No. 10

THE KINGDOM OF THAILAND

THE FEASIBILITY STUDY REPORT

ON

DISTRIBUTION SYSTEM DISPATCHING CENTER PROJECT

JANUARY 1987

JAPAN INTERNATIONAL COOPERATION AGENCY

P R E F A C E

In response to the request of the Gorvernment of the Kingdom of Thailand, the Japanese Government has decided to conduct a feasibility study on the Distribution System Dispatching Center Development Project and entrusted the study to the Japan International Cooperation Agency. J.I.C.A. sent to Thailand a survey team headed by Mr. Fuminori Sato of West Japan Engineering Consultants Inc. from June to December, 1986.

The team had discussions with the officials concerned of the Government of Thailand and conducted a survey. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute 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.

January, 1987

Keisuke Arita
President
Japan International Cooperation Agency

THE KINGDOM OF THAILAND

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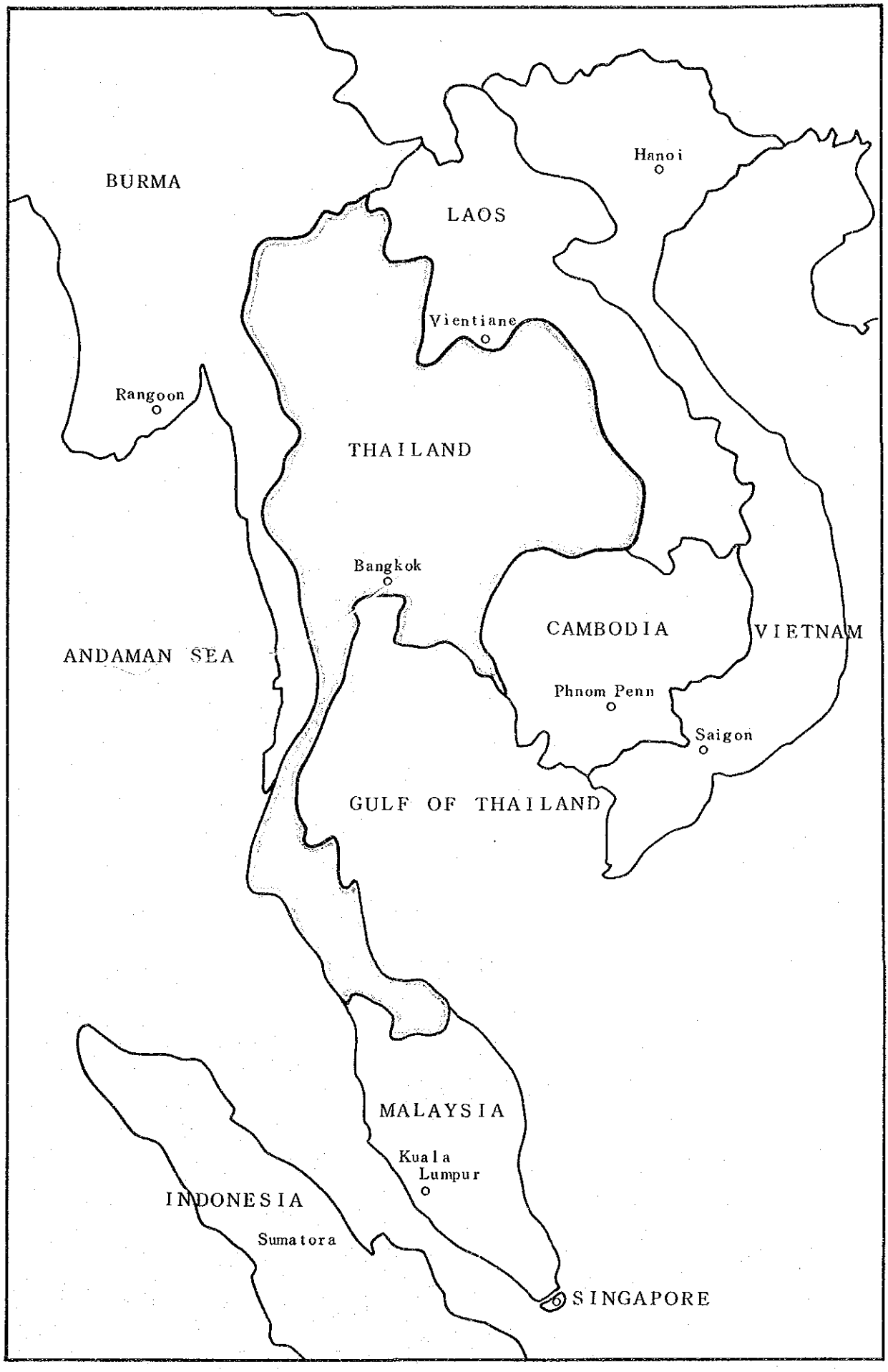
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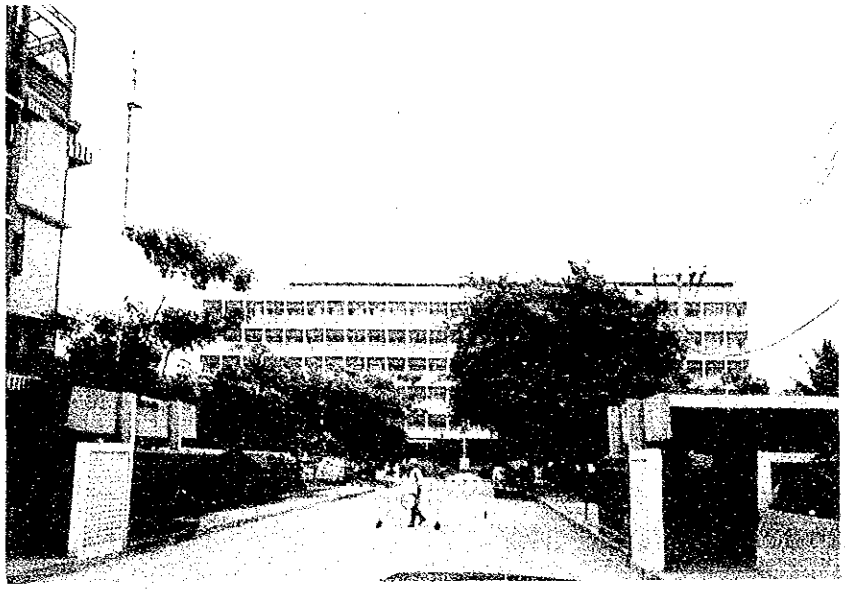
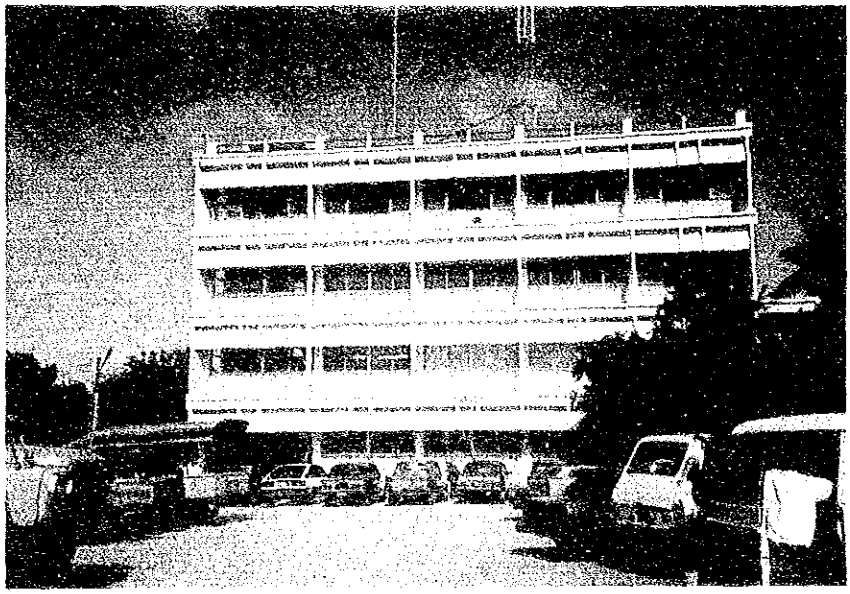


P E A Head Office (Bankok)

P E A Training Center



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Central Region 3 Office (Nakhorn Pathom)
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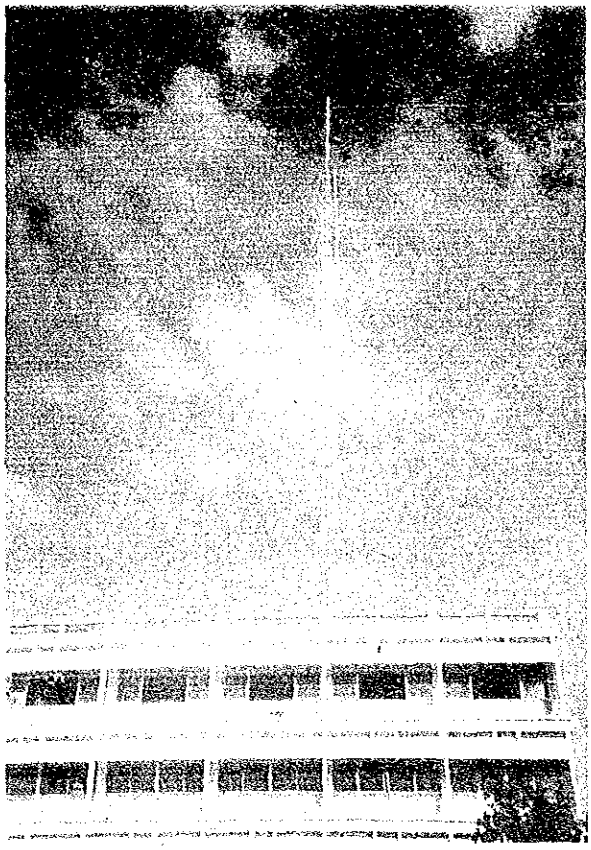
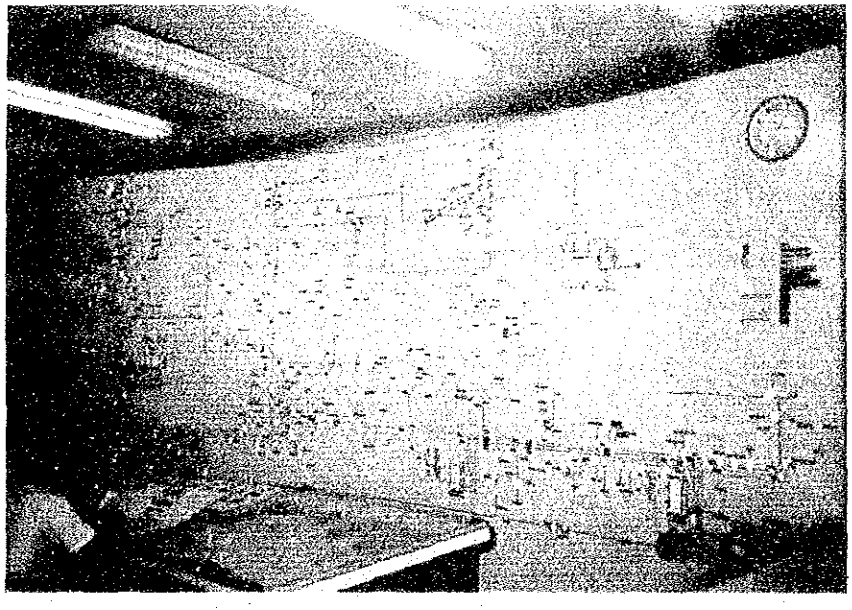
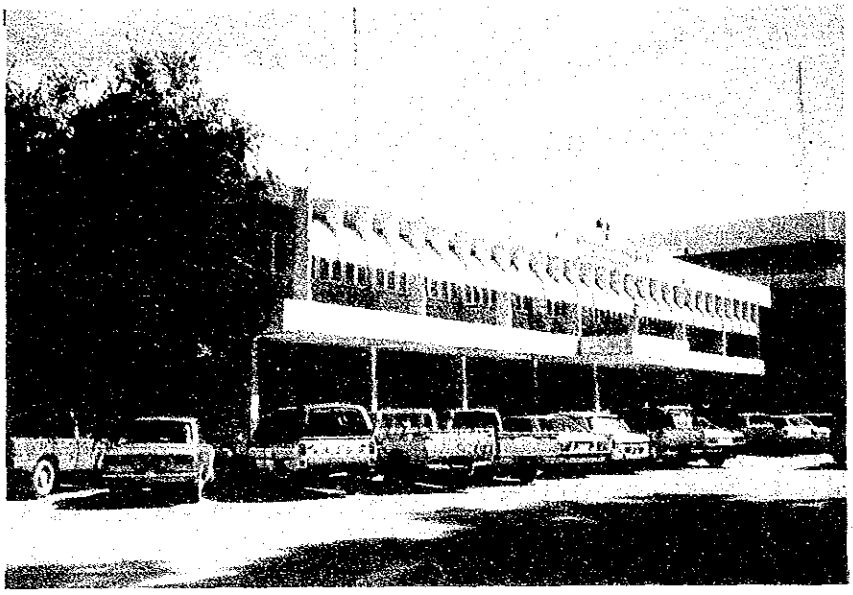


Central Region 3 Office



Nakhorn Pathom Dispatching Center



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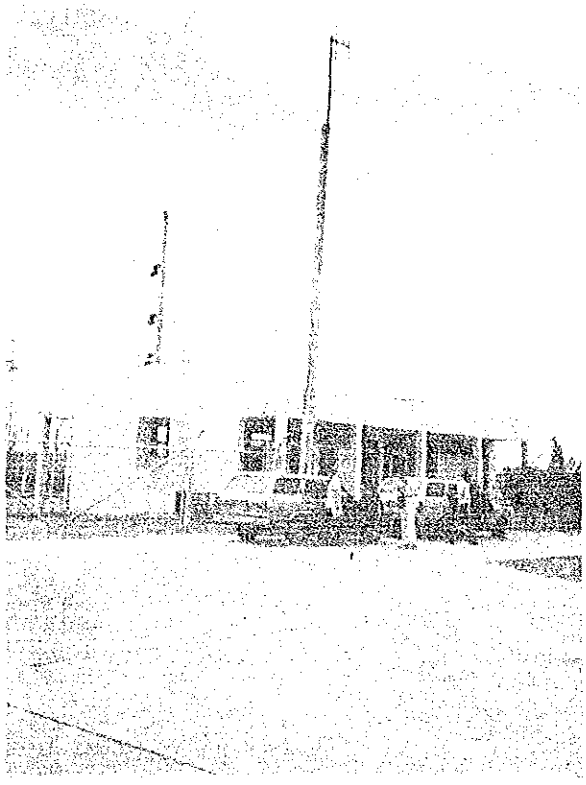
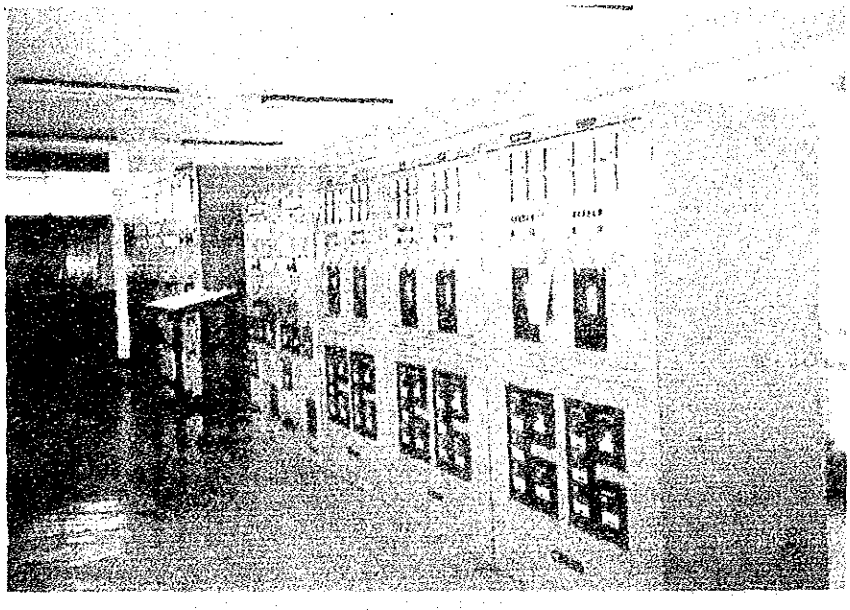
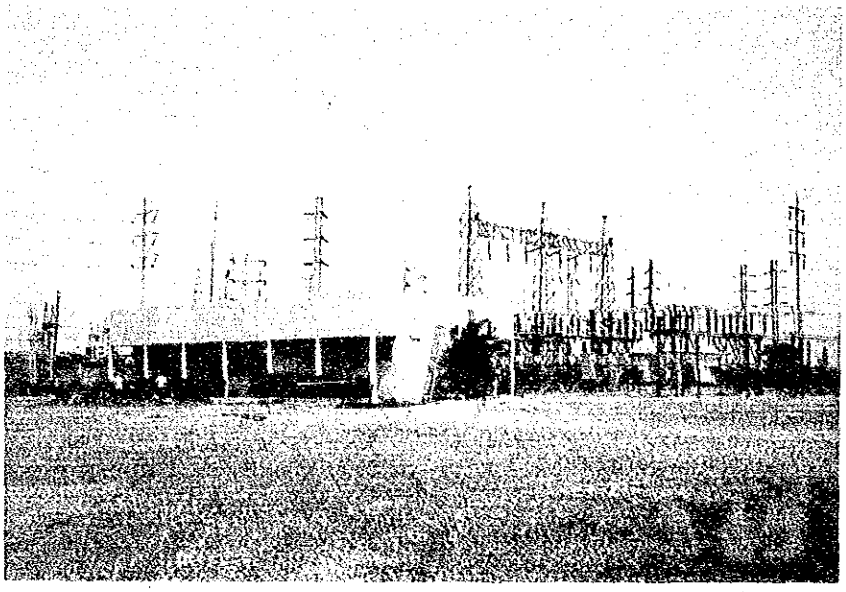


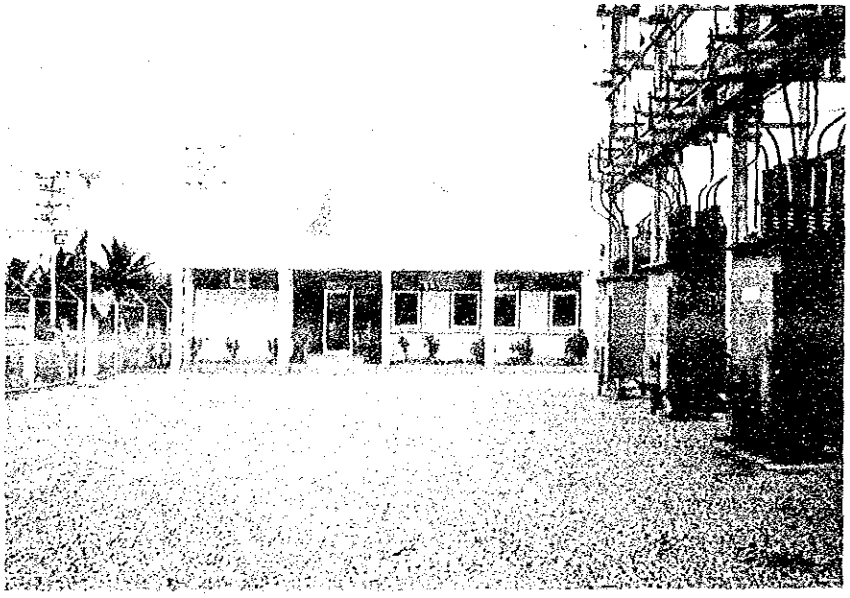
Bang Pa In Control Station (C1)
(10 m Hight Antenna)



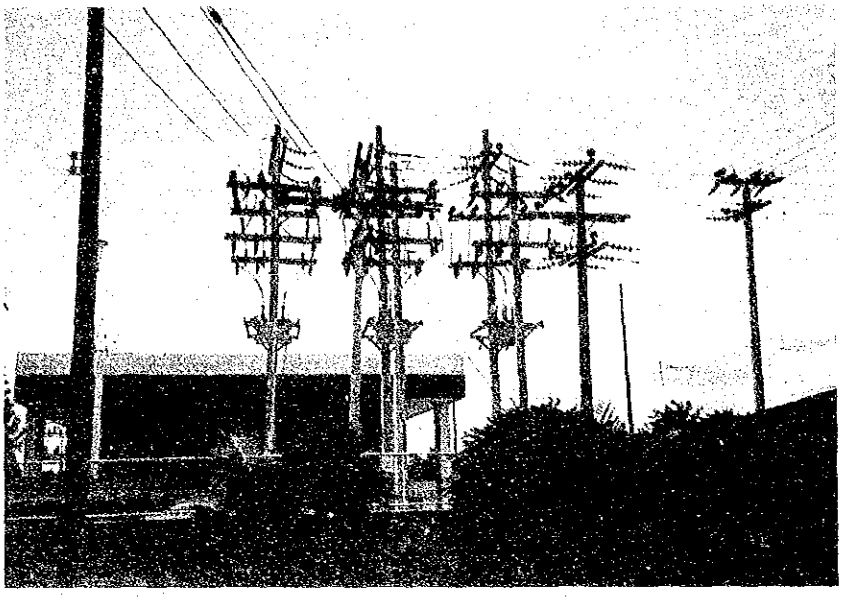
Bang Mai Control Room (C1)



Bang Mai Control Station (C1)



Suphan Buri Control Station (C3)



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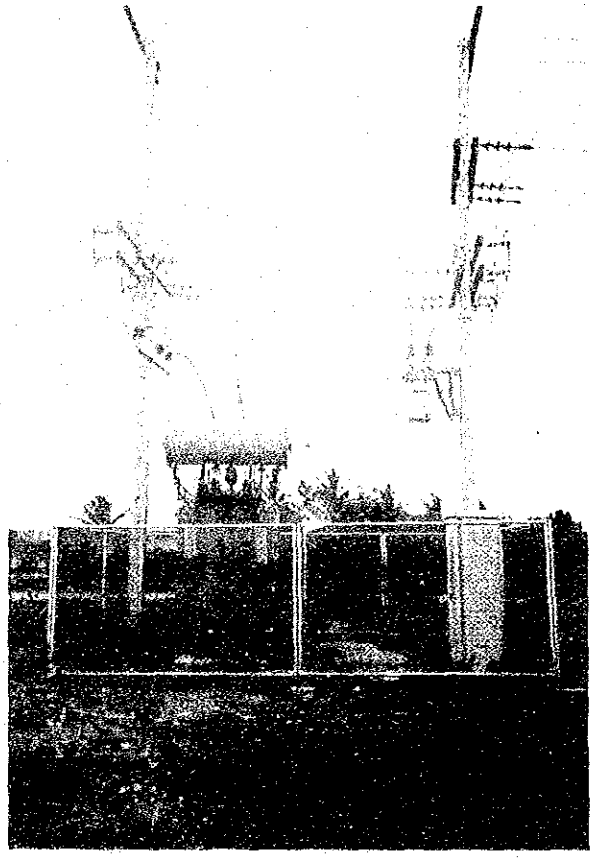
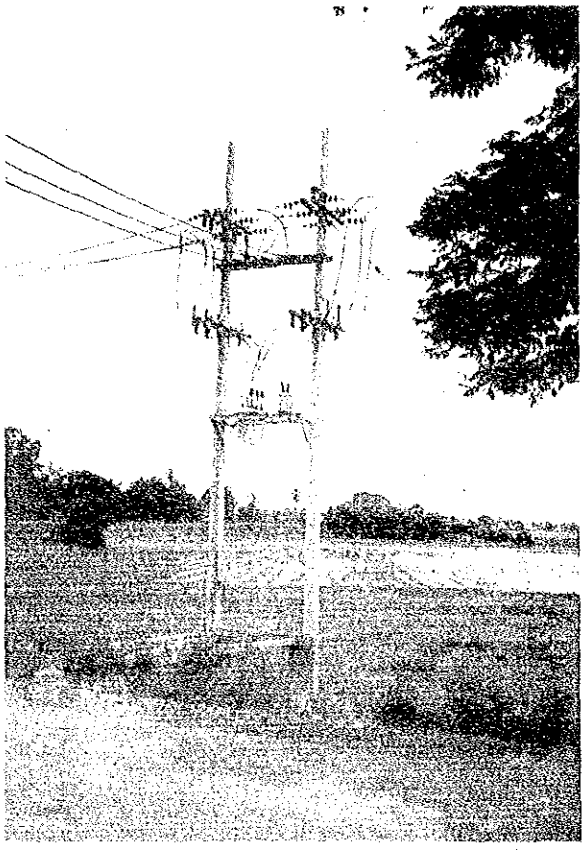
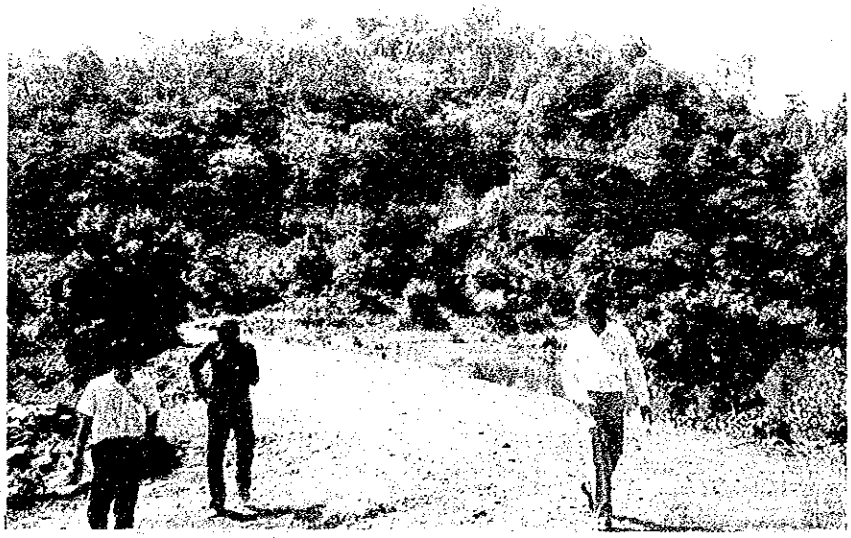


Voltage Regulator



Recloser



Khao Rang Kapoet Repeater Station Site (C3)

GLOSSARY

GLOSSARY

Unit of Measure	Unit	Symbol
Length	millimeter	mm
	meter	m
	kilometer	km (10^3m)
Area	square meter	m^2
	square kilometer	km^2 (10^6m^2)
Volume	megaliter	Ml (10^6l)
	giga cubic feet	Gft^3 (10^9ft^3)
	barrel	barrel (31.5 gallons)
Time	hour	hr
	minute	min.
	second	sec
Temperature	centigrade degree	°C = 5/9(°F - 32)
Thermal Energy	kilocalorie	kcal
Mass	kilogram	kg
	mega ton	Mt (10^6t)
Currency	million US dollars	M.US$
	million Baht	M.Baht
	million Yen	M.Yen

Electricity	Unit	Symbol	
Electric Power	watt	W	
	kilowatt	kW	(10^3W)
	megawatt	MW	(10^6W)
Electric Energy	watt hour	Wh	
	kilowatt hour	kWh	(10^3Wh)
	megawatt hour	MWh	(10^6Wh)
	gigawatt hour	GWh	(10^9Wh)
Voltage	volt	V	
	kilovolt	kV	(10^3)
Apparent Power	kilovolt ampere	kVA	
	megavolt ampere	MVA	(10^3kVA)
Frequency	herz	Hz	
	megaherz	MHz	(10^6Hz)
Signal per Noise	decibel	dB	
Field Strength	decibel	dBm	
Signaling Rate	baud	baud	
Illuminance	lux	lx	

ABBREVIATION

Authority

EGAT	Electricity Generating Authority of Thailand
MEA	Metropolitan Electricity Authority
NEA	National Energy Administration
NESDB	National Economic and Social Development Board
PEA	Provincial Electricity Authority
TOT	Telephone Organization of Thailand

Economic Terms

CIF	Cost, Insurance and Freight
COE	Crude Oil Equivalent
EIRR	Economic Internal Rate of Return
F.C.	Foreign Currency
FIRR	Financial Internal Rate of Return
FY	Fiscal Year (from October to September in Thailand)
GDP	Gross domestic Product
IRR	Internal Rate of Return
L.C.	Local Currency

Technical Terms

ACSR	Aluminum Conductor Steel Reinforced
CRT	Cathode Ray Tube
FEP	Front End Processor
FRU	Feeder Remote Terminal Unit
HF	High Frequency
MTU	Master Terminal Unit
RTU	Remote Terminal Unit
S/N	Signal per Noise
UHF	Ultra High Frequency
VHF	Very High Frequency

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

The following are conclusions and recommendations for the Distribution System Dispatching Center Development Project, for which the study was conducted by the Japan International Cooperation Agency from June 1986 through January 1987 upon the request of the government of the Kingdom of Thailand.

1. Necessity of the Project

The energy sales of PEA is expected to grow at an annual rate of 8.4 percent from 8,557 GWh in FY 1985 to 19,185 GWh in FY 1995, with the share of PEA in the three authorities (EGAT, MEA, PEA) increasing from 42.8 percent to 51.1 percent. Also, the ratio of industrial power demand to the total demand is expected to increase from 44.4 percent in FY 1985 to 46.3 percent in FY 1995. In short, the power demand of PEA will continue to grow at a high growth rate with the ratio of industrial power demand, which requires high supply reliability, continuing to increase steadily.

With the increase of power demand in the future, the power distribution facilities will continue to expand and the configuration of high voltage distribution system will become more complicated.

On the other hand, the faults of high voltage distribution lines are very frequent and the supply interruptions are very long, causing many complaints from customers. The losses of big customers by supply interruptions are estimated at 365 M.Baht in FY 1986, causing the considerable losses to the national economy. The losses of big customers are expected to reach 551 M.Baht in FY 1995 with the increase of industrial power demand.

In spite of the said situation, there is no automated supervisory control equipment provided for the dispatching operations of extensive distribution system, and the dispatching operations are carried out mainly through the voice communication with VHF (partially UHF) radio system. Hence, it is becoming increasingly difficult for PEA to carry out the dispatching operations with the conventional system. Besides, the operation of distribution system will inevitably become more complicated with the growth of power demand and the expansion of power facilities in the future and there will be an increasing social demand for a more reliable power supply.

To cope with the situation, it is essential to promote the automated dispatching operations through the introduction of an advanced distribution dispatching system and the improvement of communication system. It is advisable to carry out these measures as promptly as possible.

2. Distribution System Dispatching Center Development Program

A distribution dispatching center was planned to be constructed in each regional office to supervise and control the substations, sectionalizers and reclosers for the speedy collection of fault information, early detection of fault sections and prompt interchange of power to sound sections, as well as to collect the necessary data for efficient system operation and planning. UHF radio system was adopted for the data transmission.

The proposed distribution dispatching system consists of the following.

Distribution dispatching center	13 centers
Radio repeater station	24 stations
Substation	150 substations
Sectionalizer	871 units
Recloser	420 units

For the number of sectionalizers to be installed, the study was made for the following three cases, of which Case 2 was adopted as the optimum case in terms of the economy.

Case 1: To install one unit for every line

Case 2: To install two units for interconnected line and one unit for radial line

Case 3: To install two units for every line

On completion of the project, the interruption energy in FY 1995 is expected to decrease from 38.7 GWh to 23.3 GWh (60.2 percent), and the interruption energy of big customers is expected to decrease from 10.09 GWh to 5.77 GWh (57.2 percent), resulting in a considerable improvement of supply reliability.

3. Implementation Program of Pilot Distribution System Dispatching Center

Since the automated distribution dispatching system is the first attempt for PEA, the construction of pilot dispatching center and related training unit was planned for the following reasons.

(1) Confirmation, evaluation and improvement of proposed distribution dispatching system and determination of optimum system for the future.

(2) Acquisition of operation and maintenance techniques of automated distribution dispatching system.

(3) Study and training on evaluation, planning, design and construction of automated distribution dispatching system.

(4) Training of engineers/technicians.

The pilot dispatching center was planned to be constructed in Central Region 3 and the training unit in the Training Center.

The proposed pilot distribution dispatching system consists of the following.

Distribution dispatching center	1 center
Radio repeater station	1 station
Substation	12 substations
Sectionalizer	127 units
Recloser	19 units

4. Construction Cost

The construction cost of the project is estimated as follows.

(1,000 US$)

	F.C.	L.C.			Total
		Duties	Others	Sub-Total	
Project Total	66,587	27,290	4,335	31,625	98,212
Pilot Project	8,293	3,395	411	3,806	12,099

5. Implementation Program

The project requires the early implementation and the immediate start of the work as it involves the pilot project.

Accordingly, the study developed the program to implement the pilot project during the period from 1987 to 1989 and the master projects for remaining 11 regions during the five year period from 1990 to 1994. It was also planned to implement the master project in two stages. The project implementation schedule is as shown below.

Stage	Year	Region	Construction Cost (1,000 US$)
1st Stage	1987 - 1989	C3, Training Center	12,099
2nd Stage	1990	C1, C2	19,585
	1991	S1, S2	15,821
	1992	NE3, S3	13,532
3rd Stage	1993	N1, NE1	16,067
	1994	N2, N3, NE2	21,108

The following are recommendations for the implementation of the project.

(1) An appropriate institutional framework for the project implementation must be established.

(2) Particular attention must be paid to the completeness of training.

(3) Assistance of an experienced consultant will be needed.

(4) A package order system is required for the procurement of equipment and materials.

6. Economic Evaluation

The economic internal rate of return (EIRR) of the project was calculated at 11.20 percent for Case 1, 13.44 percent for Case 2 and 11.89 percent for Case 3, and the project may be said to be feasible from the standpoint of national economy. In particular, when the future increase of industrial power demand in the service area of PEA is taken into consideration, the project is expected to have a major effect on the improvement of productivity at customer's factories and activate the industrial investments, thereby contributing greatly to the economic development of Thailand. The effect of the project is not limited to the direct economic effect analyzed by the study but includes,

(1) improvement of power supply reliability,
(2) activation of industrial investment and electric power consumption,
(3) improvement of people's livelihood.

The so-called social rate of return will be considerably higher than EIRR calculated in the study.

The project brings about some benefits on the finance of PEA because the achievement of acceptable degree of reliability and service efficiency requires high investment cost. However a lot of additional benefits which are difficult to measure financially are expected as shown in the followings:-

(1) Effective utilization of system resources through appropriate and timely collection of necessary information.

(2) Improvement of the accuracy of reports used for the operation and planning of distribution system.

(3) Considerable contribution to the efficient implementation of PEA's other projects such as the rural electrification projects, power distribution systems reinforcement projects, etc. with the automated dispatching system and improved communication system.

(4) Reduction in labour works for system operations such as the detection of faulty sections, system operation for the interchange of power to sound sections, etc.

(5) Contribution to meeting the expectations of the publics in terms of safety and better services which will eventually create positive response to PEA and the Government.

Even though the financial burden of the project is estimated to be a considerable amount but it will be soundly managed within the overall balance of PEA by seeking financial support from local or foreign financial institutions.

Chapter 1

BACKGROUND AND OBJECTIVE OF THE PROJECT

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1-1 Background and Objective

The Provincial Electricity Authority (PEA) is under the jurisdiction of the Ministry of Interior, and responsible for the distribution of electricity all over the country, with exception of the metropolitan area where the electricity supply is under the responsibility of the Metropolitan Electricity Authority (MEA).

Since its establishment in 1960, PEA has promoted the extension of electrified area and reinforcement of distribution facilities, and as the result, the annual energy sales amounted to 8,557 GWh and the peak load to 1,956 MW in FY 1985, with the annual average growth rates being 15.0 percent and 14.2 percent, respectively, during the past 10 years. The electrification ratio was 55.2 percent at the end of FY 1985. The power distribution facilities were substantially expanded in the meantime, and the circuit length of high voltage distribution lines reached 89,369 km at the end of FY 1985, with an annual average growth rate being 19.2 percent during the past 10 years.

As for the future forecast, the trend of high growth rate is expected to continue because the government is laying emphasis on the industrial development in the provincial areas, and furthermore the electrification ratio is still low at the present time. Under the circumstances, the power demand is expected to increase to 19,185 GWh in energy sales and 3,877 MW in peak load in FY 1995 at

the annual average growth rates of 8.4 percent and 7.1 percent, respectively. The electrification ratio is expected to be 76.0 percent at the end of FY 1995.

PEA has mainly promoted electrification projects under the Fifth National Economic and Social Development Plan (1982 - 1986), and furthermore another projects consisting mainly of electrification are being planned in succession under the Sixth National Economic and Social Development Plan (1987 - 1991).

It must be kept in mind, however, that the improvement related to the operation and administration of the facilities is lagging behind because thus far PEA has concentrated all of its efforts on the construction of facilities. That being so, there are many problems remaining to be solved, such as the improvement of supply reliability and voltage, the effective utilization of facilities, etc. In particular, referring to the dispatching task of distribution system covering a wide service area, there is no automated supervisory control equipment at all, and the operation is carried out exclusively through the voice communication by VHF (partially UHF) radio system. Under the circumstances, a considerable amount of time and labour have been required for such works as the collection of fault information, detection of faulty sections, interchange of power to sound sections, etc. The frequent complaints have been made by customers because the supply interruptions are long and frequent, and it is becoming increasingly difficult to cope with the situation with the conventional system. Furthermore, it is unquestionable that the operation of distribution system will become more complicated with the increases of both demand and

facilities, and moreover the social requirement for a reliable supply of electricity will become more strict. The promotion of the automation of dispatching task by introducing a modern dispatching system and by improving the communication system is nowadays of urgent need in order to make it possible to cope with the said situation.

The study was carried out in response to the request of technical cooperation made by the Government of the Kingdom of Thailand to the Government of Japan based on the said background.

The objective of the Study is to establish the optimum plan on distribution dispatching and communication systems in the PEA's service area from both economic and technical standpoints, as well as to determine the implementation program for pilot distribution system dispatching center.

1-2 Process of the Study

With the above-mentioned background, the Japan International Cooperation Agency (JICA) organized a study team and sent it to the Kingdom of Thailand. The study team conducted a field survey during the period from June 25 to August 8, 1986. On returning to Japan, the study team reviewed and analyzed the data collected in Thailand and summarized the results of the study in the present Feasibility Study Report on Distribution System Dispatching Center Project.

The work schedule of the study team is as shown in Table 1-1.

1-3 Organization and Itinerary of the Study Team

(1) Organization

The organization of the study team is as follows.

Leader:	FUMINORI SATO,	WEST JEC	- Overall supervision
Member:	YOSHINAO YAHIRO,	WEST JEC	- Communication
Member:	KAZUO CHIJIWA,	WEST JEC	- Substation
Member:	SADAFUMI TOMONAGA,	WEST JEC	- Economic evaluation
Member:	HIROSHI KANEKO,	WEST JEC	- Distribution Dispatching
Member:	KAZUHIRO ABE,	WEST JEC	- Architecture

(2) Itinerary

The itinerary of the study team were as follows.

		Departure	Return
F. SATO	(Field Survey)	Jun. 25, 1986	Aug. 8, 1986
	(Interim Report)	Oct. 12, 1986	Oct. 18, 1986
	(Draft Report)	Dec. 21, 1986	Dec. 27, 1986
Y. YAHIRO	(Field Survey)	Jun. 25, 1986	Aug. 8, 1986
	(Interim Report)	Oct. 12, 1986	Oct. 18, 1986
K. CHIJIWA	(Field Survey)	Jun. 29, 1986	Jul. 28, 1986
S. TOMONAGA	(Field Survey)	Jun. 29, 1986	Jul. 13, 1986
H. KANEKO	(Field Survey)	Jun. 25, 1986	Aug. 8, 1986
K. ABE	(Field Survey)	Jul. 13, 1986	Jul. 22, 1986

(3) Counterparts

The study team discussed and worked with the following counterparts of PEA.

Deputy General Manager	SURASUKDI SENAVONGSE
Assistant General Manager	PRAMUAL KACHATAY
Planning and Civil Works Department	
Director	SAKOL WONGBUDDHA
Project and Planning Division	
Manager	SUNTHORN TANTHAVORN
Deputy Manager	BOONWED CHAROENCHAI
Chief	NARIS SRINUAL
Assistant Chief	CHAIWAT UDOMRATANASIRICHAI
Civil Engineering and Architecture Division	
Deputy Manager	SUBHARP NILVAN
Assistant Manager	PRASERT MANGKALA
Architect	SARANYU UDOMSILPA
Engineer	CHONLATHON SATAVARA
Engineering Department	
Director	CHUTHARAT LEERABHANDH
Electrical and Mechanical Engineering Division	
Manager	PRAVIT CHIRADEJA
Engineer	MANEE PANCHINDAR
Chief	SUWAT IUMCHITKUSOL
Research Division	
Manager	THANU CHINKRUA
Chief	WEERACHAI KOYAKUL
	VORAPOJ PILASLAKSANAKAN
Training Center	
Manager	SOMCHAI SRIRATH
Operation and Maintenance Department	
Director	PRACHA THITATHAN
Distribution System Dispatching Center	
Manager	KAYJORN SONGKAKUL
Deputy Manager	NEETHI BHAVAKUL
Chief	THO KONGSAKUL
Assistant Chief	PASSAKORN CUPTAVANICH
Engineer	SUWAT CHIOCHANCHAI

Table 1-1 IMPLEMENTATION SCHEDULE OF THE STUDY

THE FEASIBILITY STUDY ON DISTRIBUTION SYSTEM DISPATCHING CENTER PROJECT IN THE KINGDOM OF THAILAND (1986)

	NAME	ASSIGNMENT	DESCRIPTION OF WORKS
Field study in Thailand and Works in Japan	FUMINORI SATO	Team Leader Overall supervision	Overall supervision of the study Economic and financial evaluation Study of optimum distribution dispatching system Preparation of reports
	YOSHINAO YAHIRO	Communication	Review of present status and future plan of communication system Study of data transmission system Study of improvement plan of general communication system
	KAZUO CHIJIWA	Substation	Review of present status and future plan of substation Review of operation and maintenance system of control station Study of facilities to be supervisory controlled
	SADAFUMI TOMONAGA	Economic analysis	Economic and financial analysis Review of economic situation Review of past record and forecast of electric power demand
	HIROSHI KANEKO	Distribution Dispatching	Review of present status and future plan of distribution system Review of distribution dispatching and maintenance system Study and design of distribution dispatching system
	KAZUHIRO ABE	Architecture	Study of architectural requirements for dispatching center and control station Architectural design
Works in Japan	YASUO WANI	Communication Dispatching	Study of optimum data transmission system Study and design of distribution dispatching system

ITEMS / YEAR & MONTH

OVERALL SCHEDULE

1986: 6 7 8 9 10 11 12 — 1987: 1 2

Inception Report — Survey Report — Interim Report — Draft Final Report — Final Report

WORKS IN THAILAND
WORKS IN JAPAN
CONCURRENT WORKS

Chapter 2

GENERAL CONDITIONS AND ELECTRIC POWER SITUATION IN THAILAND

Chapter 2 GENERAL CONDITIONS AND ELECTRIC POWER SITUATION IN THAILAND

The Kingdom of Thailand is situated in lat. 6°-21°N. and long. 97°-106°E., occupying almost the central portion of the Indochina Peninsula. The country borders on Burma in the north and west, Laos in the north and northeast, Cambodia in the east and Malaysia in the south. The country extends over 1,800 km in the north-south direction and 750 km in the east-west direction. The total land area is approximately 513,000 km^2, which is about 1.4 times larger than Japan.

The population in 1985 was 51.3 million, with the annual average growth rate of 2.0 percent during the 1980 - 1985 period. The population in 1995 is estimated to increase to 60.5 million, with the annual average growth rate of 1.7 percent during the 1985 - 1995 period.

The climate in Thailand is that of tropical monsoon and the year is divided into the wet season (June to October) and the dry season (November to May). There is no big difference in temperature between regions, with the maximum temperature being in the range of 31 to 35°C and minimum temperature in the range of 21 to 25°C. The annual rainfall is of the order of 1,000 mm to 1,500 mm in lowland and about 1,200 mm in mountain regions, except for some part of southern regions where the rainfall exceeds 4,000 mm, and less than 1,000 mm in some part of northeastern regions.

2-1 Economic Situation

The planned economic development of Thailand started with the First National Economic and Social Development Plan (January 1961 to September 1966), and through the Second Plan (October 1966 to September 1971), Third Plan (October 1971 to September 1976), Fourth Plan (October 1976 to September 1981) and Fifth Plan (October 1981 to September 1986), the Sixth Plan (October 1986 to September 1991) is now under way. The annual average growth rate of real GDP during these period was 7.3 percent under the First Plan, 7.2 percent under the Second Plan, 7.1 percent under the Third Plan and 7.1 percent under the Fourth Plan, indicating a favorable growth of Thai economy during the 20 year period between 1961 and 1981.

Tables 2-1, 2-2 and 2-3 show the main economic indicators, real GDP by industrial origin and nominal GDP by industrial origin, respectively. The growth rate of real GDP under the Fifth Plan declined owing to the world-wide recessions following the second oil crisis, sluggish world trade and low prices of primary products, indicating 5.0 percent during the period up to September 1985. By industrial origin, the real GDP in 1985 was 23.2 percent for agriculture, 20.8 percent for manufacturing, 15.7 percent for wholesale and retail trade, 11.6 percent for services, 7.8 percent for banking, insurance and real estate, 6.9 percent for transportation and communication and 14.0 percent for others. A high growth rate was enjoyed by banking, insurance and real estate, electricity and water supply, services, mining and quarrying, manufacturing, transportation and communication.

Tables 2-4, 2-5 and 2-6 show the trade balance, exported amount by main primary products and imported amount by main goods, respectively. The trade of Thailand shows the pattern which is common to most of developing countries by exporting such primary products as rice, tapioca, crude rubber, sugar, tin, and maize and importing capital goods, including machinery, steel and chemical products, industrial raw materials and consumer goods. The trade balance of Thailand was constantly in the red, with the amount of deficits tending to increase in recent years because its exports depend largely on such primary products as agricultural and marine products and minerals, which are easily affected by the weather and the trend of international market and also because the export industry has not developed sufficiently to gain the required competitive power in the international market, and the import of crude oil, industrial raw materials and capital goods tend to increase with the growth of national economy. The international balance of payments in Thailand was such that the trade deficits were covered by the surplus of invisible trade balance and capital balance (see Table 2-1).

The second oil crisis in 1979 also had a major impact on Thai's commodity prices and the consumer price during the 1979 - 1981 period rose sharply. Thereafter, however, the prices are calming down (see Table 2-1).

2-2 Energy Situation

Tables 2-7 and 2-8 show the past records and forecast of energy consumption, respectively.

In 1984, the energy consumption in Thailand reached 23,249 Ml of crude oil equivalent. While the annual average growth rate of energy consumption in the latter half of the 70's (1975 - 1980) was 11.9 percent, it dropped to 6.0 percent in the first half of the 80's (1980 - 1984). As a result of the development of such domestic energy resources as natural gas and lignite in line with government's development policy of domestic energy resources for oil after 1973, the share of domestic energy resources increased from 19.4 percent in 1975 to 49.9 percent in 1984, with the rate of dependence on oil dropping from 80.6 percent in 1975 to 54.8 percent in 1984.

During the period from 1985 to 1992, the energy consumption is expected to increase at an annual average growth rate of 6.5 percent and reach 38.568 Ml (COE) in 1992, with the rate of dependence on oil further dropping to 48.2 percent.

The present status and future outlooks of domestic energy resources are as follows.

(1) Petroleum

The consumption of domestic petroleum products in 1984 amounted to 1,197 Ml (COE), accounting for 9.4 percent of the total consumption of petroleum products. The oil production in 1984 was 5.4 million barrels of crude oil and 3 million barrels of condensate, for a total of 8.4 million barrels.

The oil fields in operation are Lan Krabue oil field and Fang oil field, both of them located in the north region. No promising offshore oil fields have yet been discovered. The oil reserves in Thailand have not been determined definitely.

(2) Natural Gas

The consumption of natural gas in Thailand in 1984 amounted to 2,284 Ml (COE), accounting for 9.8 percent of the total energy consumption. The practical use of natural gas started in September 1981 and the production in 1984 amounted to 85.5 Gft^3. The gas fields developed are Erawan and Baanpot gas fields in the Gulf of Thailand and Lan Krabue gas field in the northern region. Currently, the natural gas is used mainly for the electric power generation, with part being used by the cement plants and others.

The reserves of natural gas have not been made public, but the confirmed reserves are said to be 4,000 Gft^3 and the potential reserves 10,000 Gft^3.

The consumption of natural gas in 1992 is estimated at 5,847 Ml (COE), accounting for 15.2 percent of the total energy consumption. The development program for natural gas thermal power plants is described in Clause 2-5.

(3) Lignite

The consumption of lignite in 1984 amounted to 852 Ml (COE), accounting for 3.7 percent of the total energy consumption. The representative lignite mines are located at Mae Moh and Li in the north and at Krabi in the south. The lignite production in 1984 was 2.4 Mt.

The lignite reserves are estimated at 680 - 1,480 Mt. In Thailand, all lignite mines are open mines. While the reserves are enormous, the greater part of lignite is of low caloric values and is used mostly for the electric power generation.

The consumption of lignite in 1992 is estimated at 3,762 Ml (COE), accounting for 9.8 percent of the total energy consumption. The development program for lignite thermal power plants is described in Clause 2-5.

(4) Hydro Power Generation

The energy generated by hydro power plants in 1984 amounted to 1,221 Ml (COE), accounting for 5.3 percent of the total energy consumption.

The potential hydro-energy is estimated at 27,015 MW, comprising 10,120 MW of domestic rivers and 16,895 MW of international rivers bordering on Laos and Burma.

The hydro power generation in 1992 is estimated at 1,717 Ml (COE), accounting for 4.5 percent of the total energy consumption. The development program for hydro power plants is described in Clause 2-5.

(5) Other Energy Resources

As for the energy resource to be used as a substitute for petroleum, the development of oil shale, geothermal, biogas, alcohol, solar energy, wind force and nuclear power may be considered.

The oil shale deposit with estimated reserves of 18,000 Mt has been discovered in the northern region.

2-3 Operation of Electric Power Industry in Thailand

The power industry of the Kingdom of Thailand is operated by 3 Authorities, the Electricity Generating Authority of Thailand (EGAT) which takes charge of the power generation and transmission, the Metropolitan Electricity Authority (MEA) which takes charge of the distribution of electricity in the metropolitan area, and the Provincial Electricity Authority (PEA) which takes charge of the distribution of electricity in other areas excluding the metropolitan area.

The power plants, transmission system and substations all over the country are under the control of EGAT, while the transmission system, substations and distribution system located in the metropolitan area are under the control of MEA. On the other hand, PEA is mainly in charge of the distribution system, but it possesses also 3 substations besides the said system, and moreover it operates diesel power plants to supply electricity in remote areas. Besides the said Authorities, the National Energy Administration (NEA) has mini-hydro power plants located at 3 places.

The general administrative affairs related to electricity are taken charge by NEA, and the coordination of the power system projects all over the country is taken charge by the National Economic and Social Development Board (NESDB).

NEA is under the jurisdiction of the Ministry of Science Technology and Energy, NESDB and EGAT are under the jurisdiction of the Office of the Prime Minister, and MEA and PEA are under the jurisdiction of the Ministry of Interior.

2-4 Electric Power Demand

(1) Past Records and Forecast of Power Demand

The past records and forecast of power demand in the Kingdom of Thailand are shown in Table 2-9. The power demand forecast is conducted by the working group consisting of members of NESDB, NEA, EGAT, MEA and PEA. This forecast was prepared in September, 1986.

In FY 1985, the power demand amounted to 19,979 GWh in energy sales and 3,878 MW in peak load, and the annual average growth rates were 9.0 percent and 9.9 percent, respectively during the past 5 years. As for the energy sales by customer classifications, Residential accounted for 25.5 percent of total energy sales, Business 24.4 percent, Industrial 44.9 percent and Others 5.2 percent. As for the annual average growth rate, Residential increased at a particularly high rate of 12.0 percent. The loss ratio was 14.5 percent and the annual load factor was 68.8 percent. The electrification ratio was 59.1 percent.

The power demand is expected to increase to 37,549 GWh in energy sales and 7,128 MW in peak load in FY 1995 at the annual average growth rates of 6.5 percent and 6.3 percent, respectively. The electrification ratio is expected to reach 79.5 percent.

Table 2-10 shows the elasticities between GDP and electric power consumption. While the annual average growth

rate of GDP during the period from FY 1975 to FY 1980 was fairly high at 7.55 percent, that of electric power consumption was extremely high at 12.12 percent, with the elasticity being high at 1.605. During the period from FY 1980 to FY 1985, the growth rate of electric power consumption declined to 8.963 percent, but because the GDP growth rate also declined to 5.279 percent due to the reason mentioned in Clause 2-1, the elasticity remained high at 1.698. The high growth rate of power consumption during the period from FY 1975 to FY 1985 was largely due to the progress of the electrification project. The electrification ratio increased sharply from 21.8 percent in FY 1975 to 59.1 percent in FY 1985 (see Table 2-9).

In the future, the electrification project is expected to have a less effect on the growth rate of electric power consumption and the annual average growth rate of electric power consumption up to FY 1995 is estimated at 6.5 percent. Accordingly the elasticities are considered to come near 1.

(2) Past Records and Forecast of Energy Sales by Authorities

The past records and forecast of energy sales by Authorities in the Kingdom of Thailand are shown in Table 2-11. By Authorities, EGAT accounted for 4.6 percent of total energy sales, MEA 52.6 percent and PEA 42.8 percent in FY 1985. The annual average growth rates were 15.5 percent for EGAT, 6.0 percent for MEA, 12.8 percent for PEA and 9.0 percent for total during the past 5 years.

In FY 1995, EGAT is expected to account for 3.1 percent of total energy sales, MEA 45.8 percent and PEA 51.1 percent. The annual average growth rates is expected to be 2.6 percent for EGAT, 5.0 percent for MEA, 8.4 percent for PEA and 6.5 percent for total. The energy sales of PEA is expected to surpass that of MEA in FY 1989, and the proportion shared by PEA is expected to continue to rise thereafter.

2-5 Present Status and Future Plans of Power Generation Facilities

The present status and future plans of power generation facilities of EGAT are shown in Table 2-12, and the power system diagram of EGAT is shown in Figure 2-1. Details of the development plan are shown in Annexes 2-1-1 to 2-1-6.

At the end of FY 1985, the total installed capacity amounted to 6,459.7 MW, comprising 2,400 MW (37.2 percent) of natural-gas-fired thermal power plants, 1,813.6 MW (28.1 percent) of hydro power plants, 985 MW (15.2 percent) of gas turbine power plants, 885 MW (13.7 percent) of lignite-fired thermal power plants, 342.5 MW (5.3 percent) of oil-fired thermal power plants, and 33.6 MW (0.5 percent) of diesel power plants. As can be seen, natural gas thermal, hydro, gas turbine and lignite thermal power plants accounted for the majority of installed capacity. As for the installed capacity by region, the Central Region accounted for 63.2 percent, the Northern Region 28.9 percent, the Southern Region 5.7 percent and the Northeastern Region 2.1 percent, and as can be seen the Southern and Northeastern Regions are lagging behind in terms of installed capacity. The main power plants of the country are listed in the following table.

Region	Power Plant	Installed Capacity (MW)	Type
Northern	Mae Moh	825	Lignite
	Bhumibol	535	Hydro
	Sirikit	375	"
	Lan Krabue	120	Gas Turbine
Central	South Bangkok	1,300	Natural Gas
	Bang Pakong	1,100	"
		720	Gas Turbine
	Srinagarind	360	Hydro
	Khao Laem	300	"
	North Bangkok	237.5	Oil

As for the energy generated by type of energy resources in FY 1985, natural gas accounted for 43.0 percent, lignite 19.0 percent, oil 18.2 percent, hydro 16.6 percent and purchased power 3.2 percent. Emphasis is being laid on the utilization of domestic energy resources (natural gas, lignite and hydro), and the proportion of oil has declined to 18.2 percent from 32.2 percent of FY 1984.

The installed capacity expected to be developed by FY 1995 amounts to 3,134.5 MW, comprising 1,184.5 MW of hydro power plants, 1,200 MW of gas turbine power plants, 675 MW of lignite-fired thermal power plants and 75 MW of oil-fired thermal power plants, and as can be seen, continuous emphasis will be laid on the utilization of domestic energy resources. As a result, at the end of FY 1995, the installed capacity will consist of 2,998.1 MW (32.8 percent) of hydro, 2,400 MW (26.2 percent) of natural-gas thermal, 2,065 MW (22.6 percent) of gas turbines, 1,500 MW of lignite thermal and 180 MW (2.0 percent) of oil thermal, totalling 9,143.1 MW, and as a consequence the proportion shared by oil in the total energy generation is expected to decline to 2.2 percent.

As for the installed capacity by region, the Central Region will account for 52.0 percent, the Northern Region 27.0 percent, the Southern Region 13.3 percent, and the Northeastern Region 7.7 percent, with the developments planned also in the Southern and Northeastern Regions.

2-6 Present Status and Future Plans of Transmission and Substation Facilities

At the end of FY 1985, the circuit length of transmission lines of EGAT reached 5,191 km of 230 kV transmission lines, 9 km of 132 kV transmission lines, 8,322 km of 115 kV transmission lines and 933 km of 69 kV transmission lines, totalling 14,455 km, and as can be seen, the 230 kV and 115 kV transmission lines account for the majority of transmission lines in the Kingdom of Thailand. The 230 kV transmission lines form the trunk systems from the power stations located in the Northern and Central Regions to Bangkok. The Northeastern Region is connected with the 230 kV system coming from the Northern Region and the 115 kV system coming from the Central Region, and on the other hand the Southern Region is connected with the 115 kV system coming from the Central Region. The local transmission systems of each Region are either 115 kV or 69 kV ones.

As for the future plans referring to the transmission system, the construction of new 500 kV transmission line from the Mae Moh power plant located in the Northern Region to Bangkok, the extension of the 230 kV transmission line to the Southern Region, the reinforcement of the 230 kV system to the Northeastern Region, and

the extension of the 115 kV systems of each Region are planned. The total circuit length of the transmission lines is expected to reach 21,400 km at the end of FY 1995 as a result of these expansion plans. The construction of the 500 kV transmission line from the Mae Moh Power Plant to Bangkok is partly expected to complete soon.

At the end of FY 1985, the number of substations under the control of EGAT consisted of twenty-three 230 kV substations with the total installed capacity of 6,455.6 MVA, one 132 kV substation of 66.7 MVA, Seventy-nine 115 kV substations of 3,338 MVA, eighteen 69 kV substations of 328.3 MVA, and 22 kV substations of 13 MVA, totalling 121 substations of 10,201.6 MVA. According to the existing plans the total installed capacity of substations is expected to reach 24,320 MVA at the end of FY 1995.

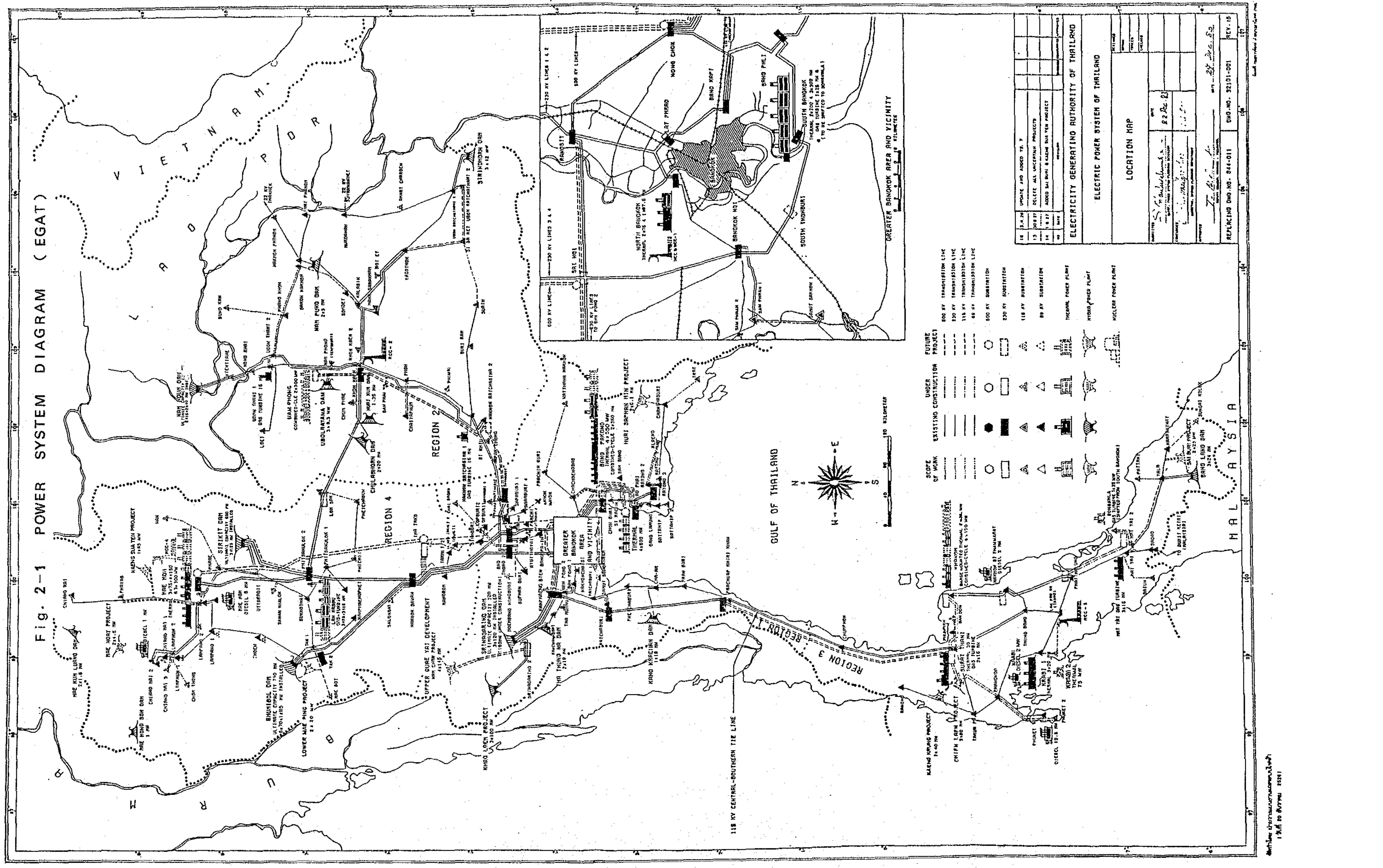
Fig. 2-1 POWER SYSTEM DIAGRAM (EGAT)
VIETNAM
LAO PDR
BURMA
MALAYSIA
GULF OF THAILAND
GREATER BANGKOK AREA AND VICINITY
ELECTRICITY GENERATING AUTHORITY OF THAILAND
ELECTRIC POWER SYSTEM OF THAILAND
LOCATION MAP
115 KV CENTRAL-SOUTHERN TIE LINE
REGION 1
REGION 2
REGION 3
REGION 4

Table 2-1 MAIN ECONOMIC INDICATORS

Item		1976	1977	1978	1979	1980	1981	1982	1983	1984
Population (x 1,000)		42,421	43,436	44,463	45,460	46,461	47,490	48,490	49,461	50,397
GDP Growth Rate (Constant Price)	(%)	8.7	7.2	10.1	6.1	5.8	6.3	4.1	5.8	6.2
GDP Growth Rate (Current Price)	(%)	13.0	19.8	21.8	18.4	23.1	14.8	7.6	9.2	7.3
Per Capita GNP	(US$)	389	441	514	589	707	738	735	790	806
Consumer Price Index		100.0	107.6	116.1	127.6	152.7	172.1	181.1	187.9	189.5
	(%)	4.2	7.6	7.9	9.9	19.7	12.7	5.2	3.8	0.9
Balance of International Payment (M. Baht)	Trade	(11,085)	(25,599)	(28,540)	(47,053)	(57,985)	(65,782)	(36,137)	(89,237)	(68,796)
	All Items	(81)	(7,538)	(13,298)	(7,925)	5,179	2,531	3,314	(18,078)	10,588
Foreign Currency Reserves	(M. US$)	1,893	1,915	2,557	3,129	3,026	2,726	2,652	2,555	2,689
Outstanding Foreign Debts (Public Sector)	(M. US$)	816	1,139	1,786	2,713	3,932	5,238	6,032	6,876	8,538
Exchange Rate (to US$)		20.400	20.400	20.336	20.419	20.476	21.820	23.000	23.000	23.639

Table 2-2 GROSS DOMESTIC PRODUCT BY INDUSTRIAL ORIGIN
(1972 Prices)

(Unit: M. Baht)

Industrial Origin	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	%	Annual Growth Rate (%)	
												1976--1981	1981--1985
Argiculture	65,898	65,537	72,513	71,408	72,784	77,701	78,502	81,449	85,902	87,897	23.2	3.4	3.1
Crops	49,013	46,794	53,583	51,804	54,179	58,528	59,904	61,919	65,518	66,696	17.6	3.6	3.3
Livestock	7,622	8,102	8,515	8,931	9,011	9,500	9,897	10,332	10,781	11,088	2.9	4.5	3.9
Fisheries	5,898	7,499	7,414	7,281	6,276	6,777	6,019	6,568	6,862	7,290	1.9	2.8	1.8
Forestry	3,365	3,142	3,001	3,392	3,318	2,896	2,682	2,630	2,741	2,823	0.7	(3.0)	(0.6)
Mining and quarrying	2,906	3,526	4,104	4,531	4,780	4,623	4,431	4,414	5,415	6,012	1.6	9.7	6.8
Manufacturing	42,529	48,071	52,521	57,841	60,597	64,490	67,317	72,252	77,081	78,921	20.8	8.7	5.2
Construction	10,022	11,996	13,583	14,547	16,576	15,500	15,097	15,927	17,680	17,603	4.6	9.1	3.2
Electricity and water supply	3,642	4,144	4,500	5,178	5,560	6,330	6,755	7,348	8,088	8,875	2.3	11.7	8.8
Traisportation and communication	13,366	14,474	16,205	17,663	18,811	20,209	21,715	23,290	24,605	26,242	6.9	8.6	6.7
Wholesale and retaid trade	38,821	41,213	43,658	45,497	48,227	51,103	52,789	55,076	57,430	59,497	15.7	5.7	3.9
Banking, insurance and real estate	10,208	11,574	13,443	15,582	17,419	19,197	21,396	24,238	26,994	29,388	7.8	13.5	11.2
Ownership of dwellings	3,664	3,823	4,052	4,289	4,502	4,723	4,936	5,178	5,369	5,594	1.5	5.2	4.3
Public administration and defence	8,893	9,555	10,166	11,594	12,423	13,192	13,833	14,498	14,106	14,873	3.9	8.2	3.0
Services	21,276	23,260	26,352	28,777	31,173	34,202	37,261	39,276	41,536	43,854	11.6	10.0	6.4
Gross domestic product (GDP)	221,225	237,173	261,097	276,907	292,852	311,270	324,032	342,946	364,206	378,756	100.0	7.1	5.0
Plus: Net factor income payment from the rest of the world	(1,020)	(1,575)	(4,054)	(7,010)	(8,279)	(12,985)	(14,910)	(14,080)	(17,372)	(17,702)		-	-
Gross national product (GNP)	220,205	235,598	257,043	269,897	284,573	298,285	309,122	328,866	346,834	361,054		6.3	4.9
Per capita GNP (BAHT)	5,191	5,424	5,781	5,937	6,125	6,281	6,375	6,649	6,882	7,038		3.9	2.9
Population (x 1,000 capita)	42,421	43,436	44,463	45,460	46,461	47,490	48,490	49,461	50,397	51,301		2.3	1.9

Table 2-3 GROSS DOMESTIC PRODUCT BY INDUSTRIAL ORIGIN
(Current Prices)

(Unit: M. Baht)

Industrial Origin	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	%	Annual Growth Rate (%)	
												1976--1981	1981--1985
Argiculture	104,657	110,929	129,094	147,076	173,806	187,886	188,742	204,443	193,436	182,279	17.4	12.4	(0.8)
Crops	77,509	79,069	96,180	107,980	130,372	138,886	139,852	149,973	141,690	132,557	12.7	12.4	(1.2)
Livestock	12,354	14,409	13,503	16,954	21,717	24,727	23,608	28,840	26,326	23,906	2.3	14.9	(0.8)
Fisheries	9,792	12,456	13,086	13,017	11,984	13,183	14,150	14,466	13,146	12,651	1.2	6.1	(1.0)
Forestry	5,002	4,995	6,325	9,125	9,733	11,090	11,132	11,164	12,274	13,165	1.2	17.3	4.4
Mining and quarrying	5,174	8,139	10,679	12,614	14,493	13,373	14,807	16,480	21,291	29,279	2.8	20.9	21.6
Manufacturing	63,025	74,676	89,089	109,740	134,515	158,272	164,659	176,200	196,793	207,691	19.8	20.2	7.0
Construction	15,784	20,251	24,344	29,240	39,865	42,008	43,040	47,129	52,772	53,758	5.1	21.7	6.4
Electricity and water supply	3,745	4,384	5,168	6,075	6,284	10,743	14,454	16,319	18,884	21,645	2.1	23.5	19.1
Transportation and communication	21,828	24,706	29,606	37,844	45,261	57,281	63,133	73,708	83,588	96,254	9.2	21.3	13.9
Wholesale and retail trade	59,391	74,931	90,053	102,853	128,731	150,293	159,849	165,812	181,993	190,676	18.2	20.4	6.1
Banking, insurance and real estate	16,075	19,537	24,624	31,396	41,891	52,025	61,021	71,722	80,577	89,751	8.6	26.5	14.6
Ownership of dwellings	4,840	5,272	5,826	6,297	7,378	8,411	9,912	11,210	12,339	13,706	1.3	11.7	13.0
Public administration and defence	13,571	14,810	17,943	21,623	28,263	30,645	37,349	42,551	43,182	47,058	4.5	17.7	11.3
Services	29,545	35,395	43,095	51,482	64,443	75,229	89,170	98,680	106,704	115,467	11.0	20.6	11.3
Gross domestic product, (GDP)	337,635	393,030	469,952	556,240	684,930	786,166	846,136	924,254	991,559	1,047,564	100.0	18.4	7.4
Plus: Net factor income payment from the rest of the world	(1,261)	(2,014)	(5,402)	(9,791)	(12,490)	(21,787)	(26,376)	(25,390)	(31,776)	(37,081)		-	-
Gross national product, (GNP)	336,374	391,016	464,550	546,449	672,440	764,379	819,760	898,864	959,783	1,010,483		17.8	7.2
Less:													
Indirect taxes less subsidy	33,438	43,717	51,733	60,903	71,473	79,879	83,904	100,947	111,397	114,246		19.0	9.4
Depreciation	24,041	28,609	34,428	41,887	50,640	59,259	65,649	73,386	81,773	89,679		19.8	10.9
National income, (NNP)	278,895	318,690	378,389	443,659	550,327	625,241	670,207	724,531	766,613	806,558		17.5	6.6
Per capita GNP (BAHT)	7,930	9,001	10,449	12,020	14,474	16,096	16,906	18,174	19,044	19,697		15.2	5.2
Population (x 1,000 capita)	42,421	43,436	44,463	45,460	46,461	47,490	48,490	49,461	50,397	51,301		2.3	1.9

Table 2-4 BALANCE OF TRADE

(Unit: M. Baht)

Year	Export		Import		Balance
	Amount (A)	Growth Rate (%)	Amount (B)	Growth Rate (%)	(A - B)
1975	44,365		64,527		(20,162)
1976	60,361	36.1	71,446	10.7	(11,085)
1977	70,463	16.7	96,062	34.5	(25,599)
1978	82,251	16.7	110,791	15.3	(28,540)
1979	106,881	29.9	153,934	38.9	(47,053)
1980	132,040	23.5	190,025	23.4	(57,985)
1981	150,218	13.8	216,000	13.7	(65,782)
1982	157,203	4.6	193,340	(10.5)	(36,137)
1983	145,076	(7.7)	234,313	21.2	(89,237)
1984	173,520	19.6	242,316	3.4	(68,796)

Source: Bank of Thailand

Table 2-5 EXPORTED AMOUNT BY MAIN PRIMARY PRODUCTS

(Unit: M. Baht)

Products	1980		1981		1982		1983		1984	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Rice	19,508	14.6	26,366	17.2	22,510	14.1	20,157	13.8	25,932	14.8
Tapioca Products	14,887	11.2	16,446	10.7	19,752	12.4	15,387	10.5	16,600	9.5
Raw Rubber	12,351	9.3	10,841	7.1	9,490	5.9	11,787	8.0	13,004	7.4
Maize	7,299	5.5	8,349	5.5	8,330	5.2	8,486	5.8	10,147	5.8
Tin	11,347	8.5	9,091	5.9	7,773	4.9	5,265	3.6	5,280	3.0
Sugar	2,975	2.2	9,572	6.3	12,932	8.1	6,338	4.3	5,222	3.0
Others	64,830	48.7	72,336	47.3	78,941	49.4	79,052	54.0	99,052	56.5
Total	133,197	100.0	153,001	100.0	159,728	100.0	146,472	100.0	175,237	100.0

Source: Bank of Thailand

Table 2-6 IMPORTED AMOUNT BY MAIN GOODS

(Unit: M. Baht)

Goods	1980		1981		1982		1983		1984	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Consumer Goods	19,286	10.2	22,985	10.6	22,783	11.6	29,699	12.6	31,939	13.0
Non Durable Goods	12,257		13,616		12,991		16,045		17,663	
Durable Goods	7,029		9,369		9,792		13,654		14,276	
Raw Material and Half-Finished Goods	45,312	24.0	53,575	24.7	48,596	24.7	59,539	25.2	61,542	25.1
for Consumer Goods	28,182		33,716		30,427		37,187		39,018	
for Capital Goods	17,130		19,859		18,169		22,352		22,524	
Capital Goods	46,075	24.4	56,772	26.2	47,778	24.3	69,358	29.3	72,431	29.5
Non Electric Machinery	20,402		25,842		21,172		33,061		34,992	
Electric Machinery	11,206		10,867		11,008		15,916		16,909	
Others	78,013	41.3	83,414	38.5	77,459	39.4	78,013	33.0	79,243	32.3
Automobile	6,912		9,568		7,687		11,416		11,834	
Crude Oil and Petroleum Producsts	58,733	31.1	65,100	30.0	60,765	30.9	57,065	24.1	57,353	23.4
Total	188,686	100.0	216,746	100.0	196,616	100.0	236,609	100.0	245,155	100.0

Source: Bank of Thailand

Table 2-7 ENERGY CONSUMPTION BY TYPES OF SOURCES

(Unit: Ml of Crude Oil Equivalent)

Year	Petroleum Products	Hydro Electric	Coal & Lignite	Fuel Wood	Charcoal	Paddy Husk	Bagasse	Natural Gas	Total	Share of Indigenous Sources (%)	Share of Petroleum (%)
1975	8,489	1,115	187	42	14	47	640	-	10,534	19.4	80.6
1976	9,593	1,193	205	42	27	41	911	-	12,012	21.6	79.9
1977	10,661	1,074	163	148	29	42	903	-	13,020	17.1	81.9
1978	11,581	704	206	116	28	46	1,136	-	13,817	16.3	83.8
1979	12,193	998	455	1,400	1,821	51	708	-	17,626	30.1	69.2
1980	12,713	432	469	1,942	2,223	50	616	-	18,445	30.7	68.9
1981	12,018	911	513	2,000	2,543	123	902	254	19,264	37.6	62.4
1982	10,872	1,156	757	2,048	2,570	142	1,438	1,302	20,285	46.9	53.6
1983	12,160	1,100	747	2,053	2,616	192	1,244	1,529	21,641	46.6	56.2
1984	12,750	1,221	852	2,075	2,638	201	1,228	2,284	23,249	49.9	54.8

Source: Thailand Energy Situation 1984 (NEA)

Table 2-8 FORECAST OF ENERGY CONSUMPTION

(Unit: Ml of Crude Oil Equivalent)

Year	Petroleum Products	Hydro Electric	Coal & Lignite	Fuel Wood	Charcoal	Paddy Husk	Bagasse	Natural Gas	Others	Total	Share of Petroleum (%)
1985	12,495	1,400	1,225	2,174	3,020	200	1,138	3,492	32	25,176	49.6
1986	12,988	1,487	1,789	2,195	3,252	203	1,182	3,916	36	27,048	48.0
1987	13,767	1,565	1,956	2,220	3,453	206	1,224	4,589	55	29,035	47.4
1988	14,749	1,672	1,961	2,241	3,736	210	1,251	4,942	66	30,828	47.8
1989	16,406	1,741	2,286	2,262	3,862	215	1,286	4,421	69	32,548	50.4
1990	16,607	1,723	2,777	2,283	4,093	219	1,300	5,346	113	34,461	48.2
1991	17,528	1,720	3,314	2,307	4,326	223	1,328	5,476	131	36,353	48.2
1992	18,585	1,717	3,762	2,339	4,575	227	1,357	5,847	159	38,568	48.2

Source: Thailand Energy Situation 1984 (NEA)

Table 2-9 POWER DEMAND IN THAILAND

Items	Actual											Growth Rate (%/year)
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
ENERGY SALES (GWh)												
Residential	1,373.12	1,540.10	1,880.28	2,221.62	2,627.83	2,884.55	3,128.12	3,461.13	4,091.38	4,572.74	5,091.75	12.0
Small Business	1,022.55	1,182.83	1,401.67	1,656.20	1,833.52	1,636.92	1,583.02	1,627.50	1,822.77	1,946.90	2,155.31	5.7
Large Business	4,072.21	4,736.05	5,466.38	6,054.74	6,830.69	1,904.26	1,906.66	2,084.73	2,236.01	2,420.51	2,726.23	7.4
Small Industrial	-	-	-	-	-	1,883.79	2,054.03	2,185.58	2,390.54	2,571.40	2,687.51	7.4
Large Industrial	-	-	-	-	-	3,746.25	4,243.34	4,436.94	4,554.14	4,894.77	5,371.15	7.5
Others	442.03	442.67	480.56	523.68	567.59	507.47	476.74	481.96	751.07	943.40	1,036.31	15.3
EGAT directly suppl.	430.89	446.35	476.97	488.24	452.68	443.73	500.61	494.33	610.12	689.73	911.00	15.5
Total	7,340.80	8,348.00	9,705.86	10,944.48	12,312.31	13,006.97	13,892.52	14,772.17	16,456.03	18,039.45	19,979.26	9.0
GENERATED ENERGY												
EGAT (GWh)	8,211.57	9,414.48	10,950.62	12,371.67	13,964.56	14,753.73	15,959.97	16,881.95	19,066.30	21,066.44	23,356.74	9.6
PEA (GWh)	110.20	117.90	97.60	84.10	82.10	69.60	44.90	25.00	26.80	20.50	20.70	(21.5)
Total	8,321.77	9,532.38	11,048.22	12,455.77	14,046.66	14,823.33	16,004.87	16,906.95	19,093.10	21,086.94	23,377.44	9.5
PEAK DEMAND (MW)	1,406.60	1,652.10	1,873.40	2,100.60	2,255.00	2,417.40	2,588.70	2,838.00	3,204.30	3,547.30	3,878.40	9.9
LOSS RATIO (%)	11.8	12.4	12.2	12.1	12.3	12.3	13.2	12.6	13.8	14.5	14.5	-
LOAD FACTOR (%)	67.5	65.9	67.3	67.7	71.1	70.0	70.6	68.0	68.0	67.9	68.8	-
ELECTRIFICATION RATIO (%)	21.8	24.6	26.7	30.3	33.0	36.6	41.4	46.3	49.4	53.5	59.1	-

Items	Forecast											Growth Rate (%/year)
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995		
ENERGY SALES (GWh)												
Residential	5,451.08	5,942.34	6,455.71	6,974.43	7,509.61	8,059.03	8,620.01	9,189.75	9,764.93	1,034.77		7.3
Small Business	2,232.96	2,372.42	2,516.54	2,663.80	2,814.00	2,967.04	2,122.61	3,280.62	3,440.76	3,602.95		5.3
Large Business	2,980.02	3,217.75	3,468.35	3,727.99	3,996.56	4,273.76	4,559.40	4,853.27	5,155.17	5,464.81		7.2
Small Industrial	2,799.37	2,945.15	3,093.72	3,243.34	3,394.11	3,546.03	3,699.10	3,853.61	4,009.68	4,167.40		4.5
Large Industrial	5,584.35	6,283.29	7,160.02	8,019.79	8,467.20	8,948.89	9,390.06	9,836.30	10,284.48	10,737.70		7.2
Others	1,192.51	1,320.85	1,409.28	1,501.16	1,595.58	1,686.56	1,775.52	1,866.57	1,959.46	2,054.38		7.1
EGAT directly suppl.	981.35	1,012.22	1,056.73	1,139.81	1,148.87	1,154.77	1,160.84	1,167.06	1,173.50	1,180.15		2.6
Total	21,221.64	23,094.02	25,160.35	27,270.32	28,925.93	30,636.08	32,327.54	34,047.18	35,787.98	37,549.16		6.5
GENERATED ENERGY												
EGAT (GWh)	24,732.00	27,145.00	29,418.00	31,774.00	33,719.00	35,726.00	37,720.00	39,743.00	41,790.00	43,862.00		6.5
PEA (GWh)	27.90	42.60	47.70	49.00	50.30	51.80	49.80	51.30	53.20	55.20		10.3
Total	24,759.90	27,187.60	29,465.70	31,823.00	33,769.30	35,777.80	37,769.80	39,794.30	41,843.20	43,917.20		6.5
PEAK DEMAND (MW)	4,177.00	4,560.00	4,947.00	5,311.0	5,614.00	5,935.00	6,244.00	6,530.00	6,824.00	7,128.00		6.3
LOSS RATIO (%)	14.3	15.1	14.6	14.3	14.3	14.4	14.4	14.4	14.5	14.5		-
LOAD FACTOR (%)	67.7	68.1	68.0	68.4	68.7	68.8	69.1	69.6	70.0	70.3		-
ELECTRIFICATION RATIO (%)	64.2	68.7	71.5	73.1	74.6	76.0	77.1	78.1	78.8	79.5		-

Table 2-10 GDP, ELECTRIC CONSUMPTION AND ELASTICITIES

Item		1975	1976	1977	1978	1979	1980	1975--1980
G.D.P at 1972 price	(M. Baht)	203,514	221,225	237,173	261,097	276,907	292,852	
Annual Growth Rate	(%)		8.703	7.209	10.087	6.055	5.758	7.550
Electricity Consumption	(GWh)	7,341	8,348	9,706	10,944	12,312	13,007	
Annual Growth Rate	(%)		13.717	16.267	12.755	12.500	5.645	12.120
Elasticities			1.576	2.256	1.264	2.064	0.980	1.605

Item		1981	1982	1983	1984	1985		1980--1985
G.D.P at 1972 price	(M. Baht)	311,270	324,032	342,946	364,206	378,756		
Annual Growth Rate	(%)	6.289	4.100	5.837	6.199	3.995		5.279
Electricity Consumption	(GWh)	13,893	14,772	16,456	18,039	19,979		
Annual Growth Rate	(%)	6.812	6.327	11.400	9.620	10.754		8.963
Elasticities		1.083	1.543	1.953	1.552	2.692		1.698

Table 2-11 ENERGY SALES BY AUTHORITY IN THAILAND

Items	Actual											Growth Rate (%/year)
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	
ENERGY SALES (GWh)												
EGAT	430.89	446.35	476.97	488.24	452.68	443.73	500.61	494.33	610.12	689.73	911.00	15.5
MEA	4,789.91	5,284.95	6,054.49	6,806.64	7,605.92	7,867.44	8,182.20	8,438.00	9,166.38	9,917.16	10,511.16	6.0
PEA	2,120.00	2,616.70	3,174.40	3,649.60	4,253.70	4,695.80	5,209.71	5,839.84	6,679.53	7,432.56	8,557.10	12.8
Total	7,340.80	8,348.00	9,705.86	10,944.48	12,312.31	13,006.97	13,892.52	14,772.17	16,456.03	18,039.45	19,979.26	9.0

Items	Forecast											Growth Rate (%/year)
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995		
ENERGY SALES (GWh)												
EGAT	981.35	1,012.22	1,056.73	1,139.81	1,148.87	1,154.77	1,160.84	1,167.06	1,173.50	1,180.15		2.6
MEA	10,847.69	11,532.60	12,203.82	12,887.01	13,582.16	14,282.91	14,990.90	15,710.42	16,441.18	17,183.61		5.0
PEA	9,392.60	10,549.20	11,899.80	13,243.50	14,194.90	15,198.40	16,175.80	17,169.70	18,173.30	19,185.40		8.4
Total	21,221.64	23,094.02	25,160.35	27,270.32	28,925.93	30,636.08	32,327.54	34,047.18	35,787.98	37,549.16		6.5

Table 2-12 PRESENT STATUS AND EXPANSION PLAN OF POWER PLANT (EGAT)

(Unit: MW)

Type of Power Plant \ Year / Region		FY 1985						FY 1995					
		Northern	North Eastern	Central	Southern	Total	%	Northern	North Eastern	Central	Southern	Total	%
Hydro		914.8	108.5	698.0	92.3	1,813.6	28.1	919.3	108.5	1,638.0	332.3	2,998.1	32.8
Thermal	Oil			237.5	105.0	342.5	5.3				180.0	180.0	2.0
	Lignite	825.0			60.0	885.0	13.7	1,425.0			75.0	1,500.0	16.4
	Natural Gas			2,400.0		2,400.0	37.2			2,400.0		2,400.0	26.2
	Sub-total	825.0		2,637.5	165.0	3,627.5	56.2	1,425.0		2,400.0	255.0	4,080.0	44.6
Gas Turbine		120.0	30.0	25.0	90.0	265.0	4.1	120.0			25.0	145.0	1.6
Gas Turbine & Combined Cycle				720.0		720.0	11.1		600.0	720.0	600.0	1,920.0	21.0
Diesel		9.0		5.0	19.6	33.6	0.5						
Total		1,868.8	138.5	4,085.5	366.9	6,459.7	100	2,464.3	708.5	4,758.0	1,212.3	9,143.1	100