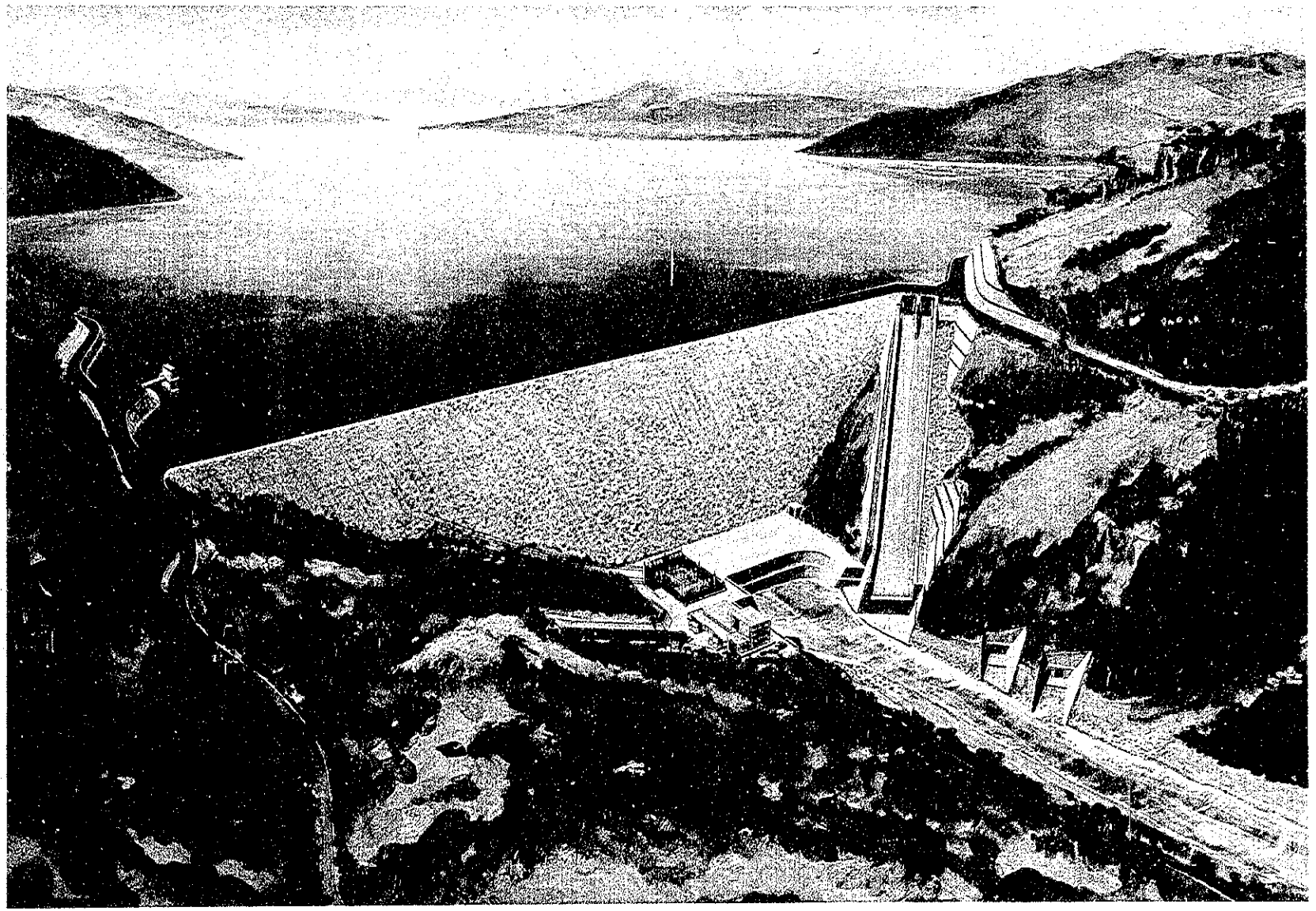
I hope that this report will contribute to the development of the Project and to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation extended to the team.

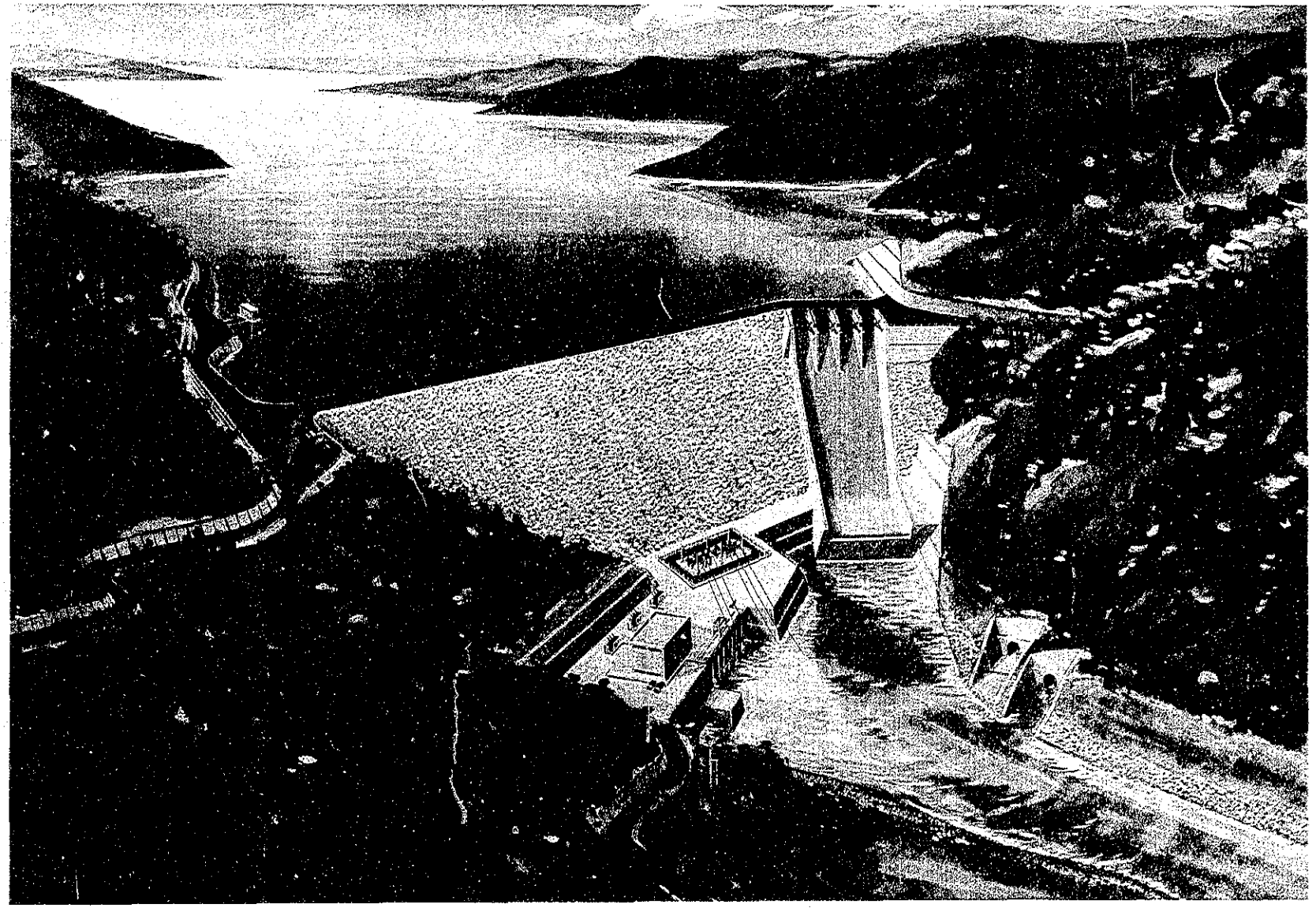
December, 1989



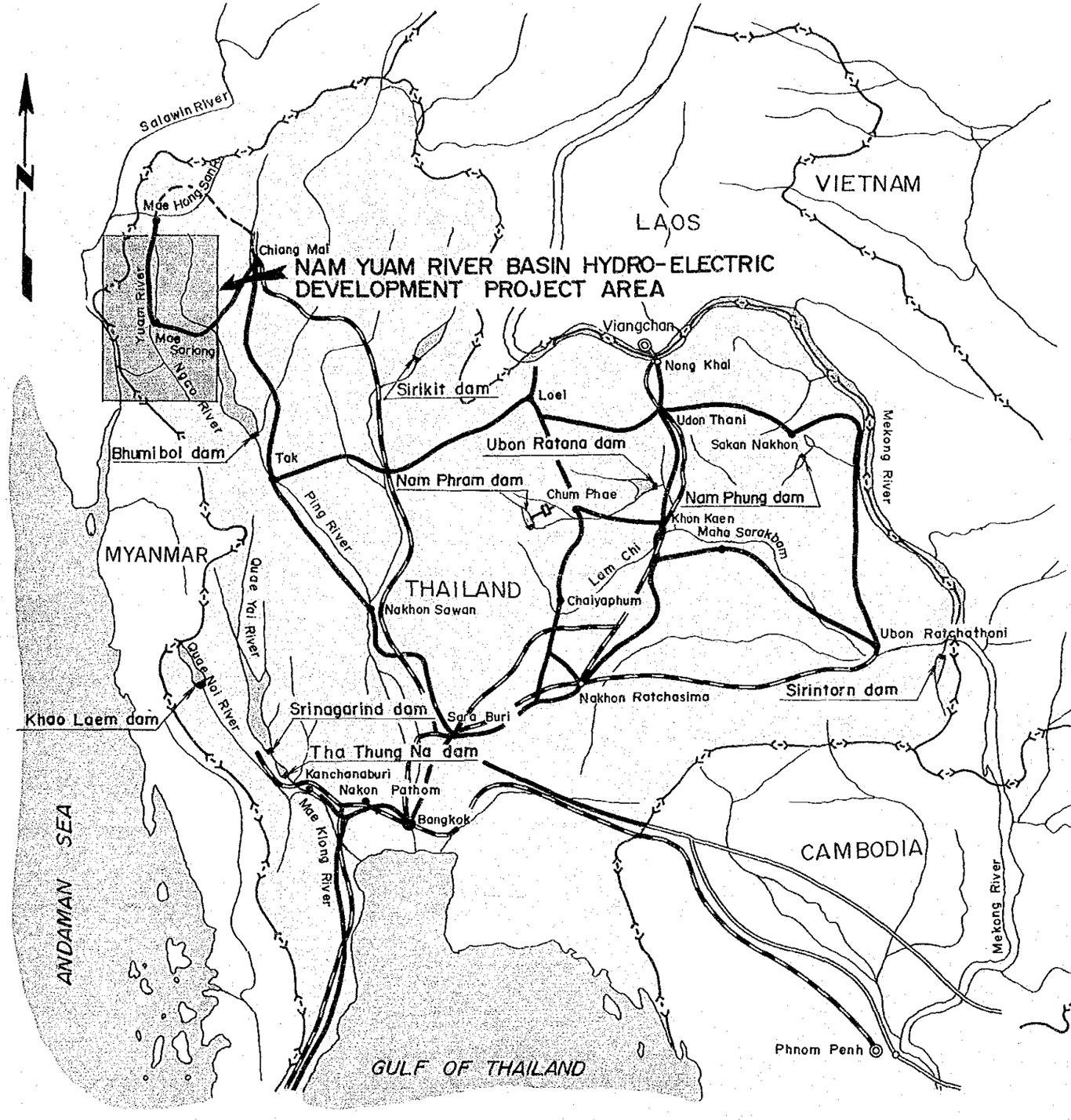
Kensuke Yanagiya
President
Japan International Cooperation Agency

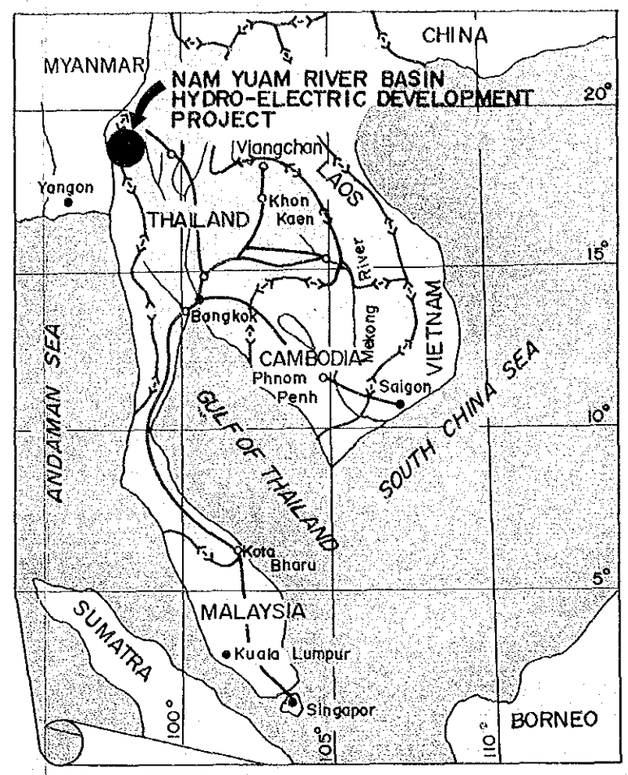


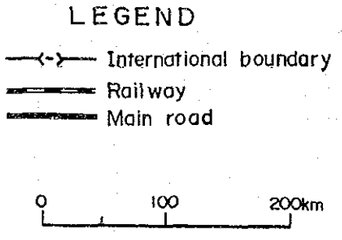
NAM NGAO PROJECT



MAE LAMA LUANG PROJECT

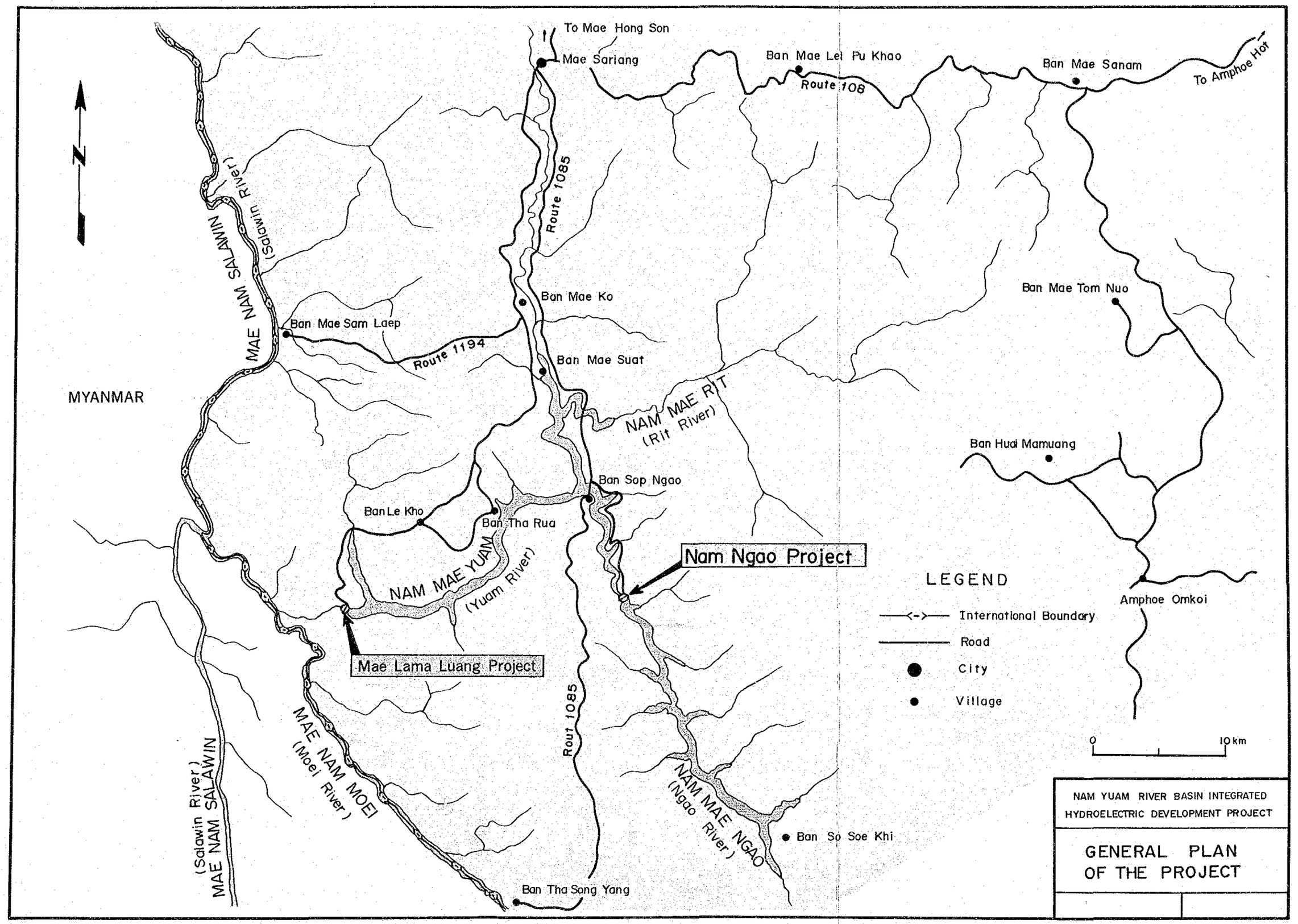






NAM YUAM RIVER BASIN INTEGRATED HYDROELECTRIC DEVELOPMENT PROJECT

KEY AND LOCATION MAP


To Mae Hong Son
Mae Sariang
Ban Mae Lei Pu Khao
Route 108
Ban Mae Sanam
To Amphoe Hot
N
MAE NAM SALAWIN (Salawin River)
Route 1085
Ban Mae Ko
Ban Mae Sam Laep
Route 1194
Ban Mae Suat
Ban Mae Tom Nuo
MYANMAR
NAM MAE RIT (Rit River)
Ban Huai Mamuang
Ban Sop Ngao
Ban Le Kho
Ban Tha Rua
Nam Ngao Project
NAM MAE YUAM (Yuam River)
LEGEND
International Boundary
Road
City
Village
Amphoe Omkoi
Mae Lama Luang Project
Rout 1085
MAE NAM MOEI (Moei River)
(Salawin River) MAE NAM SALAWIN
NAM MAE NGAO (Ngao River)
Ban So Soe Khi
Ban Tha Song Yang
0
10 km
NAM YUAM RIVER BASIN INTEGRATED HYDROELECTRIC DEVELOPMENT PROJECT
GENERAL PLAN OF THE PROJECT

Nam Ngao Dam Site
View from downstream

Mae Lama Luang Dam Site
View from upstream

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UNITS AND GLOSSARIES

(1) Units

mm	:	Millimeter
cm	:	Centimeter
m	:	Meter
km	:	Kilometer
cm^2	:	Square centimeter
m^2	:	Square meter
km^2	:	Square kilometer
m^3	:	Cubic meter
MCM	:	Million cubic meter (for development planning)
kg	:	Kilogram
t	:	Metric ton
m^3/s	:	Cubic meter per second
kW	:	Kilowatt
kWh	:	Kilowatt hour
MW	:	Megawatt
GWh	:	Gigawatt hour
kV	:	Kilovolt
kVA	:	Kilovolt-Ampere
MVA	:	Megavolt-Ampere
MCM	:	Thousands of circular mils (for transmission line)
rpm	:	Revolutions per minutes
Hz	:	Hertz (cycles per second)
El.	:	Elevation
°C	:	Degree in centigrade
mb	:	Millibar
%	:	Percentage
Lu	:	Lugeon value (rate of water loss from a drillhole)
ℓ	:	Liter
1 MW	:	1,000 kW
1 GWh	:	1,000,000 kWh
1 barrel	:	159 ℓ
1 rai	:	1,600 m^2
gal	:	cm/sec^2 (acceleration of earthquake motion)
kine	:	cm/sec

(2) Glossaries

(i) Terms

NHWL	:	Normal High Water Level
LWL	:	Low Water Level
TWL	:	Tail Water Level
US$	:	U.S. dollar
฿	:	Baht
M฿	:	Million Baht
hrs	:	Hours
yr	:	Year
ea.	:	Each
Max.	:	Maximum
Min.	:	Minimum
cct	:	Circuit
a.c.	:	Alternative current
ACSR	:	Aluminum Conductor Steel Reinforced
ASTM	:	American Standard for Testing and Materials
CA	:	Catchment Area
FY	:	Fiscal Year
GDP	:	Gross Domestic Product
M_B	:	Body Wave Magnitude
M_S	:	Surface Wave Magnitude
IRR	:	Internal Rate of Return
EDR	:	Equalizing Discount Rate
PAX	:	Private Automatic Exchanger
PMF	:	Probable Maximum Flood
PMP	:	Probable Maximum Precipitation
UHF	:	Ultra High Frequency
VHF	:	Very High Frequency
B-C	:	Net Present Value of Surplus Benefit
B/C	:	Benefit Cost Ratio

(ii) Agencies

AIT	:	Asian Institute of Technology
EGAT	:	Electricity Generating Authority of Thailand
EPDC	:	Electric Power Development Co., Ltd.
JICA	:	Japan International Cooperation Agency
Lao PDR	:	Lao People Democratic Republic
MEA	:	Metropolitan Electricity Authority
NEA	:	National Energy Administration
NEPO	:	National Energy Policy Office
NESDB	:	National Economic and Social Development Board
NIDA	:	National Institute of Development Administration
OPEC	:	Organization of Petroleum Exporting Countries
PEA	:	Provincial Electricity Authority
RID	:	Royal Irrigation Department
TDRI	:	Thailand Development Research Institute
IBRD	:	International Bank for Reconstruction and Development

CONCLUSION AND RECOMMENDATION

CONCLUSION AND RECOMMENDATION

The Nam Yuam River Basin Integrated Hydroelectric Development Project consists of the Nam Ngao Project and the Mae Lama Luang Project. The Nam Ngao Project is located on the Ngao River, a tributary of the Yuam River and the Mae Lama Luang Project at the downstream stretch of the Yuam River. This Feasibility Study reveals that both projects are feasible from technical, economic and environmental points of view. An outline of the conclusions and recommendations are given below.

Conclusions

(1) The electric power demand in Thailand showed an annual growth rate of 15 percent in 1988 as a result of rapid industrialization. It is predicted that hereafter, from 1989 to 2001, there will be growth at an annual rate of approximately 8 percent. Accordingly, the peak demand in 1988 of 5,444 MW would become 15,112 MW in 2001, and there will be a necessity for new facilities of approximately 800 MW, every year.

(2) At present, practically no power source exists to meet the peak demand of the northern part of Thailand. In order to supply reliable electric power in the future corresponding to industrialization of northern Thailand, it is necessary to develop hydroelectric power stations capable of coping with the load in this area (Region 4). The Nam Ngao and Mae Lama Luang projects are extremely promising as a part of the power sources needed to cope with the abovementioned increase in demand and as power sources to supply the peak load of northern Thailand.

Furthermore, the electric power demand and supply situation of Mae Sariang district, which is a major town close to the projects' area and isolated from EGAT transmission network, can be improved because the area will be connected to the EGAT transmission network by this Integrated Development Project.

(3) From the point of view of developing and utilizing the Yuam River Basin in the most effective manner, it will be advantageous to deve-

lop the power stations in an integrated form rather than to develop them individually (Nam Ngao Project: 140 MW; Mae Lama Luang Project: 160 MW; total: 300 MW). In this case, the optimum development scale is 140 MW for the Nam Ngao Project and 240 MW for the Mae Lama Luang Project, a total of 380 MW. The annual energy productions from these projects are 318 GWh and 617 GWh, respectively, for a total of 935 GWh.

(4) It is desirable to commence operation of the two projects at the earliest, and it was considered that this is in the year 1997.

Further, in the case that the simultaneous development is not possible, the Mae Lama Luang project should be implemented first. The reason is that "when the cost of the transmission line of a length of approximately 200 km, and the economics of the projects are considered, the Mae Lama Luang Project is far superior to the Nam Ngao Project." In other words, even if development of the Nam Ngao Project were to be greatly delayed because of a sudden change in the energy situation, it would not affect the economics of the Mae Lama Luang Project which is to be started first.

(5) The project costs of the two schemes including import duty, interest during construction and escalation up to 1997 would be 6,470 million Baht (US$249 million) for the Nam Ngao Project, 8,350 million Baht (US$321 million) for the Mae Lama Luang Project, a total of 14,820 million Baht (US$570 million). The project cost of the Nam Ngao project includes the transmission line cost between the power station and the Mae Sariang substation, and the cost of the Mae Lama Luang project includes the transmission line cost between the power station and the Chiang Mai 3 substation.

(6) The net present value (discount rate 12 percent) of surplus benefit (B - C), benefit-cost ratio (B/C), and equalizing discount rate (EDR) of the integrated development project obtained from economic comparison of the hydroelectric power stations and an alternative thermal plant are: 950 million Baht, 1.13 and 14.02 percent, respectively. These values indicate that the integrated development of the projects is economically feasible.

The results of the evaluation of FIRR and the debt service ratio in the financial analysis are 13.39 percent and 2.43, respectively.

It can be concluded that the Project is financially sound.

(7) Giving consideration to factors such as geology, topography, construction materials, earthquakes, etc., a fill type dam is selected for both the Nam Ngao and Mae Lama Luang dams. The geology of the both dam sites consists of sedimentary rock of Mesozoic to Paleozoic era. The geology of the dam sites is sound with ample bearing strength and with low permeability, therefore no problems should be encountered. Foundation rock having high permeability were found in parts of the sites. However, they can be improved by appropriate foundation treatment. As mentioned above, there are no technical problems which would influence the realization of the projects. In conclusion, both of the projects are technically feasible.

(8) There are many villages located at the uppermost reaches of the Mae Lama Luang reservoir, and a high water level of 165 m was selected giving consideration to hold to a minimum the number of houses to be submerged. Further, by restricting the water level of the reservoir during the flood season to 163 m, this would mitigate flood damages to upstream villages.

(9) Potential resettlement areas identified on the left bank of the Yuam river within Sub-district Sop Moei assuming a possibility that all the households of approximately 500 in the three villages to be affected by the reservoir would remove into resettlement areas.

(10) The projects are located within national reserve forests. The tropical forest is of tropical rainforest, mix-deciduous forest, and dipterocarp forest depending on the rainfall distribution in the project basin. Wild animals, reptiles, birds and fishes can be seen in the basin. Environmental mitigation cost is included in the project cost so as to reduce the environmental impact as little as possible.

As aforementioned in (8), (9) and (10), the projects are preliminarily feasible from an environmental point of view.

Recommendations

(1) The Nam Ngao Project and the Mae Lama Luang Project in the Nam Yuam river basin should be developed as an integrated development project to achieve the most effective utilization of the river.

(2) It is necessary for both the Nam Ngao Project and the Mae Lama Luang Project to be advanced to the stage of definite study in order that the projects are implemented according to the commercial operation schedule in the year 1997.

(3) Before starting the definite study, the following additional investigations are recommended:

- For the definite study and to confirm the watertightness of the dam sites, detailed field investigation of the ridges of both banks and foundation of the Nam Ngao dam site, and of the right bank of the Mae Lama Luang dam site should be performed.

- Investigation of available construction materials and blending test of the core material should be performed. The blending test has the purpose of economically improving the quality of the impervious material.

- Detailed investigation on the Moei-Uthai Thani fault near the project area should be conducted in the field, and the earthquakes should be recorded at the dam site and the surrounding area.

- On the assumption that the project construction work will be awarded on an international tender, a concrete facing rockfill dam is selected for the Nam Ngao dam from an economic viewpoint. Final decision, however, should be made taking into account the construction capability of local contractors and the policy of Thai Government.

- Detailed further environmental investigation on water quality, merchantable wood, fish cultivation, tourism resources and potential resettlement areas should be performed.

General Project Description of Nam Yuam River Basin
Integrated Hydroelectric Development Project

Project Name		NAM NGAO	MAE LAMA LUANG
1. LOCATION		Ngao River Tributary of Yuam River District, King Amphoe Sop Moei province: Mae Hong Son	Yuam River District, King Amphoe Sop Moei Province: Mae Hong Son
2. PURPOSE		Power Generation	Power Generation
3. HYDROLOGY			
Catchment Area	km^2	835	6,030
Period of Runoff Analysis	yrs.	28	28
Average Annual Inflow	MCM	1,366	2,948
Flood			
- Maximum Record	m^3/sec	770 (estimated)	1,180
- Probable Maximum Flood	m^3/sec	2,100	5,200
4. RESERVOIR			
Normal High Water Level (NHWL)	m	270.0	165.0
High Water Level During Flood Season* (HWL)	m	-	163.0
Minimum Water Level	m	255.0	146.0
Total Storage Capacity	MCM	925	486
Effective Storage Capacity at NHWL	MCM	329	252
Surface Area at NHWL	km^2	24.2	19.2
5. DIVERSION TUNNEL			
Diameter	m	7.0	9.0
Length	m	No.1 702 No.2 658	No.1 818 No.2 675
Capacity	m^3/sec	940	1,780

Project Name		NAM NGAO	MAE LAMA LUANG
6. DAM			
Type		Rockfill Dam with Concrete Facing	Rockfill Dam with Vertical Clay Core
Dam Height	m	123	119
Crest Elevation	m	273.5	168.0
Crest Length	m	655	355
Dam Volume	10^3 m^3	5,380	3,820
Upstream Face Slope	-	1 : 1.4	1 : 2.0
Downstream Face Slope	-	1 : 1.4	1 : 1.8
7. SPILLWAY			
Type	-	Chute with Radial Gates	Chute with Radial Gates
Capacity	m^3/ sec	2,100	5,200
Number of Gate	set	2	4
Size of Gate	m	Width 13.5 x Height 14	Width 12 x Height 15
8. POWER INTAKE			
Type		Inclined Screen with Control and Maintenance Gates	Inclined Screen with Control and Maintenance Gates
Sill Elevation	m	234.5	120.5
Number of Gates	set	1	1
9. HEADRACE TUNNEL			
Type	-	Concrete Lined Pressure Type	Concrete Lined Pressure Type
Number	-	1	1
Inner Diameter	m	7.4	8.6
Length	m	204	142
10. PENSTOCK			
Type	-	Inclined Shaft Embedded Steel	Inclined Shaft Embedded Steel
Number	-	1 - 2	1 - 3
Inner Diameter	m	7.4 - 3.9	8.6 - 4.5
Length (including bifurcation)	m	525	337
Bifurcation			
- Diameter	m	6.0 - 3.9	7.4 - 4.5
- Length	m	25	52

Project Name		NAM NGAO	MAE LAMA LUANG
11. POWERHOUSE			
Type	-	Outdoor	Outdoor
Size (Width x Length x Height)	m	36 x 58 x 35.5	39 x 83 x 38
Tailrace Gate			
- Type	-	Roller Gate	Roller Gate
- Number	set	2	2
12. TURBINES			
Type		Vertical Shaft Francis	Vertical Shaft Francis
Number of Units		2	3
Max. Gross Head	m	107.1	98.0
Rated Intake Water Level	m	264.0	157.0
Rated Tail Water Level	m	162.9	67.0
Gross Head	m	101.1	90.0
Normal Effective Head	m	96.1	85.0
Max. Power Discharge	m^3/sec	85.0	110
Rated Output	MW	72	83
Revolving Speed	rpm	231	200
13. GENERATOR			
Type		3-phase AC Synchronous	3-phase AC Synchronous
Number of Units		2	3
Rated Output	MVA	78	90
Voltage	kV	13.8	13.8
Power Factor	-	0.9 (Lag)	0.9 (Lag)
Frequency	Hz	50	50
Revolving Speed	rpm	231	200
14. MAIN TRANSFORMER			
Number of Units	unit	2	3
Type	-	3-phase Outdoor Type	3-phase Outdoor Type
Capacity	MVA	78	90
Voltage	kV	115/13.8	230/13.8

Project Name		NAM NGAO	MAE LAMA LUANG
15. SWITCHYARD			
Type		Conventional Type	SF_6 Gas Insulated Switchgear Type
Nominal Voltage	kV	115	230
Number of Circuits	cct	2	2
16. TRANSMISSION LINE			
Location		To Mae Sariang Substation	To Chiang Mai 3 Substation through Mae Sariang Substation
Nominal Voltage	kV	115	230
Number of Circuits	-	2	2
17. Mae Sariang Sub-station			
Location		Mae Sariang	
Type		Conventional Type	
Number of Circuits	cct	230 kV x 4 cct (to Mae Lama Luang P/S: 2 cct to Chiang Mai 3 S/S: 2 cct)	
		115 kV x 2 cct (to Nam Ngao P/S)	
Nominal Voltage	kV	230, 115	
18. POWER GENERATION			
Installed Capacity	MW	140	240 380
Annual Energy Production	GWh	301 (318) 1) 2)	583 (617) 1) 2) 884 (935) 1) 2)
Annual Capacity Factor	%	25.9	29.4

Project Name		NAM NGAO	MAE LAMA LUANG
19. PROJECT COST 3)	M฿	6,470 (249)	8,350 (321)
	(MUS$)	14,820 (570)	
20. ECONOMIC COST	M฿	4,028 (155)	5,103 (196)
	(MUS$)	9,131 (351)	
21. ECONOMICS			
B - C	M฿	950	
B/C	-	1.13	
EDR	%	14.02	
FIRR	%	13.39	
22. CONSTRUCTION PERIOD	yrs.	5	5
23. COMMISSIONING		1997	1997

Note: 1) at the entrance of Chiang Mai 3 substation
2) at the generating end
3) including price contingency (escalation) and interest during construction

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

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CHAPTER 1 INTRODUCTION

1.1 Background of Project

Thailand's economic growth rate in 1988 was marked at 11%, being prominent among Asian developing nations. Particularly, the growth of its industrial sector was significant.

The installed capacity of electric power generating facilities in Thailand was 7,771 MW in 1988. Composition of power sources consisted of 2,256 MW in hydro plants (29.0%) and 5,515 MW in thermal plants (71.0%).

The rates of average annual increase of EGAT's power and energy generation for the five years from 1984 to 1988 were 11.1% and 10.9% respectively. The rates increased in 1988 by 15.0% and 13.5% respectively. The rates of increase of future demand will decrease gradually to be 9.9% and 10.5% in 1992, and 6.8% and 7.2% in 1997. After 1992, the annual increase of demand is considered to be about 800 MW and about 5,200 GWh respectively. Therefore, new power plants having a capacity of 800 MW should be implemented every year.

The Thai Government has a policy of utilizing indigeneous energy sources such as natural gas, lignite, hydropower etc., while suppressing the increase of oil importation as much as possible.

In the view of the policy situation mentioned above, hydroelectric power resources development in Thailand has been carried out through large-scale projects such as the Bhumibol Dam (535 MW) on the Ping river, the Sirikit Dam (375 MW) on the Nam river, the Srinagarind Dam (540 MW) on the Quae Yai river, the Khao Laem Dam (300 MW) on the Quae Noi river and the Rajjaprabha Dam (240 MW) on the Khlong Saeng river. As a result of these developments, it may be that the remaining possible large-scale hydroelectric power resources are limited mainly to international rivers such as the Mekong river and the Salawin river, existing along the borders. However, the Mekong river projects include internationally-complicated factors, so that it is very hard to imagine that the development will be realized in the near future.

Under such circumstances, keen attention has been focussed recently on the Yuam river basin, a tributary of the Salawin river, and studies for its development have been carried out in recent years.

The Mae Lama Luang project was studied on the feasibility study level in 1984. Later, in 1987, a prospective project called Nam Ngao project located upstream of the Mae Lama Luang project was revealed in the "Master Plan Study of Nam Yuam River Basin". Since these two projects profoundly affect each other and the Yuam river can be utilized more effectively by integrated development than by individual development, a feasibility study on the integrated development of the Nam Ngao and Mae Lama Luang projects was requested to the Japanese Government by the Thai Government in 1987.

1.2 Objective and Scope of the Study

1.2.1 Objective of the Study

The main objective of the study is to formulate the optimum development scheme for the integrated hydroelectric projects between the Mae Lama Luang and the Nam Ngao sites. Thus, it is necessary to assess technical, environmental, financial and economic aspects of the projects, and to determine the sequence of development for both projects. In addition, technology transfer to Thai counterparts is carried out during the study.

1.2.2 Scope of the Study

The study covers the formulation of individual development and integrated development plans for the Nam Ngao project and the Mae Lama Luang project at the feasibility study level. However other projects studied in the Master Plan, except the Mae Lama Luang and the Nam Ngao projects, are not included in the study.

1.2.3 Contents of the Study

The study is carried out in two stages, the Investigation Stage and the Feasibility Design Stage. The stages correspond to the progress of the investigation. The contents of each stage are as follows.

Investigation Stage:

° Collection and review of all relevant existing data, reports and information on the project.

° Formation of alternative development schemes based on the existing data.

Feasibility Design Stage:

° Finalization of the project based on the results of the study in the Investigation Stage and up-to-date information, including environmental data. Confirmation of the project's viability from engineering, economic and environmental points of view.

1.3 Existing Reports

The following studies have been conducted up to the present and the reports below are available.

(Report 1)

Feasibility Study on Nam Mae Yuam Hydro-electric Power Development Project (March 1984, JICA)

(Report 2)

Master Plan Study on Nam Yuam River Hydro-electric Development Project (March 1987, JICA)

(Report 3)

Nam Yuam Basin Integrated Hydroelectric Project, Work Progress Summary (November 1987, EGAT)

1.4 Activities of the Team in Thailand and Participants Concerned

1.4.1 Activities of the Team in Thailand

Several activities were carried out in Thailand by the JICA Team during the study period from February 1988 to December 1989 as follows;

(1) First Investigation Work

Period: February 29 - March 29, 1988

(2) First Discussion on Progress of the Project

Period: August 16 - 25, 1988

(3) Second Investigation Work

Period: November 10 - December 20, 1988

(4) Third Investigation Work

Period: February 15 - March 7, 1989

(5) Second Discussion on Progress of the Project

Period: June 21 - 29, 1989

(6) Forth Investigation Works

Period: August 2 - 16, 1989

(7) Discussion on Draft Final Report

Period: October 17 - 31, 1989

1.4.2 List of Participants

The following participants were involved in the feasibility study.

EGAT

Name	Position
Mr. Sommart Boonpiraks	Assistant General Manager-Hydro Power Development
Mr. Taweesak Mahasandana	Director, Hydro Power Engineering Department
Mr. Wuthi Poonudom	Director, Survey and Ecology Department
Mr. Chalermchai Ratnarak	Assistant Director, Hydro Power Engineering Department-Technical
Mr. Prasit Srisaichua	Chief, Water Resources Planning and Development Division
Mr. Kitti Naparaxawong	Chief, Meteorology and Hydrology Division
Mr. Chamnan Thanakorn	Chief, Survey Division
Mr. Somkid Vuthicholthee	Assistant Chief, Water Resources Planning and Development Division
Mr. Manop Mamowat	Assistant Chief, Survey Division
Mrs. Suphawan Klaipongpan	Assistant Chief, Geology and Soil Engineering Division
Mr. Plew Chittrakarn	Head, Geology Section
Mr. Niwat Patanasemakul	Engineer Level IX
Mr. Opas Kietsirikul	Head, Photogrametry Section
Mr. Songpan Panvanich	Head, Nam Yuam Development Project Section
Mr. Peerawat Pumthong	Assistant Head, Water Resources Development Section
Mr. Punpong Vivatlananon	Geologist
Mr. Nipon Pienpucta	Head, Powerhouse and Structure Section
Mr. Chutha Promchinavongs	Engineer
Mrs. Siriluck Srivichit	Scientist
Dr. Virawan Sombutsiri	Assistant Head, Environmental Evaluation Section
Mr. Prakob Dhienhirunya	Chief, Power System Planning Division

Mr. Thawat Pinta	Assistant Head, Transmission System Planning Section
Mr. Payak Ratnarathorn	Chief (Former), Water Resources Planning and Development Division
Mr. Ryuichi Abe	Expert of Colombo Plan
Mr. Kenji Yokokawa	Expert of Colombo Plan

JICA

Name	Position
Mr. Tetsuo Nishigori	Team Leader
Mr. Junichi Tani	Civil Engineer
Mr. Yoshio Kishida	Civil Engineer
Mr. Senzo Hakoshima	Civil Engineer
Mr. Takashi Mimura	Civil Engineer
Mr. Takayuki Niimura	Civil Engineer
Mr. Hirotoshi Sano	Hydrologist
Mr. Yozo Fukutake	Geologist
Mr. Kazuhisa Takeda	Geologist
Mr. Kaname Sofue	Geologist
Mr. Tadashi Takayanagi	Electrical Engineer
Mr. Yosuke Suzuki	Electrical Engineer
Mr. Akiyoshi Noda	Environment Engineer
Mr. Kei Kitamura	Environment Engineer
Mr. Masahide Takaraya	Economist

CHAPTER 2

GENERAL SITUATION OF THE KINGDOM OF THAILAND

CHAPTER 2 GENERAL SITUATION OF THE KINGDOM OF THAILAND

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CHAPTER 2 GENERAL SITUATION OF THE KINGDOM OF THAILAND

2.1 General

(1) Location and Area

Thailand is situated in between lat. 5° 36' N and 20° 24'N, and in between long. 97° 14' E and 105° 41' E. It is bounded by Lao PDR in the north and the east, by the Cambodia in the east, by the Federation in Malaysia in the south and by the Union of Myanmar in the west.

International rivers forming the boundaries with the neighboring countries are the Mekong river for Laos, the Salawin river and the Moei river for Myanmar as shown in Fig. 2-1.

The total area of the country is 513,115 km^2. The area of the farmland is 199,088 km^2 and accounts for about 40% of the total area. Main rivers and mountain ranges are shown in Fig. 2-1.

(2) Climate

A climate of Thailand is divided into three seasons: a rainy season, cool season and hot season.

The rainy season starts from around the middle of May when the south-west monsoon starts to blow, and ends around the middle of October in the northern region and in November in the southern region. In the rainy season, there is a shower lasting for one to two hours almost virtually every day. Especially it rains heavily in September.

The season from the middle of November to February is called cold season which is affected by the north-east monsoon blowing in whole of the Thailand. Due to the monsoon the temperature in Bangkok falls to 15°C at night.

The season covering the three months from March to May is called the hot season while it is the hottest time of the year. As the north-east monsoon weakens in this season and the sun moves from

the equator to above Thailand, the temperature rises, becoming especially very high in April. It reaches almost 40°C in April in Bangkok.

Annual rainfall is around 1,300 mm in Bangkok, 1,200 mm in Chiang Mai of the northern part, 1,100 mm in Khon Kaen of the northeastern part and 2,000 mm in Hat Yai of the southern part of Thailand.

(3) Population

The population of Thailand as of December 31, 1987 is 53,873,172 and has increased by 900,000 persons or 1.7% compared with the end of 1986. The population of the Bangkok metropolitan area is 5,609,352 and has increased by 140,000 persons or 2.57%. The population of the Bangkok area accounts for 10.4% of the total population. The relative density of population is 105 and 3,584 persons/km^2 for the whole of Thailand and Bangkok, respectively.

(4) Government System

Constitutional monarchy has been established in Thailand in 1932. The present constitution was promulgated in December 1978 and its major points are as follows:

° Thailand is a Kingdom having a king as a sovereign.

° Sovereignty rests with the people.

° Freedom of religion, speech, publication, association, formation of political parties and correspondence.

° Support of the democratic form of government and obligation of military service based on the nation, religion, king and constitution.

° Parliament with a two-chamber system (members of the Upper House: appointed, the Lower House: publicy-elected).

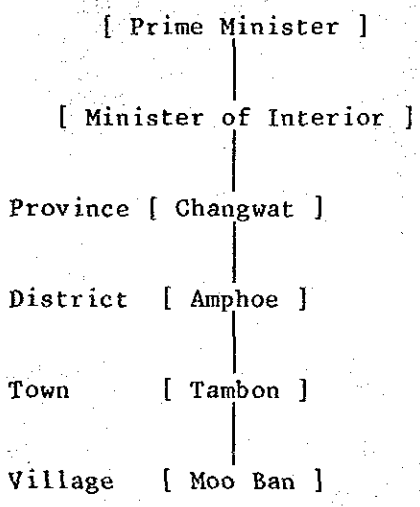
° Promotion of party politics (members of the Lower House must belong to parties).

° Cabinet consisting of a prime minister and ministers of state.

The organization of the government consists of one Prime Minister's office and thirteen Ministries. The organization chart is shown in Fig. 2-2.

The organization of the local government as seen in the figure below mainly consists of "Province (Changwat)", "District (Amphoe)", "Town (Tambon)" and "Village (Mo Ban)". These are under the supervision of the central government. Governors of the provinces are appointed by the Minister of Interior. However, the governor of the Bangkok metropolitan area has been publicy-elected since 1985.

Organization Chart of Local Government



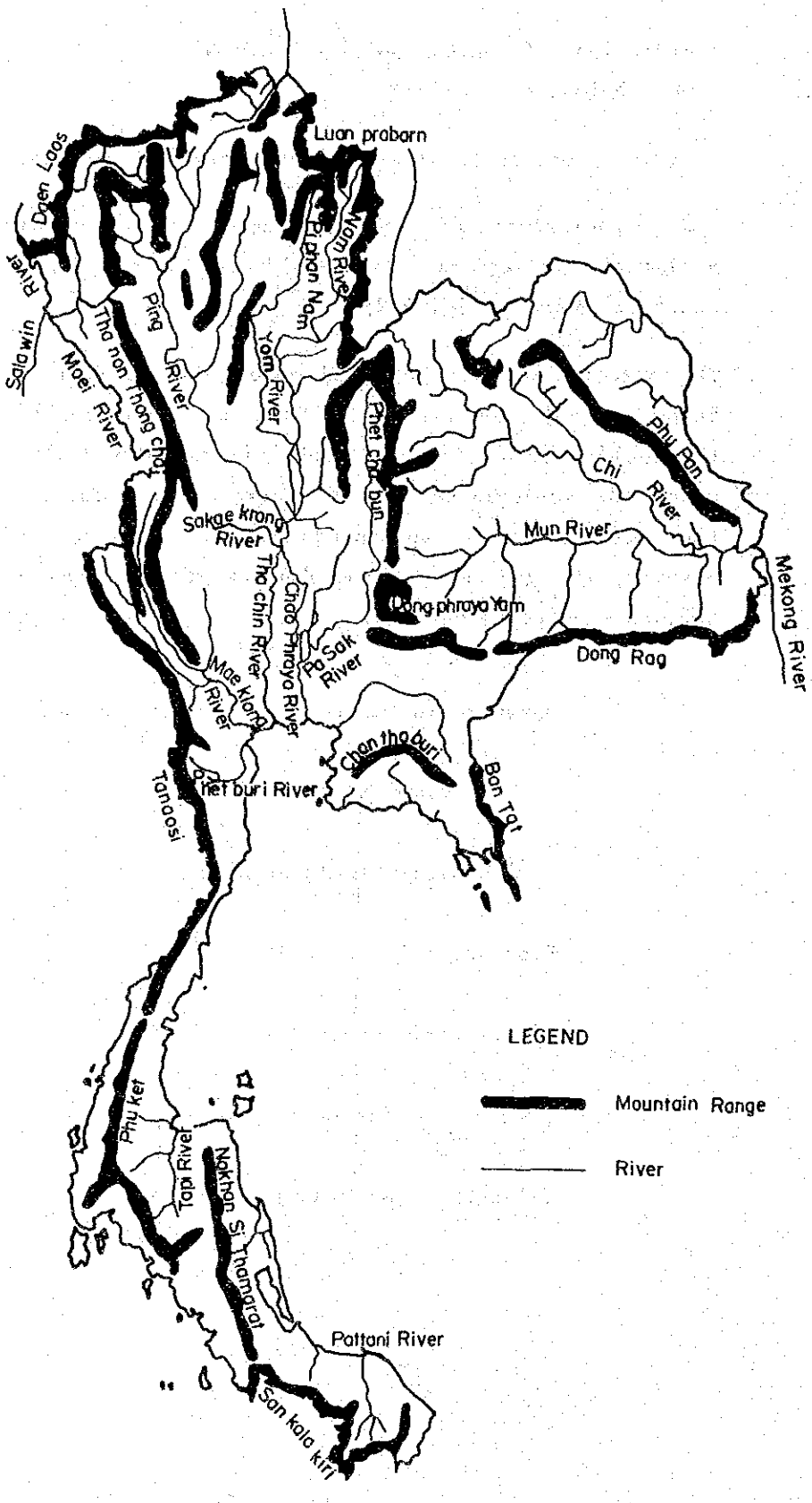
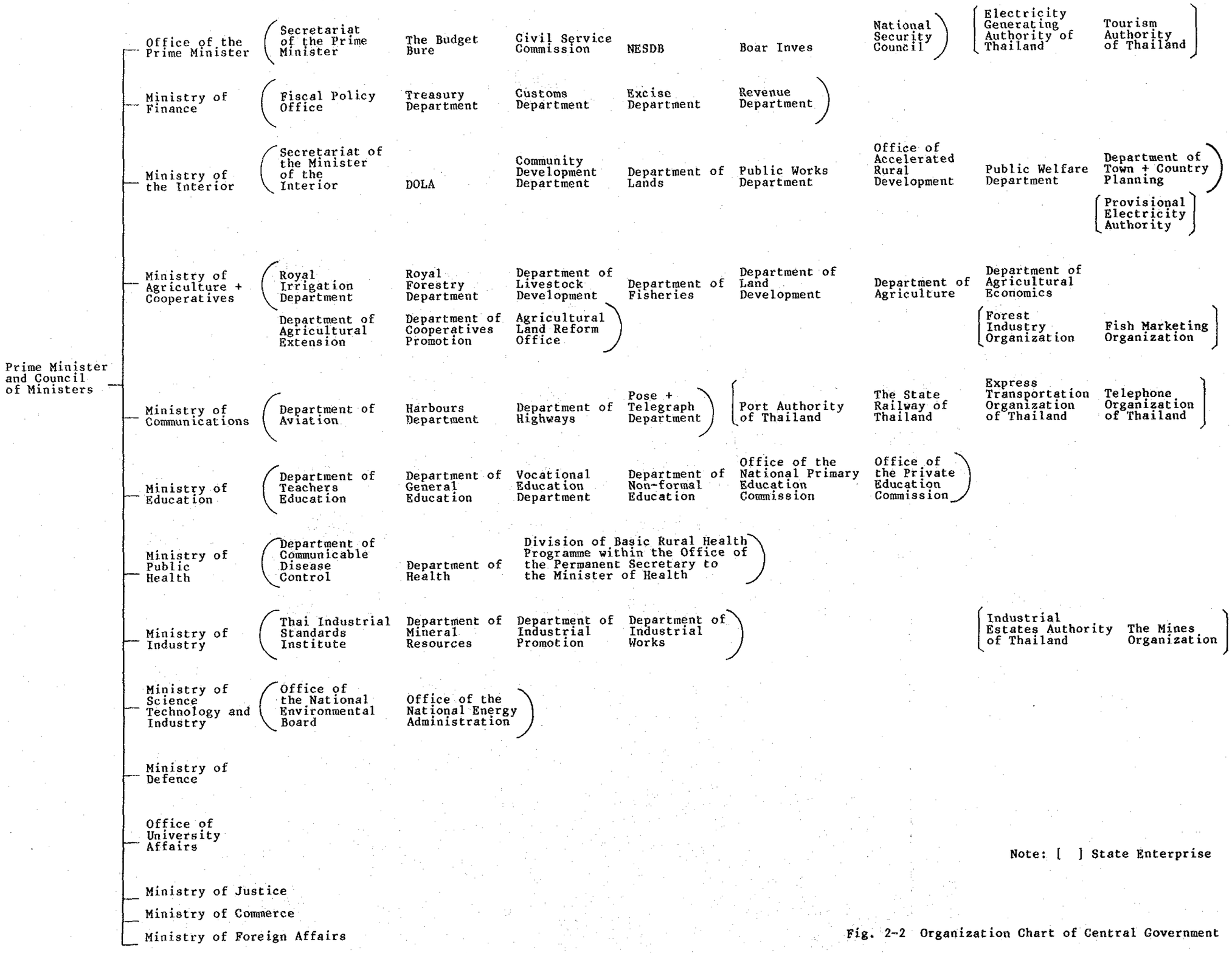


Fig. 2 - 1 MAIN RIVERS AND MOUNTAIN RANGES



Note: [ ] State Enterprise

Fig. 2-2 Organization Chart of Central Government

2.2 Economics

2.2.1 Outline of Economics

(1) With plenty of arable land, natural resources and a large labor force, the economy of Thailand in the years following World War II developed steadily achieving a high economic growth rate while diversifying its industrial structure. Till the mid-1950s, its per-capita GDP was only $80, a figure dwarfed by the $900 or so of today's GDP per capita. Though the income level is still low and the regional variation of income not small, the fact is that Thai economy tided over the oil crisis and other jolts and unwaveringly grew. It is now touted as the most likely country to be a new member of NIES (Newly Industrializing Economies), the group of countries in Asia whose economic status has markedly risen in the recent years.

(2) Factors contributing to this success of the Thai economy may be found in its flexibly constituted economic structure, capable of readily adjusting itself to changes, and in the economic policy sustained by the government. The basis of Thai economy is agriculture and this fact cannot be ignored in assessing the economic aspect of Thailand today and in weighing the role Thai agriculture has played and is playing. About 70% of the people, who derives their livelihood from agriculture, still account for a sizable portion of the national output and exports, though their productivity can hardly be said to be high by world standards. Diversification has been taking place to increasingly eclipse the mainstream produce, rice, by such products as maize, cassava, sugar cane, etc., thus paving the way for growth of agro-industry, nurtured by the rich variety of agricultural produce that Thailand is capable of turning out.

The share of agriculture in Thailand's national economy, however, has been shrinking, in relative terms, as manufacturing industry kept steadily expanding to increase its share. In 1987, primary industry accounted for 19% of GDP and manufacturing and construction industries combined accounted for 29%.

In the export area, apparel became the top export item by surpassing rice, and jewelry, gems and personal ornaments took higher places in the list of Thai exports.

Processing and machining services rendered to foreign manufacturers is contributing measurably to Thai export performance. Besides all these, businessmen from Japan, Taiwan and other countries are finding a promising place of business in Thailand. Their high-valued currencies, notably the Japanese Yen, are giving impetus to the inflow of capital in the form of foreign manufacturers setting up plants and shops in Thailand. This trend, often appearing like an inrush of industrial funds, is likely to fuel the industrialization of Thailand for many years to come and to induce a change, if not a radical change, in the economic outlook of Thailand.

(3) The economic policy long pursued by the Thai government may be viewed as being characterized by enlightened conservatism founded on free enterprise but preferring balanced expansion to high-pitched economic growth. During the period from the first economic development plan (1961-1966) to the current 6th, the government restricted its economic role to that of developing the social capital; namely, the transportation network, public utilities, housing, etc. It took a cautious stance on the launching of largescale development projects while aiming at fiscal balance and refraining from rash overseas borrowing. Unlike many developing countries, Thailand did not hasten to expand its heavy and chemical industries. Rather, it courted a slow industrialization centered on light industries taking into account the limited levels of technological skill and available funds at home. This traditional policy is still alive, keeping Thailand moving in the direction of industrialization locked into agriculture as one of the NAIC (New Agro-Industrial Countries) and preventing itself from following the footsteps of some countries who ventured on the course of export-oriented high-tech industrialization. Today, Thai economic policy seems to address the problems of how to narrow the development gap existing among regions and to minimize the dif-

ferences in personal income while maintaining the free play given to the nation's economic engines.

(4) The economic performance of Thailand in the recent years has been on an upward swing, with a 3.5% growth rate for 1985 and 4.7% for 1986 in terms of real GDP (gross domestic product), thanks mainly to the expansion of exports which began in mid-1986. For 1987, real GDP grew by 7.1% and, of the 1987 GNE (Gross National Expenditure), 16.3% is accounted for by exports and 9.3% by the formation of fixed capital, both being considerably up from the preceding year. Imports expanded by a large bound, up 26.7% because of increasingly strong domestic demand. Agricultural output sank by 2.5%, however, owing to the drought but manufacturing industry registered a growth of as much as 10.3%. Tertiary industries, electric power, water supply, financial business, insurance and services, have all fared well in 1987.

Thailand's position in international trade is quite involved. By 1986, the deficit in trade balance had been on the decrease and, as a result of this, the current account for 1986 turned into the black, though this surplus was small. Since then, imports have increased because of recovery of business at home and exceeded exports to drive both trade balance and current account into the red while capital inflow kept increasing so as to hold the overall balance of payments in favor of Thailand. Therefore its foreign currency reserve has been growing steadily and, moreover, its debt service ratio, once hovering at a high level, shrank to 17.0% at the end of 1987.

Wholesale prices in Thailand were on a downward course after 1983 but tipped upward in 1987. This change of trend raised the consumer price level but only by a little. Coming into 1988, the Thai economy continued to show an expansionary trend to foretell a real growth rate of 8 to 9%. The expected increase in the trade imbalance, which would push up prices and make money supply tighter, because of circulatory factors, has not affected the basic mechanisms of Thai economy enough to signal any negative influence on its current performance, which is good, if not excellent.

Major Economic Indicators and Balance of International Payments are shown on tables below.

Major Economic Indicators

Indicator	1982	1983	1984	1985	1986	1987
Real GDP growth rate (%)	4.1	7.3	7.1	3.5	4.7	7.1
Consumer price rise (%)	5.2	3.8	0.9	2.4	1.9	2.5
Whole price rise (%)	0.9	2.0	-3.1	-0.1	-0.9	11.3
Foreign currency reserves (US$ million)	2,652	2,555	2,689	3,004	3,776	5,212
Debt service ratio (%)	16.6	19.5	19.9	21.9	20.1	17.0
Private sector (%)	7.7	9.2	9.8	10.9	9.3	7.5
Public sector (%)	8.9	10.3	10.1	11.0	10.8	9.5
Debt to foreign lenders (US$ billion)	8.3	9.5	10.8	12.8	14.1	15.1
Private sector	2.3	2.7	3.4	3.4	3.1	2.9
Public sector	6.0	6.9	7.4	9.4	11.0	12.2
Government finance:						
Revenue (Bil. Baht)	116.1	143.6	148.1	160.6	169.9	202.0
Expenditure (Bil. Baht)	157.2	166.5	181.3	200.0	204.3	212.0
Balance (Bil. Baht)	-41.0	-23.7	-34.0	-39.4	-34.4	-10.0

Source: Thai Central Bank and NESDB

Balance of International Payments

(Unit: Billion Baht)

Item of Balance	1982	1983	1984	1985	1986	1987
Exports (% change from preceding year)	157.2 (4.6)	145.1 (7.7)	173.6 (19.9)	191.7 (10.7)	231.5 (20.7)	298.2 (28.8)
Imports (% change from preceding year)	193.3 (-10.5)	234.3 (21.1)	243.2 (4.1)	253.4 (4.6)	245.9 (-3.0)	343.9 (39.9)
Balance of trade	-36.1	-89.2	-69.6	-61.7	-14.4	-44.8
Current account	23.1	-66.1	-49.2	-41.9	6.5	-15.0
Overall balance of payments	3.3	-18.1	10.6	12.5	33.6	18.2
Baht per U.S.$ (average)	22.98	22.98	23.61	27.13	26.35	25.71

Source: Thai Central Band and NESDB

Note: Re-exports and similar transactions are not included in the export and import figures.

2.2.2 Progress of Industrial Policy

The industrialization policy the government of Thailand has been pushing is built on two policy pillars. One is that which is embodied in the 1962 legislation, "Industrial Investment Promotion Law," and the other be the economic development plan which started life in 1961. It is policy relying on initiatives in the private sector; this is the basic line which has been consistently followed to date. At present, the 6th economic development plan (1987 to 1992) is in progress and this latest plan includes in its features that of welcoming direct investment from overseas enterprises. The decade of the 1980s opened its door to see the real GDP of Thailand rising rapidly at an annual average of not lower than 5% while the other countries of Asia were compelled to resort to a policy of adjustment in order to avoid increases in overseas debt at the cost of growth rate curtailment. Of the ASEAN countries, Thailand cut an enviable figure with its high growth rate, twice as high as the 2.5% growth rate of world economy during the same period.

2.2.3 Underpinnings of the Economic Growth

The Thai economy, maintaining the high rate of growth we have just noted, is steadfastly supported by eight underpinnings and each will be considered.

The first underpinning is Thai agriculture. Thailand has been one of the major exporters of primary products: rice, rubber, tin and teak have been traditional export items. To these are added the new export items which surfaced after World War II, namely; cassava, maize, sugar cane, canned fish, frozen shrimp and squid, canned fruit, frozen chicken, etc. Despite the conspicuous changes taking place in the overall export makeup, the share of these agro-aquatic products in the total export volume is at a level of over 50% and signifies the large weight of agro-aquatic industry in the national economy of Thailand.

The second is the diversification of production output. Not only agriculture has been expanding rapidly to take on a new outlook. In addition to such manufactured products as processed foods and textiles, new export products are emerging in increasing quantity from the plants set up by direct investment from overseas or by joint venture of indigenous and foreign capital. Examples of the new export products are IC parts, jewelry, plastic articles, woodwork and furniture. Countries importing these Thai products are diversified; 60% of the total export volume go to OECD countries and the remaining 40% to developing countries.

The third is the government self-restraint on public spending and monetary policy, which improved Thailand's position markedly in regard to fiscal balance and international finance, and helped sustain the stability of domestic economy. Compare Thailand with those developing countries currently struggling under a heavy debt burden, and it will be seen that Thailand is far better circumstanced. This policy of self-restraint is eloquently illustrated by the ceiling that the government imposed on itself during the ongoing 6th economic development plan to limit the annual borrowing from overseas to U.S. $1 billion.

The fourth is the innovation worked into the administrative mechanisms, which streamlined administrative decision-making processes. This innovation lies mainly in the introduction of the committee system into governmental organs. Many committees have been instituted to stimulate cooperation between governmental organs and private-sector businesses.

The fifth is the integrity of economic policy. Comings and goings of cabinet members in the executive branch do not affect the economic policy once charted. Even the now remote chance of coup d'etat can not swerve or alter the general tenor of economic policy. This means that a policy once set rolling continues to run on the charted course.

The sixth is the relatively favorable environment for investment. The committee responsible for this area is the government Board of Investment (BOI). The Board has been positive in according generous measures to investors. This attitude, plus several social factors, makes Thailand highly attractive to overseas investors. For one thing, labor is not only plentiful but has high aptitude for technical work. For another, agriculture, as the bedrock of social stability, is steadfast. The political climate, rendered bland and tranquil by the spiritual sway of the Thai royal household and Buddhism, has long precluded intervention by the military. The land is expansive (513,000 km^2), with a large enough population (53.8 million), to promise a potentially huge domestic market. Racial discrimination is practically non-existent as compared to other Asian countries. Ethnic minorities are well assimilated and blended with the Thais. A good example is the Chinese minority; they are no longer referred to as such but as Thai nationals.

The seventh is a large income from tourists of foreign countries. This income in 1987, 45.0 billion Baht spent by 3.2 million tourists, increased by around 21% as compared to 1986, 37.3 billion Baht spent by 2.8 million tourists. This income in 1987 was larger than that of apparel which was the top export item. It is estimated that income from tourists and the number of tourists will increase to 50.0 billion Baht and 3.9 million, respectively.

The eighth is the rapid increase in direct investment of recent years. This increase was triggered in the latter half of 1986 by investors from Japan and Taiwan, and in 1987 the number of applications for investment permits rose considerably. The trend picked up speed in 1988, as witnessed by the 393 applications submitted to the Board of Investment during the first 4 months from January to April. The amount of investment ran up to 99.380 billion Baht, of which Japanese firms accounted for 36.231 billion Baht (first place) with a total of 121 applications and Taiwan firms account for 15.188 billion Baht (second place) with a total of 111 applications. In contrast with the corresponding period of 1987, the number of large-scale investments for which applications were submitted to the Board of Investment was significantly large, 49 from Japanese firms and 31 from Taiwanese firms. Obviously, direct investment from overseas is a prominent factor in the continuing growth of Thai economy.

Table 2-1 Targets and Accomplishments of the Development Plans

Growth Item	1st Plan (1961-1966)		2nd Plan (1967-1971)		3rd Plan (1972-1976)		4th Plan (1977-1981)		5th Plan (1982-1986)		6th Plan (1987-1991)	
	Target	Reached	Target	Reached	Target	Reached	Target	Reached	Target	Reached	Target	Reached
Economic Growth Rate (%)	6	8.1	8.5	7.8	7.0	7.1	7.0	7.1	6.6	4.4	5.0	-
Agriculture	4.5	5.0	4.3	4.1	5.1	3.9	5.0	3.5	4.5	2.1	2.9	-
Manufacturing	-	10.5	10.9	9.2	8.0	8.6	9.6	8.7	7.6	5.1	6.6	-
Income per Capita (Baht)	-	2,787	-	3,835	-	7,330	-	17,200	35,700	21,935	27,783	-
Population Increase (%)	3.0	3.3	3.3	3.2	2.5	2.6	2.1	2.2	1.5	1.7	1.3	-
Balance of Trade (Mil. baht)	-	-2,167	-	-10,484	-	-13,047	-17,940	-45,000	-78,400	-54,000	-35,900	-
Commodity Price Rise (%)	-	-	-	-	10.0	12.0	6.0	11.6	10.6	2.7	2.3	-

Source: NESDB

2.3 Characteristics of Economics and Electric Power

(1) GDP, Electricity Consumption and Elasticity

The elasticity of the demand for electric power (hereafter, the electricity consumption), in respect to the GDP (Gross Domestic Product) is approximately 1.7.

(2) Electricity Consumption by Categories of Consumers

Table 2-2 shows the electricity consumption by categories of consumers; residential, commercial (offices, government and public offices, leisure, and shops), industrial (factories), agricultural, and others. In the ten-year period from 1978 to 1987, residential use increased by 2.6 times, commercial use by 2.1 times, and industrial use by 2.1 times. The percentage of the total consumption for 1987 accounted for by each category is shown in the following table. Industrial use, primarily factories, accounts for almost 50% of the total.

	(1987) Electricity Consumption (10^6 kWh)	Percentage
Residential	6,262	25%
Commercial	7,205	28%
Industrial	11,319	46%
Agricultural	61	0.2%
Others	47	0.8%
Total	24,894	100%

(3) Electric Consumption per Capita

The population, electric consumption, and electric consumption per capita for the nine year period from 1979 to 1987 is shown in Table 2-3. The figures for 1987 are shown below.

Electric Consumption (10^6 kWh)	24,894
Population (10^3)	53,873
Electric Consumption per Capita (kWh/person)	462

The figures for the 1987 electricity consumption, population, and electricity consumption per capita broken down by area into

Bangkok and environs, Northern Thailand, Northeastern Thailand, Middle Thailand, and Southern Thailand are shown in Table 2-4. The electricity consumption per capita is shown below.

Electricity Consumption per Capita (kWh/capita)

Whole Kingdom	462
Bangkok and Environs	1,699
Northern Thailand	184
Northeastern Thailand	100
Middle Thailand	671
Southern Thailand	246

The nationwide electricity consumption per capita is 462 kWh. However the population of Bangkok and its environs, only 13% of the total population, has the highest consumption rate at 1,699 kWh. In Northeastern Thailand, where 35% of the population resides, the average is the lowest at 100 kWh, only 1/17 of the rate for those in the capital and its surrounding areas.

The table below shows the electricity consumption per capita in Thailand compared with that of other ASEAN and NIES countries.

(1985) Country	Electricity Consumption per Capita (kWh/person)	Remarks
Thailand	387	
Philippines	386	
Malaysia	962	
Singapore	3,840	(NIES)
Indonesia	167	
Taiwan	2,520	Electricity Consumption for 1984
South Korea	1,520	
Hong Kong	3,278	

As can be understood from this, the electricity consumption per capita in Thailand falls in about the middle of the range of those of the ASEAN countries, and is closest to that of the

Philippines. Compared with the lowest figure of the NIES nations, South Korea, the figure for Thailand is about 1/3 that for South Korea. As previously indicated, the consumption rate for the Bangkok Area was 1699 kWh of electricity consumption per person for the year 1987. However, when compared with the capital region in Singapore or in Hong Kong, the Bangkok consumption rate is only one-half.

(4) Electricity Consumption in the Bangkok Area and in the Provinces

The electricity consumption and the percentages for the Bangkok area (MEA) and provincial regions (PEA) for the years 1982 and 1986 are shown below.

	Electricity Consumption (10^6 kWh)	
	1982 (%)	1987 (%)
Capital Region (MEA)	8,389 (59%)	12,464 (50%)
Provincial Region (PEA)	5,839 (41%)	12,430 (50%)

The increase in consumption in the PEA, in other words provincial areas excluding Bangkok and its environs, as evidenced in the above table, is remarkable. The electric consumption for the years 1982 and 1987, broken down by Bangkok area and provincial area are shown in the table below. From this table it is seen that in this five-year period, the rate of increase was greatest in Northern Thailand while the amount of increase was greatest in Bangkok area and the second largest was Central Thailand. In total, the provincial consumption became almost equivalent to the figures for the Bangkok Area (MEA). The economic growth in Central Thailand is thought to have been brought with it a similar economic growth in Bangkok.

Comparison of Electricity Consumption
by Region for 1982 and 1987

	Electricity Consumption (10^6 kWh)		Growth	
	(1) 1982	(2) 1987	(3) Increase (2)-(1)	Times (2)/(1)
Bangkok Area	8,389	12,464	4,075	1.5
Provinces	6,645	12,431	5,786	1.9
Northern Thailand	761	1,949	1,188	2.6
Northeastern Thailand	1,095	1,890	795	1.7
Central Thailand	3,734	6,940	3,206	1.9
Southern Thailand	1,055	1,652	597	1.6
Whole Kingdom	15,034	24,895	9,861	1.7

Table 2-2 Electricity Consumption by Categories of Consumers

Year	Residential		Commercial		Industrial		Agriculture		Street Lighting		Others		Total
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	GWh (%)
1978	2,427.4	21.4	3,556.6	31.3	5,276.0	46.4	8.0	0.1	79.7	0.7	18.7	0.1	11,366.2 (100)
1979	2,737.8	22.0	3,616.8	29.1	5,969.2	48.0	17.0	0.1	72.6	0.6	20.4	0.2	12,433.8 (100)
1980	3,005.3	22.9	3,561.0	27.1	6,454.5	49.1	22.5	0.2	72.4	0.4	34.7	0.3	13,149.2 (100)
1981	3,168.0	22.9	3,468.2	25.1	7,064.2	51.1	20.1	0.1	83.6	0.6	33.4	0.2	13,837.1 (100)
1982	3,630.6	24.1	3,862.4	25.7	7,389.0	49.2	32.5	0.2	90.6	0.6	28.0	0.2	15,033.0 (100)
1983	4,187.7	24.9	4,455.5	26.5	8,013.6	47.6	41.2	0.2	103.6	0.6	30.6	0.2	16,831.8 (100)
1984	4,731.5	25.4	4,912.5	26.5	8,723.5	47.0	47.8	0.3	118.6	0.6	38.6	0.2	18,572.2 (100)
1985	5,164.7	25.8	5,344.1	26.7	9,298.0	46.4	55.0	0.3	127.6	0.6	42.2	0.2	20,031.9 (100)
1986	5,795.1	26.3	5,847.8	26.5	10,162.7	46.1	56.7	0.3	140.6	0.6	31.2	0.2	22,034.4 (100)
1987	6,261.9	25.2	7,204.8	28.9	11,319.4	45.4	61.3	0.2	-	-	46.8	0.2	24,894.2 (100)

Table 2-3 Trend of Electricity Consumption per Capita

Areas	1979	1980	1981	1982	1983	1984	1985	1986	1987
Whole Kingdom									
1. Electricity Consumption (10^6kWh)	12,433.8	13,149.2	13,837.1	15,033.0	16,831.8	18,572.2	20,031.9	22,034.4	24,894.2
2. Population (10^3)	46,114.0	46,961.0	47,848.0	48,847.0	49,433.0	50,583.0	51,769.0	52,969.0	53,873.0
3. kWh Per Capita	269.63	280.00	289.19	307.76	340.50	367.16	386.95	415.99	462.09
4. Index (kWh Per Capita)[1/]	194.0	201.0	208.0	221.0	245.0	264.0	278.0	299.0	332.0
MEA Area									
1. Electricity Consumption (10^6kWh)	7,553.7	7,872.6	7,951.7	8,388.5	9,287.4	10,122.9	10,307.3	10,968.9	12,464.0
2. Population (10^3)	6,201.0	6,401.0	6,625.0	6,817.0	6,456.0	6,660.0	6,915.0	7,086.0	7,338.0
3. kWh Per Capita	1,218.14	1,229.90	1,200.26	1,230.53	1,438.57	1,519.95	1,490.57	1,547.97	1,698.56
4. Index (kWh Per Capita)[1/]	157.0	159.0	155.0	159.0	186.0	196.0	192.0	200.0	219.0
Outside MEA Area									
1. Electricity Consumption (10^6kWh)	4,880.1	5,276.6	5,885.4	6,644.5	7,544.4	8,449.3	9,724.6	11,065.5	12,430.2
2. Population (10^3)	39,913.0	40,560.0	41,223.0	42,030.0	42,977.0	43,923.0	44,881.0	45,883.0	46,535.0
3. kWh Per Capita	122.27	130.09	142.77	158.09	175.55	192.37	216.68	241.17	267.12
4. Index (kWh Per Capita)[1/]	250.0	265.0	291.0	323.0	358.0	393.0	442.0	492.0	545.0
Northern Area									
1. Electricity Consumption (10^6kWh)	561.5	618.0	675.8	761.0	1,044.9	1,194.1	1,537.8	1,719.0	1,948.8
2. Population (10^3)	8,271.0	8,350.0	9,714.0	9,834.0	10,106.0	10,281.0	10,392.0	10,490.0	10,585.0
3. kWh Per Capita	67.89	74.01	69.57	77.38	103.39	116.15	147.98	163.87	184.11
4. Index (kWh Per Capita)[1/]	247.0	269.0	253.0	281.0	376.0	422.0	598.0	596.0	669.0
Northeasten Area									
1. Electricity Consumption (10^6kWh)	692.8	811.1	925.6	1,095.1	1,240.0	1,430.6	1,544.8	1,712.5	1,889.7
2. Population (10^3)	15,793.0	16,090.0	16,366.0	16,720.0	17,147.0	17,638.0	18,061.0	18,552.0	18,884.0
3. kWh Per Capita	43.87	50.41	56.56	65.50	72.32	81.11	85.53	92.31	100.07
4. Index (kWh Per Capita)[1/]	219.0	252.0	283.0	327.0	362.0	406.0	428.0	462.0	500.0
Central Area									
1. Electricity Consumption (10^6kWh)	2,890.1	2,995.8	3,339.4	3,733.9	4,149.7	4,635.6	5,339.7	6,242.9	6,939.8
2. Population (10^3)	10,134.0	10,297.0	9,208.0	9,430.0	9,558.0	9,704.0	9,987.0	10,233.0	10,349.0
3. kWh Per Capita	285.19	290.94	362.66	395.96	434.16	477.70	534.67	610.08	670.58
4. Index (kWh Per Capita)[1/]	219.0	224.0	279.0	305.0	334.0	367.0	411.0	469.0	516.0
Southern Area									
1. Electricity Consumption (10^6kWh)	735.7	851.7	944.6	1,054.5	1,019.8	1,189.0	1,302.3	1,391.1	1,651.9
2. Population (10^3)	5,715.0	5,823.0	5,935.0	6,046.0	6,166.0	6,300.0	6,441.0	6,608.0	6,717.0
3. kWh Per Capita	128.73	146.26	159.16	174.41	179.99	188.73	202.19	210.52	245.93
4. Index (kWh Per Capita)[1/]	274.0	311.0	339.0	371.0	383.0	402.0	430.0	448.0	523.0

Sources : EGAT, MEA, PEA, NEA, POF, Department of Local Administration
Note : 1/Base 100 in 1972

CHAPTER 3

PRESENT SITUATION OF ELECTRIC POWER SECTOR

CHAPTER 3 PRESENT SITUATION OF ELECTRIC POWER SECTOR

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CHAPTER 3 PRESENT SITUATION OF ELECTRIC POWER SECTOR

3.1 Organizations of Electric Power Sector

The electric power enterprises in Thailand are for the most part under the management of the government, while installed capacity owned by private companies accounts for about 10% of the entire electric power capacity.

The responsibility for comprehensive administration concerning electric power comes under the jurisdiction of the National Energy Administration (NEA) of the Ministry of Science, Technology and Energy.

The responsibility for electric power supply comes under the jurisdiction of EGAT for power generation and transmission to the primary substations and that of the two power distribution organizations, the MEA and the PEA, for on and thereafter.

(1) NEA: National Energy Administration

The NEA is responsible for managing energy policies for all of Thailand. It establishes and adjusts the electric power development plan in addition to being responsible for small scale hydroelectric power projects, etc., which are to be incorporated in the 5-year plan for economic and social development.

(2) EGAT: Electric Generating Authority of Thailand

The EGAT was set up in May 1969 by consolidating 3 organizations: YEA (the Yanhee Electric Authority), NEEA (the North-East Electricity Authority) and LA (the Lignite Authority).

EGAT has been charged, according to the EGAT Act 1968, with responsibility for carrying out the following objectives:

- To generate, acquire, transmit or distribute electric energy to:

o the Metropolitan Electricity Authority (MEA), the Provincial Electricity Authority (PEA) or other electricity distribution authorities as prescribed;

o other electricity consumers as directed by a Royal Decree;

o neighbouring countries.

- To undertake various activities concerned with energy sources derived from natural resources e.g. water, wind, natural heat, sunlight, mineral or fuel such as oil, coal or gas and including nuclear energy for the production of electric energy and other activities which will promote the scheme of EGAT.

- To produce and commercialize lignite and chemicals derived from or utilizing lignite, or join with other bodies for such activities.

To fulfill the aforesaid objectives, the scope of responsibilities entrusted to the Authority by the government are as follows:

- To construct and operate dams and reservoirs or other equipment connected with electric power production and to develop water resources with a view to expanding such opportunities.

- To construct thermal, hydro, nuclear and other types of power plant.

- To improve and expand substation and transmission system including associated equipment for electric power transmission and distribution.

- To specify standard, type and size of substation, transmission system, power plant, lignite chemical plant and fuel for power production as well as associated equipment.

- To formulate policy in connection with the production of power and sales of electricity, lignite and lignite by-products.

To achieve these objectives and responsibilities, EGAT has formed a main policy to ensure that sufficient power is constantly

available, the services are reliable, and that power is sold at the lowest possible rates.

The reliability of power supply has been and is being continuously improved and the level of services has become considerably higher than before. EGAT, as a self-supporting organization, has an independent authority in the management of the organization. Although the decision or power rates is subject to approval of the Cabinet, it draws up the plan independently to cover all costs of power generation.

The financing depends on financing from the government, borrowings from both domestic and international financial organizations in addition to the issuance of bonds which are authorized by the government.

EGAT buys extra electric power from the Nam Ngum Power Plant in Lao PDR, transmitted through power distribution lines in Thakhek and Savannakhet.

Also, Thailand has been interconnected with Malaysia by the transmission lines of 115 kV/132 kV since August 1980, allowing mutual interchange of electric power.

The organization chart of EGAT is shown on Fig. 3-1.

(3) MEA: The Metropolitan Electricity Authority

The MEA was set up in 1958, combining the Bangkok Electric Power Company which was under the jurisdiction of the Ministry of Interior at that time and the Power Generating Bureau of the government, as an organization fully subsidized by the government.

The MEA does not possess its own power generating facilities, but distributes the electric power supplied by EGAT to users through its own transmission and distribution facilities. The scope of distribution includes Bangkok, Nonthaburi and Samut Prakan in the area adjacent to Bangkok.

The MEA, together with the PEA, come under the jurisdiction of the PWD (Public Works Department of the Ministry of Interior).

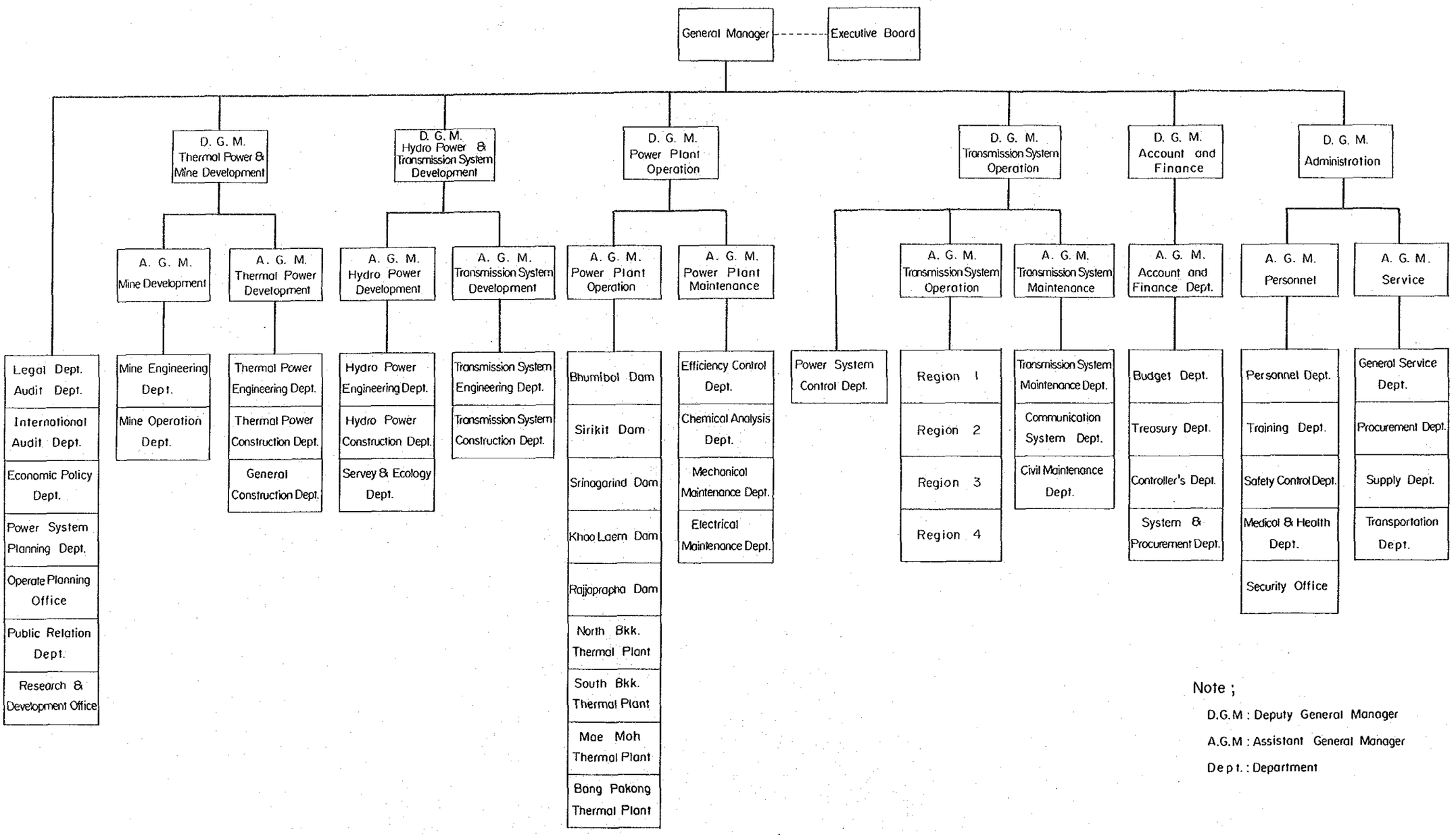
(4) PEA: The Provincial Electricity Authority

The PEA is the public enterprise in charge of distributing electricity to the provinces other than those which come under the jurisdiction of the MEA.

The distribution to users depends mainly on electric power provided by EGAT, but it owns diesel power generating facilities on a small scale, promoting the electrification of agricultural villages.

(5) OAEP: The Organization of Atomic Energy for Peace

The OAEP comes under the jurisdiction of the Ministry of Science, Technology and Energy, administratively. It executes the promotion of the development of nuclear power, safety management, control business, etc., under the policies established by the Atomic Energy Committee of Thailand.



Note ;

D.G.M : Deputy General Manager

A.G.M : Assistant General Manager

Dept. : Department

Fig. 3 – 1 Organization Chart of EGAT

3.2 Power Supply Facilities

3.2.1 Generating Facilities

(1) Generating Facilities

The total capacity of the generating facilities of Thailand is 7,771 MW as of July 1988, and the details of ownership and type of facility are as follows:

(MW)

	EGAT	PEA	NEA	Private	Total
Hydro	2,250	-	6	-	2,256
Steam Turbine	3,607	-	-	528	4,135
Combined Cycle	772	-	-	-	772
Gas Turbine	265	-	-	-	265
Diesel	-	55	-	288	343
Total	6,894	55	6	816	7,771

(Note) Figure above except EGAT: as of 1987
(Note) 241 MW in Private 816 MW: for standby

The ratio of each facility to total installed capacity is 29% for hydro and 71% for thermal.

(2) Power Supply by EGAT

A list of EGAT's existing power plants is shown in Table 3-1, and the location of the main power plants and transmission system is shown in Fig. 3-2. The supply area is devided into 4 areas and these are connected by 230 kV or 115 kV transmission lines.

The base load generation in Region 1 is mainly provided by the South Bangkok, Bang Pakong oil/gas-fired thermal plants and lignite-fired power plants at Mae Moh supplemented by Bang Pakong combined cycle power plants as an intermediate load

plant. For peak generation, capacity is obtained from Bhumibol, Sirikit, Srinagarind, Kang Krachan, Khao Laem and Tha Thung Na hydroelectric plants.

The power supply for base load in Region 2, the Northeast, is mainly obtained from the interconnection with Region 4 through a 230 kV transmission line and a 115 kV transmission line for interconnection with Region 1. Part of the energy needed for this region has been obtained by the purchase of surplus energy from Nam Ngum power plant in Lao PDR.

The base load generation in Region 3, the South, is provided by the thermal power plant barge at Khanom, the lignite-fired power plant at Krabi and the oil-fired power plant at Surat Thani. The energy is transmitted using the 115 kV Central-Southern transmission line (1st CSTL) which has been in operation since August 1980. Peak power is provided by Bank Lang, Rajjaprabha (Chiew Larn) hydroelectric plants and gas turbines.

The power system in Region 3 is also interconnected with its neighbouring system in Malaysia via a 132 kV interconnector, through which part of Region 3 load during peak periods can be supplemented by power import from Malaysia whenever it is considered necessary.

The power supply in Region 4 is supplied by the Mae Moh lignite thermal plant of 825 MW.

(3) Hydroelectric Power Plants

Thailand has abundant hydro power resources and the main rivers are located in four areas i.e. the Chao Phraya river and its tributaries, the Quae Yai river and the Quae Noi river basins, the northeast plateau whose rivers pour into tributaries of the Mekong river and the southern isthmus area.

The Bhumibol (535 MW) and Sirikit (375 MW) power plants are located on the Ping river, and the Nan river, tributaries of Chao Phraya river, respectively and represent the large scale

hydroelectric power plants of Thailand together with Srinagarind (540 MW).

The Srinagarind power plant is situated on the Quae Yai river, a tributary of the Mae Klong river and has a capacity of 540 MW of which one generator with a capacity of 180 MW is for a pumped storage power plant.

These hydroelectric power plants operate corresponding to the fluctuating peak load of the demand and take into account the supply of irrigation water to the downstream basin.

Table 3-4 shows the existing principal hydroelectric power plants.

(4) Thermal Power Plants

The South Bangkok plant (1,300 MW) located in Bangkok is the largest thermal power plant in Thailand. It uses natural gas produced in the Gulf of Thailand or heavy oil.

The Mae Moh thermal power plant (825 MW) near Chiang Mai in the northwest uses lignite obtained from the strip mine nearby as fuel. As of 1988, No. 8 and No. 9 generators (300 MW each) are under construction. It is a large scale plant, which is planned to be expanded to No. 19 generator, eventually.

The North Bangkok thermal power plant started operation in 1960's using heavy oil as fuel, but it is deteriorating with its efficiency being lowered.

3.2.2 Transmission Lines and Substations

The standard voltages for power transmission in the EGAT system are 500, 230, 115 and 69 kV at a frequency of 50 Hertz. Table 3-2 shows the existing facilities of transmission lines and substations as of July 1988. Fig. 3-3 illustrates the total transmission line length classified by voltage levels over the period 1960 - 1995. As of July 1988, the breakdown of the circuit-km of EGAT's transmission system is: 326 circuit-km of 500 kV, 6,122 circuit-km of 230 kV, 9,473 circuit-km of 115 kV and 642 circuit-km of 69 kV lines.

The 500 kV transmission lines that connect Mae Moh thermal power plant and Bangkok area (Region 1) have been partially completed (as far as the Tha Tako substation) and are being operated at 230 kV, which is scheduled to be boosted to 500 kV in 1989.

The following transmission lines form the nucleus of the system.

- o 230 kV transmission lines between substations in the North Bangkok, South Bangkok and Bang Pakong thermal power plant
- o 230 kV transmission lines connecting remote hydroelectric power plants and Region 1
- o 230 kV transmission lines connecting Phitsanulok and Khon Kaen

The power system is formed by the nucleus system linked with the 115 kV transmission lines connecting small hydroelectric power plants scattered in the northeast of Thailand and the 115 kV transmission lines connecting central and southern parts.

As for high voltage substations, there are thirty-one 230 kV, one-hundred and ten 15 kV and ten 69 kV units, totalling 151 substations. The total installed transformer capacity, excluding station service and generator unit transformers, is 13,054 MVA.

3.2.3 Distribution Facilities

The electric power provided by EGAT is transmitted to MEA substations at 115 kV and 69 kV, dropped to 24 kV and 12 kV and supplied to households at 220 V and 220/380 V for commercial use.

In the area of jurisdiction under the PEA, distribution lines of 33 kV, 22 kV, 11 kV, etc., are being used but electric power is supplied to general users at 220 V.

Total length of the distribution line in circuit-km is shown below.

Voltage (kV)	Circuit-km	
33	16,534	(PEA)
24/12	5,413	(MEA)
22	95,755	(PEA)
11	922	(PEA)

Table 3-1 EGAT EXISTING INSTALLED GENERATING CAPACITY

AS OF JULY 1988

Plant Type	Number of Units	Capacity (MW) Installed	Capacity (MW) Ultimate	Average Energy Capability (GWh/yr)
A. Hydroelectric Plant				
Bhumibol	7	535.0	710.0	1,200.0
Sirikit	3	375.0	500.0	1,000.0
Ubolratana	3	25.0	25.0	56.0
Sirindhorn	3	36.0	36.0	86.0
Chulabhorn	2	40.0	40.0	95.0
Kang Krachan	1	19.0	19.0	78.0
Nam Pung	2	6.0	6.0	15.0
Srinagarind	4	540.0	720.0	1,140.0
Bang Lang	3	72.0	72.0	200.0
Tha Thung Na	2	38.0	38.0	165.0
Khao Laem	3	300.0	300.0	760.0
Huai Kum	1	1.3	1.3	2.0
Ban Yang	3	0.12	0.12	0.3
Ban Santi	1	1.3	1.3	6.0
Ban Chong Klum	1	0.02	0.02	0.2
Ban Khun Klang	2	0.18	0.18	0.7
Mae Ngat	2	9.0	9.0	29.0
Huai Sapnan Hin	2	12.2	12.2	27.0
Rajjaprabha	3	240.00	240.00	550.0
Total	48	2,250.12	2,730.12	5,410.2
B. Thermal Power Plant				
North Bangkok	3	237.5		1,250.0
South Bangkok	5	1,300.0		9,110.0
Mae Moh	7	825.0		5,420.0
Krabi	2	40.0		200.0
Surat Thani	1	30.0		210.0
Khanom PPB	1	75.0		525.0
Bang Pakong Thermal	2	1,100.0		7,710.0
Total	21	3,607.5		24,425.0
C. Combined Cycle Power Plant				
Bang Pakong Combined-Cycle Blocks 1 & 2	10	771.6		4,055.0
Total	10	771.6		4,055.0
D. Gas Turbine				
Nakhon Ratchasima	1	15.0		33.0
Udon Thani	1	15.0		33.0
Hat Yai	3	45.0		99.0
Surat Thani	3	45.0		99.0
Lan Krabu	7	145.0		888.0
Total	15	265.0		1,152.0
GRAND TOTAL	94	6,894.22		35,042.2

Table 3-2 Installed Transmission Lines and Substations

As of Sep. 1987

Region and System Voltage	Substations		Transmission Lines (Circuit-Kilometers)		
	Number	Transformer a/ Capacity (MVA)	Double-Circuit	Single-Circuit	Total
Region 1					
230 kV	19	6,120	2,750	18	2,736
115 kV	41	2,185	632	1,437	2,069
69 kV	1	27	-	128	128
Total	61	8,332	3,382	1,583	4,965
Region 2					
230 kV	1	400	290	-	290
115 kV	28	1,043	1,711	1,686	3,397
69 kV	4	35	-	327	327
Total	33	1,478	2,001	2,013	4,014
Region 3					
230 kV	3	400	806 b/	-	806
115 kV	21	926	1,149	1,137 c/	2,286
Total	24	1,326	1,955	1,137	3,092
Region 4					
500 kV	-	-	-	326 d/	326
230 kV	8	750	2,040	218	2,258
115 kV	20	924	634	1,072	1,706
69 kV	5	100	7	187	194
Total	33	1,774	2,681	1,803	4,484
All Region					
500 kV	-	-	-	326	326
230 kV	31	7,670	5,886	236	6,122
115 kV	110	5,078	4,126	5,332	9,458
69 kV	10	162	7	642	649
Total EGAT	151	12,910	10,019	6,536	16,555

Notes : a/ Excluding Station and generator unit transformers.

b/ 550 circuit-km is presently energized at 115 kV.

c/ Including 9 circuit-km of 132 kV transmission line.

d/ Presently energized at 230 kV.

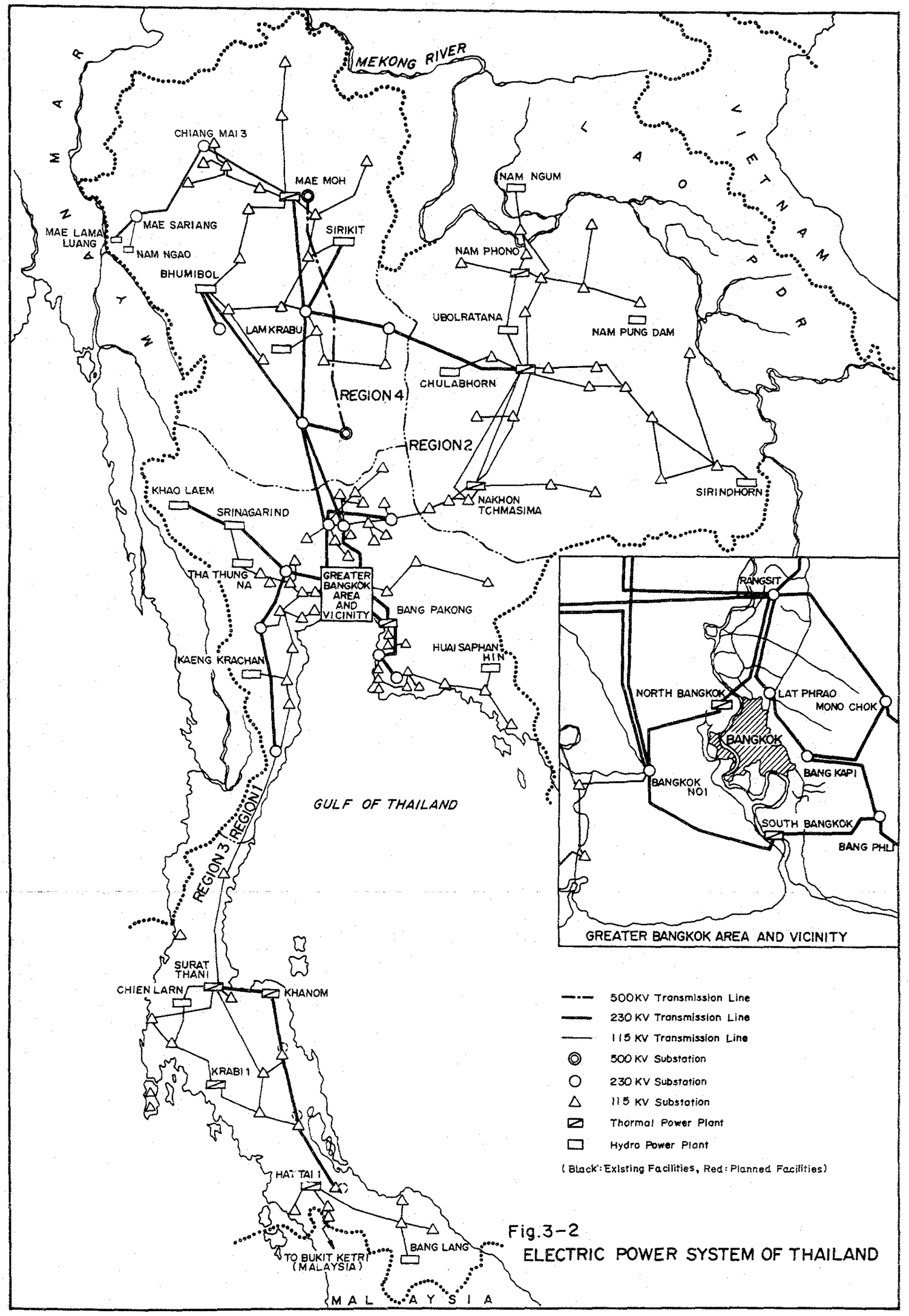
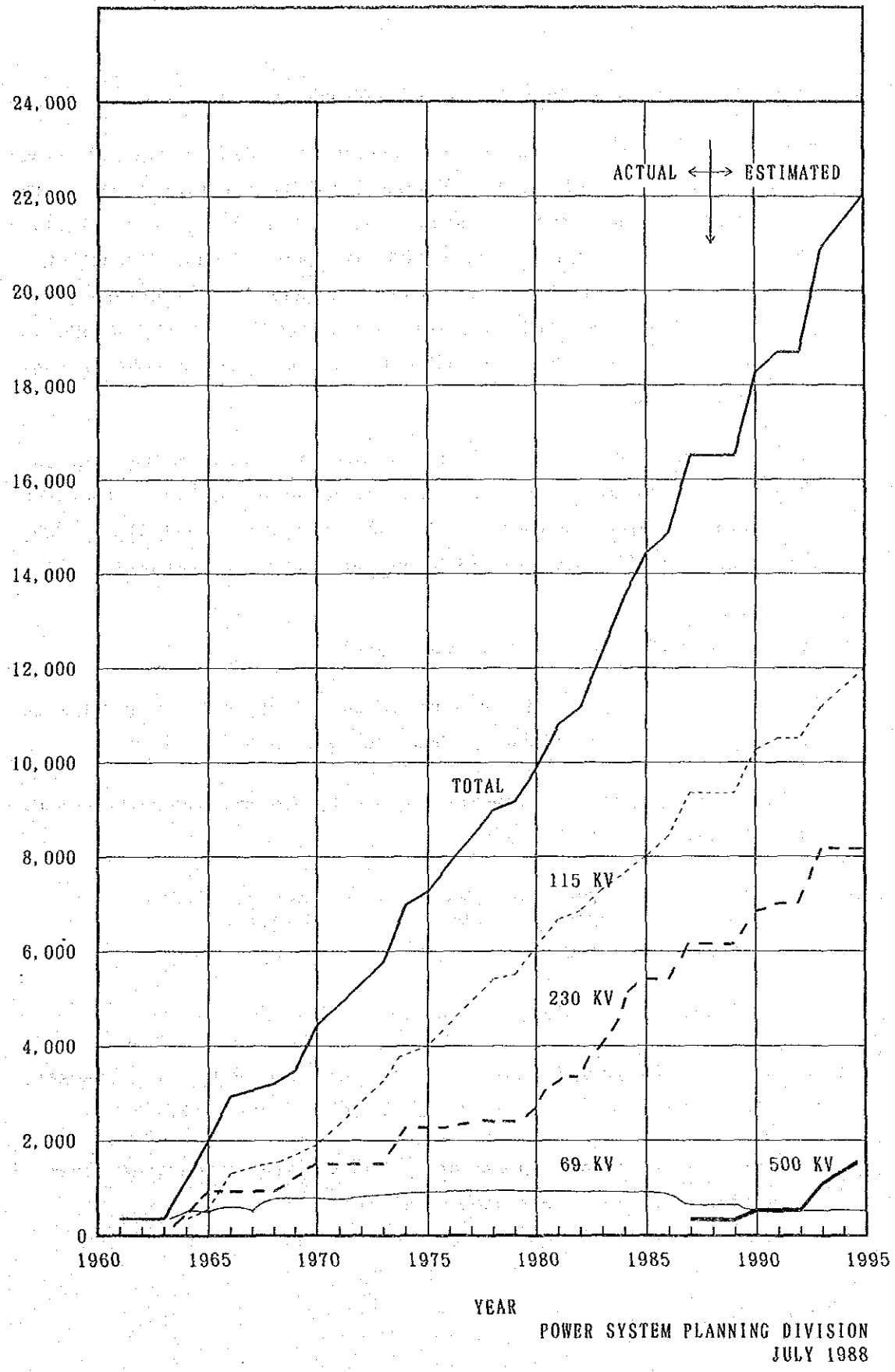


Fig.3-2
ELECTRIC POWER SYSTEM OF THAILAND



POWER SYSTEM PLANNING DIVISION
JULY 1988

Fig.3-3 GROWTH OF HIGH VOLTAGE AND 500KV TRANSMISSION LINES

3.3 Power Demand and Supply

3.3.1 Trend and Present Situation of Power Demand

The peak demand and energy generation of EGAT increased from 1,199 MW and 6,873 GWh in FY 1973 to 2,255 MW and 13,969 GWh in FY 1979 at high annual increase rates of 11.1% and 12.5%, respectively. In the first three years of the 1980s the power demand did not show such a rapid increase due to the second oil crisis. Afterwards, the power demand resumed its increase from 2,417 MW and 14,754 GWh to 4,180 MW and 24,780 GWh in FY 1986 at annual increase rate of 9.6% and 9.0%, respectively.

Although, the power demand after FY 1986 was estimated to increase moderately continuing the same trend as in the early 1980s, the peak generation of EGAT recorded in FY 1988 was 5,444 MW and 31,997 GWh, being increased by 15.0% and 13.5% respectively, as compared 1987.

3.3.2 Maximum Power Demand and Installed Capacity

Trend of maximum power demand and installed capacity from 1979 to 1987 for the whole Thailand is shown in Table 3-4.

The relation between the installed capacity and maximum power demand is as follows, as of FY 1987:

Installed Capacity (MW)	Dependable Capacity (MW)	Max. Power Demand (MW)	Reserve Capacity (MW)	Margin (%)
6,894	6,393	4,734	1,659	35.0

Further, the figures in Table 3-4 are for calendar year, however, the figure above are for the end of the fiscal year 1987.

EGAT used a figure of approximately 25% of reserve margine several years ago, however, it has adopted 15% now.

3.3.3 Energy Balance

The trend of energy balance between energy generation and consumption from 1978 to 1987 is shown in Table 3-5.

The net electric energy supplied as of 1987 amounted to 24,894 GWh. This figure is obtained by adding net imported electric energy of 398 GWh to the total electric energy of 28,652 GWh generated in Thailand and deducting the loss within power plants of 1,191 GWh and the transmission and distribution loss of 2,965 GWh.

The net imported electric energy of 398 GWh was from Nam Ngum hydroelectric power plant in Lao PDR. The transmission and distribution loss is about 10% (transmission lines 5%, distribution lines 5%) of the total electric energy generated.

3.4 Energy Sources

Electric generation by energy sources from 1978 to 1987 is shown in Table 3-6. Comparisons of the figures between 1978 (second oil crises) and 1987 is tabulated below.

(GWh)

	1978	1987
Import	222 (2)	398 (1)
Diesel Oil	315 (2)	67 (0.2)
Hydro	2,110 (16)	4,075 (14)
Fuel Oil	9,723 (76)	2,188 (8)
Lignite	489 (4)	6,698 (23)
Natural Gas	0 (0)	15,624 (53)
Total	12,859 (100)	29,050 (100)

(Note) ( ): Percentage to total

The proportion of energy generation using petroleum was 76% in 1978, however it declined sharply to 8% in 1987. On the other hand, energy generation using lignite increased from 4% to 23% and that using natural gas accounted for only 10% in 1981 when the facility was newly installed, but it accounted for 53% in 1987.

As mentioned above the peculiarity of the power source facilities in Thailand can be seen in a diversification of the thermal power plant facilities.

In Thailand, hydropower, natural gas and lignite constitute the main national energy resources and the self-sufficiency rate of the generation of electric energy made rapid progress from 20% in 1978 to 90% in 1987.

This is attributable to efforts to reduce the dependency on imported oil and a high powered promotion of the effective use of national resources based on the experience of the oil crises in the past.

Table 3-3 TOTAL EGAT GENERATION REQUIREMENT

Fiscal Year	Peak Generation		Energy Generation		Load Factor
	MW	% Increase	GWh	% Increase	%
		Actual			
1974	1,256	4.75	7,259	5.61	65.96
1975	1,407	11.96	8,216	13.13	66.64
1976	1,652	17.45	9,414	14.64	65.05
1977	1,873	13.40	10,951	16.32	66.73
1978	2,101	12.13	12,372	12.98	67.23
1979	2,255	7.35	13,965	12.88	70.69
1980	2,417	7.20	14,754	5.65	69.67
1981	2,589	7.09	15,960	8.18	70.38
1982	2,838	9.63	16,882	5.78	67.91
1983	3,204	12.91	19,066	12.94	67.92
1984	3,547	10.70	21,066	10.49	67.79
1985	3,878	9.33	23,357	10.87	68.75
1986	4,181	7.80	24,780	6.06	67.66
1987	4,734	13.23	28,193	13.78	67.99
1988	5,444	15.00	31,997	13.49	67.09
Average Growth Rate % 1978 - 1988	-	9.99	-	9.96	-

Table 3-4 Total Installed Capacity and Peak Generation

Fiscal Year	Installed Capacity (MW)	Peak Generation (MW)
1978	2,902	2,175
1979	2,964	2,201
1980	3,448	2,379
1981	4,008	2,561
1982	4,403	2,823
1983	5,032	3,200
1984	6,128	3,545
1985	6,705	3,826
1986	6,805	4,202
1987	6,985	4,842

SOURCES : ETAT, PEA, NEA, POF

Table 3-5 Electricity Energy Balance

Year	Electricity Supply		Station Service	Transmission and Distribution Line Losses	Electricity Consumption		
	Gross Generation	Net Import			Free Electricity Supply (Official Use, Staff Supply etc.)	Electricity Avaiable for Sale	Total
1978	12,637	215	519	967	24	11,342	11,366
1979	13,443	781	498	1,292	21	12,412	12,434
1980	14,426	759	618	1,418	21	13,128	13,149
1981	15,370	731	617	1,647	26	13,811	13,837
1982	16,620	739	681	1,646	28	15,005	15,033
1983	18,857	676	681	2,019	30	16,802	16,832
1984	21,025	688	885	2,256	35	18,537	18,572
1985	23,074	703	1,086	2,660	39	19,993	20,032
1986	24,717	741	1,013	2,411	46	21,988	22,034
1987	28,652	398	1,191	2,965	105	24,789	24,894

Table 3-6 Energy Generation by Sources

Year	Hydro	Fuel Oil	Diesel Oil	Lignite	Natural Gas	Total
1978	2,110	9,723	315	489	-	12,637
1979	3,264	8,500	406	1,273	-	13,443
1980	1,273	11,352	391	1,410	-	14,426
1981	2,974	8,979	216	1,675	1,526	15,370
1982	3,837	5,857	56	1,859	5,011	16,620
1983	3,660	7,100	124	1,804	6,169	18,857
1984	4,082	6,335	28	2,317	8,263	21,025
1985	3,692	3,379	24	5,313	10,666	23,074
1986	5,554	3,332	34	5,545	10,252	24,717
1987	4,075	2,188	67	6,698	15,624	28,652

3.5 Fluctuation in Demand per Day and by Season

Fig. 3-4 shows the transition of the load curve on the day when the maximum demand occurred.

The maximum demand occurred between 7PM - 8PM in all cases, which were greatly affected by the fluctuation in demand in the region supplied by PEA and can be seen as a typical situation due to demand by household.

After 1980, the difference between the peak demand and off-peak demand has been remarkable due to the promotion of industrialization, which is predicted to continue in the future. Therefore, the future problems will be to control the lowering of the load factor and to secure the reserve margin.

Fig. 3-5 shows the transition of daily load factor and yearly load factor.

Looking at the seasonal fluctuation of the demand, although there were fluctuations in demand month by month, it is clear that the maximum demand tends to increase gradually. At the same time the effect of changes in temperature is remarkable on the energy generated. In other words, the lower the temperature between December and February, the lower the demand, and in March when the temperature starts to become higher, the electric energy generated increases by a large margin. Fig. 3-6 shows the transition of the maximum demand and the electric energy generated in recent years.

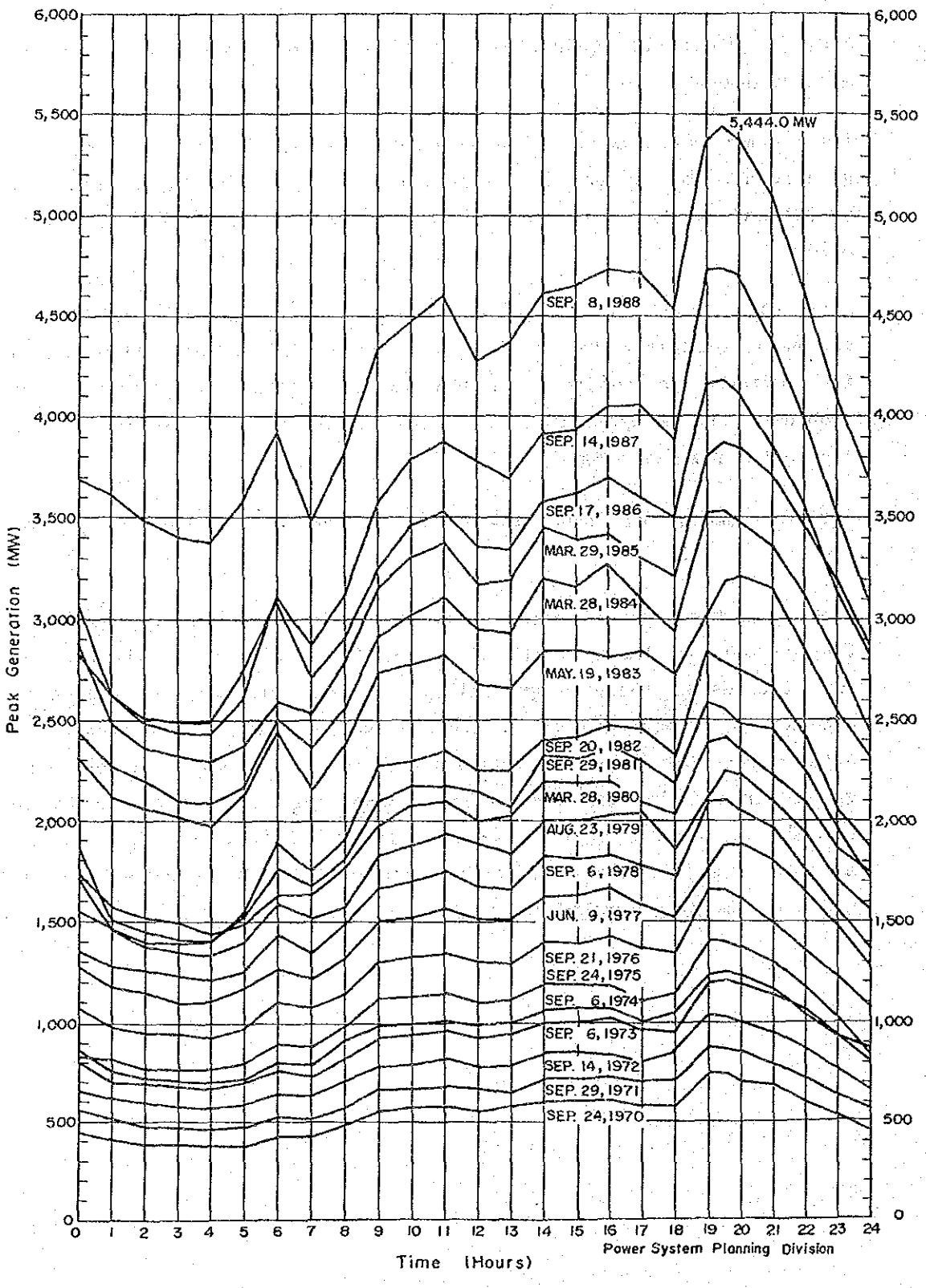


Fig. 3-4 EGAT Recorded Daily Load Curves on Peak Day
(Fiscal Years 1970 - 1988)

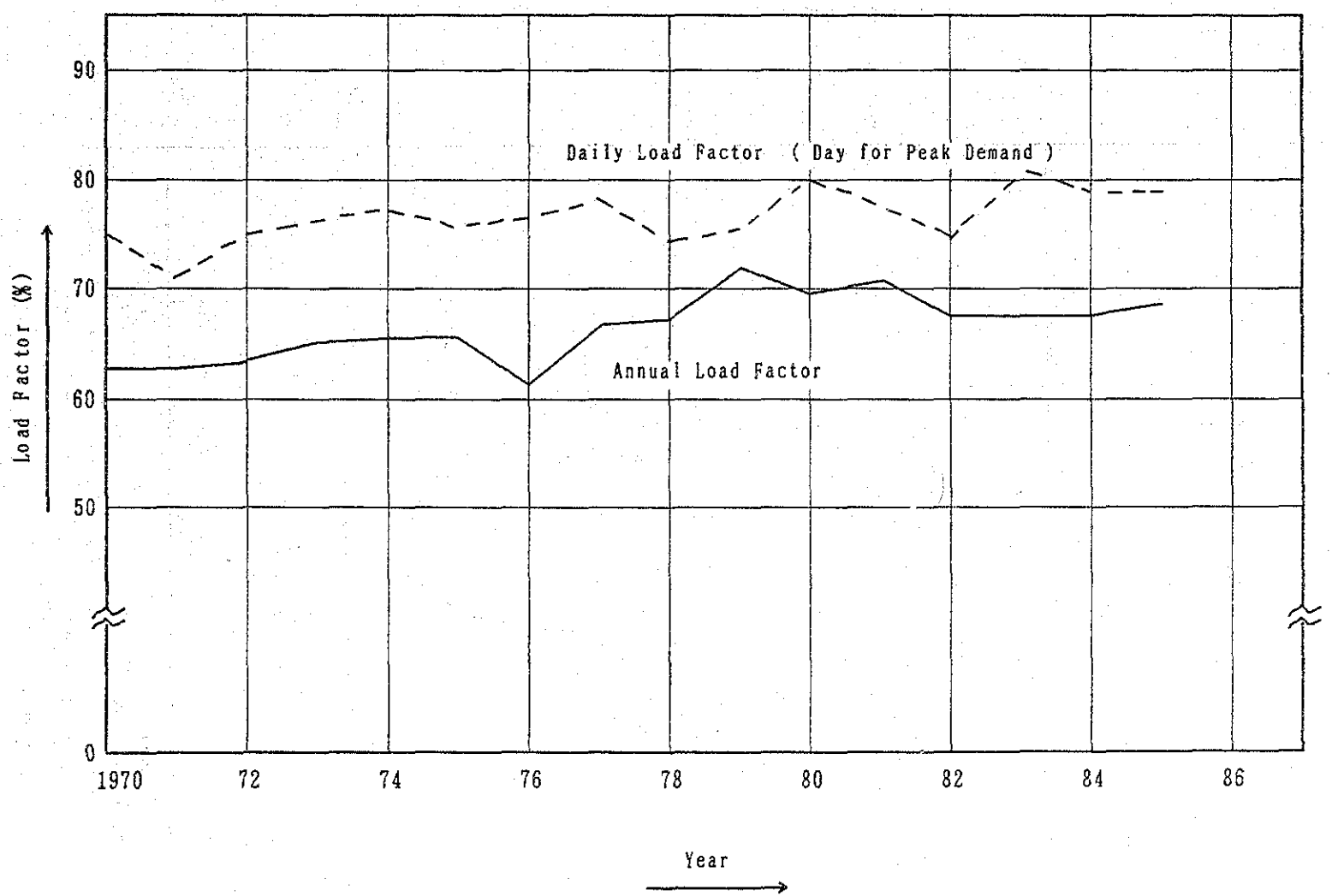


Fig. 3-5 Relation between Annual and Daily Load Factors EGAT Whole System (1970 - 1986)

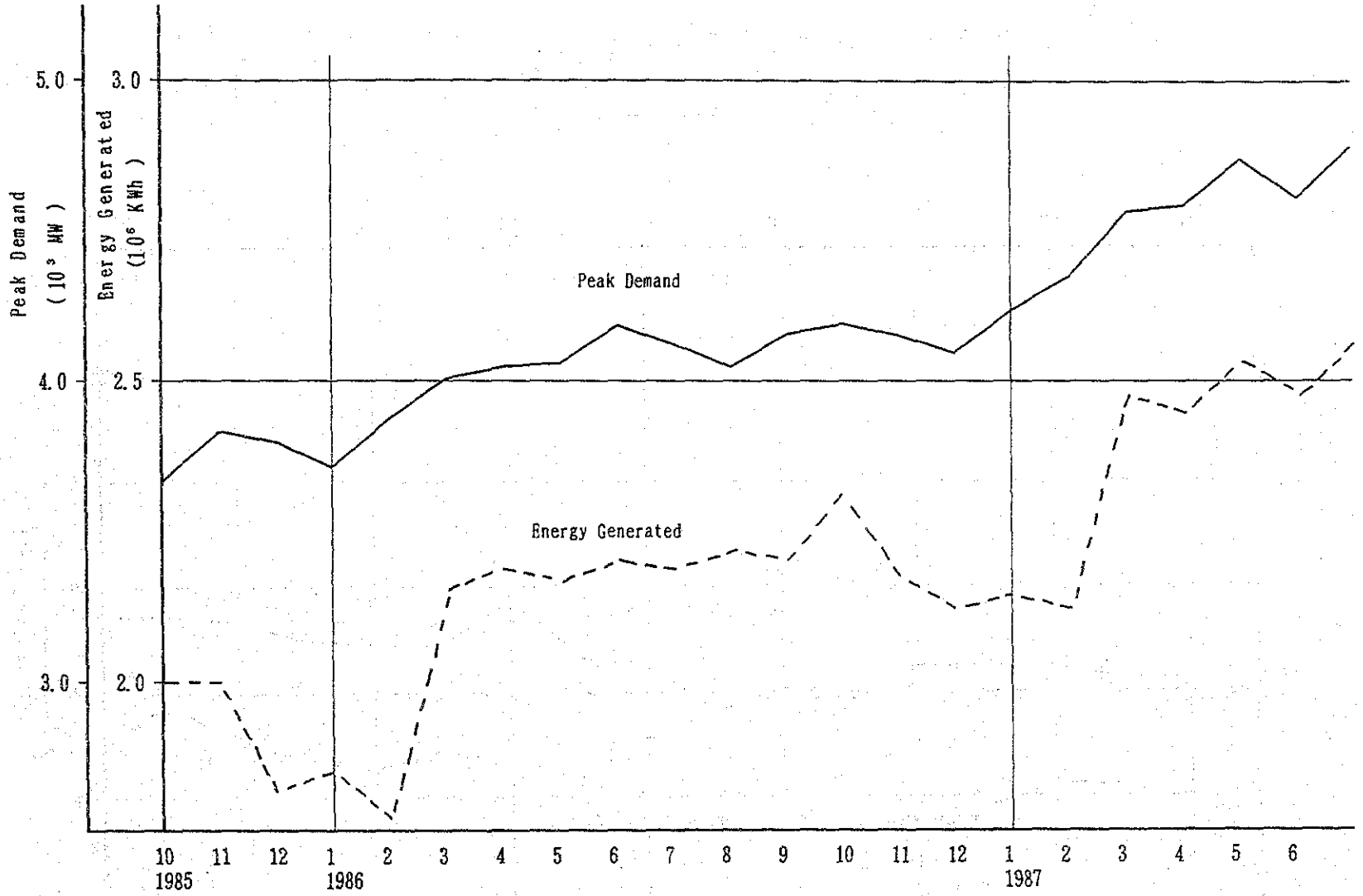


Fig. 3-6 Trend of Monthly Peak Demand and Energy Generated

3.6 Electricity Tariff

The electricity tariffs in Thailand can be roughly divided into the wholesale tariffs of EGAT and retail tariffs of the MEA and the PEA.

The wholesale tariffs for the PEA have been set relatively lower than for the MEA. The reason is the political consideration in determining the electricity tariffs for the PEA because of its weak managerial basis.

The electricity tariffs which were contracted between EGAT and the MEA and the PEA in June 1987, were as follows:

MEA: 1.4777 ฿/kWh
PEA: 1.0399 ฿/kWh

The average unit tariff for large users who directly contract with EGAT was 1.22 ฿/kWh according to the records of 1987.

On the other hand the retail rates of the MEA and the PEA consist of a tariff system organized by the type of use and by amount.

Table 3-7 shows the tariff structure of the electricity distributors (MEA, PEA).

Table 3-7 Tariff Structure of Electric Distributors (MEA, PEA)

1. Residential

Energy Charge :	First 5 kWh or less	5.00	Baht
	Next 10 kWh	0.70	Baht/kWh
	Next 10 kWh	0.90	Baht/kWh
	Next 10 kWh	1.17	Baht/kWh
	Next 65 kWh	1.58	Baht/kWh
	Next 50 kWh	1.68	Baht/kWh
	Next 150 kWh	1.76	Baht/kWh
	Next 100 kWh	2.02	Baht/kWh
	Next 400 kWh	2.11	Baht/kWh
	Over 800 kWh	2.43	Baht/kWh
	Minimum Charge: 5.00 Baht/month		

2. Small Business

Energy Charge :	First 40 kWh or less	88.12	Baht
	Next 260 kWh	1.77	Baht/kWh
	Next 200 kWh	1.88	Baht/kWh
	Next 500 kWh	2.21	Baht/kWh
	Next 2,000 kWh	2.43	Baht/kWh
	Over 3,000 kWh	2.50	Baht/kWh
	Minimum Charge: 88.12 Baht/month		

3. Large Business (30 kW or over)

3.1 For below 12 kV		
Demand Charge	239.00	Baht/kW
Energy Charge	1.28	Baht/kWh
3.2 For 12 kV or over		
Demand Charge	229.00	Baht/kW
Energy Charge	1.23	Baht/kWh

4. Specific Business (Tourist Hotel)

4.1 For below 12 kV		
Demand Charge	233.00	Baht/kW
Energy Charge	1.28	Baht/kWh
4.2 For 12 kV or over		
Demand Charge	216.00	Baht/kW
Energy Charge	1.23	Baht/kWh

5. Small Manufacturing & Mining (30 - 499 kW)

All Voltage		
Demand Charge	177.00	Baht/kW
Energy Charge	1.23	Baht/kWh
Dicount	4% from demand and energy charge	

6. Medium Manufacturing & Mining (500 - 1,999 kW)

All Voltage		
Demand Charge	174.00	Baht/kW
Energy Charge	1.23	Baht/kWh
Discount	4% from demand and energy charge	

7. Large Manufacturing & Mining (2,000 kW or over)

All Voltage		
Demand Charge	170.00	Baht/kW
Energy Charge	1.22	Baht/kWh
Discount	4% from demand and energy charge	

8. Electric Smelting/Fusing Industry or Electroysis Industry

All Voltage		
Demand Charge	165.00	Baht/kW
Energy Charge	1.20	Baht/kWh
Discount	4% from demand and energy charge	

9. Public Utility (Water Works)

9.1 A maximum 15 minute integrated demand of less than 30 kW

Energy Charge :	First 10 kWh or less	18.20	Baht
	Over 10 kWh	1.82	Baht/kWh
Minimum Charge:	18.20 Baht/month		

9.2 A maximum 15-minute integrated of 30 kW or over

Demand Charge	167.00	Baht/kW
Energy Charge	1.23	Baht/kWh

10. Government Office

Energy Charge :	First 10 kWh or less	18.20	Baht
	Over 10 kWh	1.82	Baht/kWh
Minimun Charge:	18.20 Baht/month		

11. Non-Profit Organization

Energy Charge :	First 100 kWh or less	18.40	Baht
	Over 100 kWh	1.84	Baht/kWh
Minimum Charge:	18.40 Baht/month		

12. Agricultural Pumping

Energy Charge :	First 10 kWh or less	117.00	Baht
	Over 100 kWh	1.17	Baht/kWh
Minimum Charge:	117.00 Baht/month		

Note: Effective June 1, 1987
Minimum charge for schedule 3, 4, 5, 6, 7, 8 and 9.2 are 30% of the highest billing demand occurring during the 12 months ended with the current month