No. 57

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ELECTRICITY GENERATING AUTHORITY OF THAILAND (EGAT)
THE KINGDOM OF THAILAND

FEASIBILITY STUDY
ON
BULK POWER SUPPLY PROJECT
FOR
THE GREATER BANGKOK AREA

FINAL REPORT

AUGUST 1993

ELECTRIC POWER DEVELOPMENT CO., LTD.

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PREFACE

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a feasibility study on Bulk Power Supply for the Greater Bangkok Area Project and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team headed by Mr. Takuya Takaoka of Electric Power Development Co., Ltd. 4 times during the period from July 1992 to July 1993.

The team held discussions on the project with officials concerned of the Government of Thailand, and conducted field surveys at the study area. 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 promotion of the project and to the enhancement of friendly relations between our two countries.

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

August 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

August 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency

Dear Mr. Yanagiya,

Letter of Transmittal

We are pleased to submit to you the feasibility report on "Bulk Power Supply Project for the Greater Bangkok Area" in the Kingdom of Thailand. The report contains the advice and suggestions of the authorities concerned of the Government of Japan and your Agency as well as the formulation of the above mentioned project. Also included are comments made by the Electricity Generating Authority of Thailand (EGAT) and Metropolitan Electricity Authority (MEA) of the Government of Thailand during technical discussions on the draft report which were held in Bangkok.

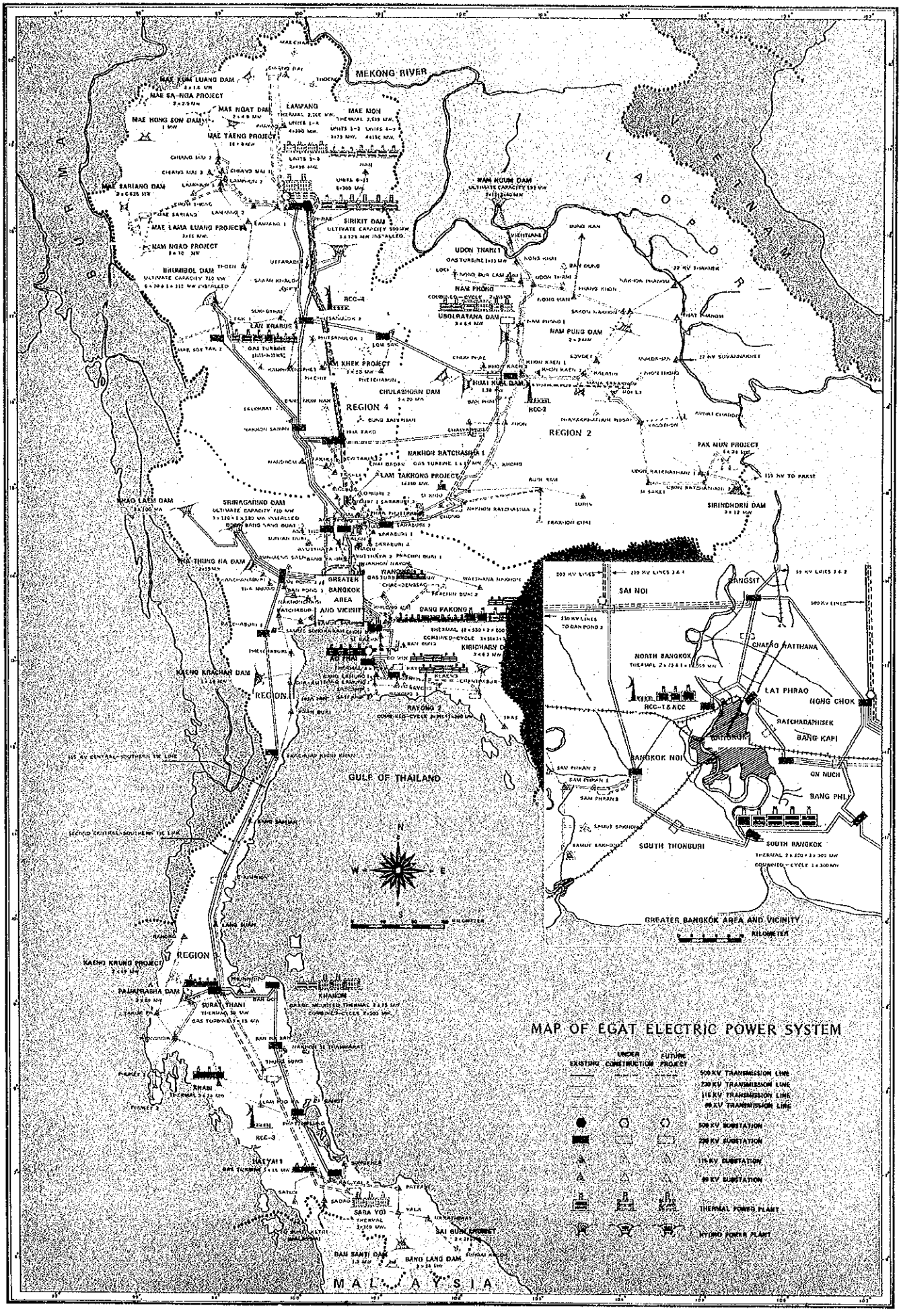
This report presents a scheme for long term power distribution system expansion in the greater Bangkok area at 230 kV and higher voltage levels. Due to the recent extremely rapid growth of the urban area of Bangkok, construction of transmission and distribution lines and substations in the area becomes difficult, therefore, electric power supply to the greater Bangkok area is one of the difficult problems in Thailand and a scheme based on the long term plan has been strongly required. After completion of this project, electric power will be secured steadily.

In view of the urgency of the expansion of power transmission and distribution systems and of the need for socia-economic development of the Kingdom of Thailand as a whole, we recommend that His Majesty's government implement this Project as a top priority.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs, the Ministry of International Trade and Industry and the Ministry of Finance. We also wish to express our deep gratitude to the Department of Technical and Economic Cooperation and other authorities concerned of His Majesty's Government of Thailand for the close cooperation and assistance extended to us during our investigations and study.

Very truly yours,

Takuya Takaoka
Team Leader
Feasibility Study Team
of Bulk Power Supply Project
for the Greater Bangkok Area


MEKONG RIVER
MYANMAR
LAO P.D.R.
VIETNAM
MAE KOM LUANG DAM
MAE KA-NGA PROJECT
MAE NGAT DAM
MAE HONG SON DAM
MAE TAENG PROJECT
LAMPANG
MAE MOH
MAE SARIANG DAM
MAE LAMA LUANG PROJECT
NAM NGAO PROJECT
BHUMIBOL DAM
SIRIKIT DAM
NAM NGUM DAM
UDON THANI
NAM PHONG
UBOLRATANA DAM
NAM PUNG DAM
LAM KRABUE
LAM KHEK PROJECT
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HUAI KUM DAM
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LAT PHRAO
NONG CHOK
RCC-1 & RCC
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BANGKOK NOI
BANG KAPI
ON NUCH
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HYDRO POWER PLANT

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CONCLUSION AND RECOMMENDATION

CONCLUSION AND RECOMMENDATION

CONCLUSIONS

1. Power Demand in Greater Bangkok Area

In Thailand, the power generation is done by Electricity Generating Authority of Thailand (EGAT) and the maximum power generation and annual energy production in 1992 were recorded at 8,877 MW and 56,021 GWh, respectively. The power supply to the customers in the greater Bangkok area is made by Metropolitan Electricity Authority (MEA) and the maximum demands in the future are as follows:

Year	Max. Demand
1992	3,890 MW
1997	6,089 MW
2001	7,952 MW
2006	10,264 MW
2011	13,569 MW

2. Present Situations and Problems of Power Supply Facilities

In the Greater Bangkok area, there are two thermal power plants, say North Bangkok Thermal Power Plant (237.5 MW) and South Bangkok Thermal Power Plant (1,339 MW). The power supply to the demand in the Greater Bangkok Area is from the above two power plants and from power plants outside the area by 500 kV and/or 230 kV transmission lines from north, west and southeast.

The power supply facilities such as transmission lines and substations are expanded according to the demand increasing. However, it is difficult to expand the necessary power facilities following to the demand by EGAT itself since the power demand increase is extraordinary high pitch due to rapid development of the city areas and arising the many problems such as land acquisition for substations and transmission lines as well as environmental issues for installing new power facilities.

Under these circumstances, EGAT has realized the needs of the feasibility study on the power supply project for the Greater Bangkok Area based on the long range vision and requested the study to the Japanese government through Thai government, and the study has been done by this Japan International Cooperation Agency (JICA) Study Team.

3. Basic Assumptions of the Feasibility Study

This feasibility study has been made based on the following assumptions:

(1) Economy

Growing up steady as same as that at the present.

(2) Power Demand

The power is to be supplied without load control.

(3) Budget for the Project

The planning of the Project is based on the technical requirement, say there is no power supply interruption after clearing fault when a transmission line or a transformer damaged. Therefore, the planning has not been reduced in the scale due to any budgetary restriction.

(4) Right of Way of Transmission Line

The present right of way is available in the future.

(5) Environmental Issues

Only predicted issues are considered within the present environmental restricts.

(6) Power System Design

In principle, the planning is based on the single contingency criteria used by EGAT.

(7) Implementation of the Project

The planning of transmission lines is mainly by overhead transmission lines taking economy into consideration, only the route where overhead transmission line could not be built by physical restrictions or by aviation regulations.

The planning is without considerable power supply interruption during implementation of the Project.

(8) Level of Technology

The planning is made by using the proven technology. (Unproven new technology was not considered.)

4. Major Features of Bulk Power Supply Project

(1) Outline

- 500 kV Overhead Transmission Line (new) : 226 circuit-km
- 230 kV Overhead Transmission Line (new) : 146 circuit-km
- 230 kV Overhead Transmission Line (Renov.) : 472 circuit-km
- 230 kV Underground Transmission Line (new) : 242 circuit-km

- 500 kV Substations : 6 substations (5 new, 1 expansion)

- 230 kV Substations : 18 substations (10 new, 8 expansion)

(2) Project Cost (including both of EGAT's and MEA's portions and estimated in 1992 price level)

- Stage 1 (to be completed by 1997) : US$696,285,000.-

- Stage 2 (to be completed by 2001) : US$470,739,000.-

- Stage 3 (to be completed by 2006) : US$365,768,000.-

- Stage 4 (to be completed by 2011) : US$421,288,000.-

Total : US$1,954,080,000.-

Note: The cost of foundation of the transmission lines is different by the foundation soil, the most of the transmission lines tower foundation is constructed at the poor soil area. The above cost is based on the assumption that all the foundations are in the poor soil.

5. Economic Justification

In the study, the cost of the Project was estimated for the poor soil tower foundation case. In the study of the economic evaluation of the Project, the Project is considered economically to be justified.

6. Financial Analysis

In the financial analysis of the Project, the flow of cost and flow of the benefit are considered as follows:

(1) Cost flow consists of the construction cost and the operation and maintenance cost of the power facilities, and:

(2) Benefit flow consists of increased electricity sales due to the Project.

As the result of the financial analysis, the Project is considered also financially to be sound.

RECOMMENDATIONS

(1) This study is made globally taking long range view of bulk power supply for the Greater Bangkok Area into consideration. Therefore, in advance to the actual implementation of the Project, it is necessary to study the Project further in detail. During the study, when the better alternatives be found, the revision of the plan will be preferable taking the long range view into consideration.

(2) In the study, the 500 kV transmission lines to supply the power to the Greater Bangkok Area Project has been designed based on the present Power Development Plan (PDP) by EGAT. Therefore, if there is any change in the 500 kV transmission line system, the transmission system has to be reviewed accordingly.

(3) Since the preparation of the required budget, the field survey, the detailed design and negotiation of the land acquisition will take for long time, the preparatory works should be started few years before the construction work start.

(4) This is the first feasibility study on the Bulk Power Supply for the Greater Bangkok Area, therefore, the basic drawing for the Project is in the report taking the present situation of the power supply for the area into consideration. The study of the Project has to be reviewed time to time when the circumstances be changed.

(5) Consequence to this study, the feasibility study on the expansion and renovation of the transmission line and distribution network system with the voltages 230 kV and below in the Greater Bangkok Area is necessary.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INRTRODUCTION

1.1 Background of the Project

In Thailand, due to increase of population and vivid commercial and industrial activities as well as grading-up of living standard, the electric energy consumption is heavily increasing in these years. In Greater Bangkok Area which electricity is supplied by Metropolitan Electricity Authority (MEA), the average annual growth rate of power demand in these five years is 12.35%. It is noted that this growth rate is tremendously high comparing to 6.3% in Japan. The maximum power demand of the Greater Bangkok area in 1992 was recorded at 3,890 MW, and according to the Working Group for Load Forecast which members compose of staff of Electricity Generating Authority of Thailand (EGAT) and MEA, the expected maximum power demand will be:

6,089 MW	in 1997
7,952 MW	in 2001
10,264 MW	in 2006

To meet the power demand of MEA, EGAT has expanded power facilities in accordance with the short and long term plans. However, due to rapid development in the Greater Bangkok Area, it is very difficult to obtain spaces for substations and new right of ways for transmission lines. In long term view, it is jeopardized to expand the power facilities in accordance with the long term plan if the demand is increased steadily.

To solve these problems, EGAT took up "Bulk Power Supply Project for the Greater Bangkok Area" as an emergency issue, which is a long term power facilities expansion plan in the Greater Bangkok Area up to the year of 2011 including 500 kV and 230 kV transmission lines and substations.

The Government of Thailand therefore requested technical assistant for "the feasibility study on Bulk Power Supply Project for the Greater Bangkok Area" to the Government of Japan in May 1991.

In response to this request, the Government of Japan had the Japan International Cooperation Agency (JICA) dispatched the Preliminary Study Mission to Thailand in November 1991, and the Mission surveyed the background of the request, performed site surveys, collected information and data, and made a preliminary study in the future policies and other relevant matters.

On November 8, 1991, the Preliminary Study Team of JICA and EGAT reached an agreement on "the Scope of Work for Feasibility Study on Bulk Power Supply Project for the Greater Bangkok Area".

Based on the Agreement, the Government of Japan decided to conduct a feasibility Study on the Project, and assigned this work to JICA.

1.2 Objective and Scope of the Study

1.2.1 Objective of the Study

The objrective of this study is;

- To estimate the power demand growth in the Greater Bangkok Area of the Kingdom of Thailand, and

- To formulate the optimal transmission line and substation facility expansion plan which is designated to meet this power demand growth up to the year of 2011.

In formulating this plan,

- all factors affecting the future electric power supply potentials, including the current status of power supply facilities as identified by available data,

- constraints on power supplies including site problems and technical problems,

- as well as environmental issues that may affect social reactions,

shall be thoroughly addressed and evaluated.

1.2.2 Scope of the Study

This study is a feasibility study, the objective area of which consists of the Greater Bangkok Area and the Central Area which are respectively defined as below.

Greater Bangkok Area

230 kV transmission lines and 500 kV transmission lines, plus substations related to these transmission lines (including the 230 kV facilities of MEA)

Central Area

500 kV transmission lines and substations related to these transmission lines

1.2.3 Study Items

Study items in this feasibility study consists of;

a) Collection and evaluation of existing data and information

b) Field investigation

c) Power survey

d) Environmental studies

e) Optimal power system plan

f) Basic Design

g) Economic and financial analyses

h) Cost estimation and construction scheduling

1.3 Activities of the Team in Thailand and Participants Concerned

1.3.1 Activities of the Team in Thailand

During the period from July 1992 to August 1993, the JICA study team performed following activities in Thailand.

1st: July 1st to 30th, 1992

Presentation of the methodology and the schedule of the study based on the Inception Report (Draft), the field survey for the related areas, collection of the study data and discussion on the Inception Report (Draft).

2nd: October 7th to 21st, 1992

Presentation of the progress and achievement of the study. Discussion on updated EGAT Power Development Plan (PDP), progress of environmental survey and basic approach to economic analysis.

3rd: February 16th to March 2nd, 1993

Presentation of the Interim Report. Discussion on power system planning, power system analysis and change of transmission line route by proposed new airport area. Site survey to proposed new substation.

4th: June 20th to July 4th

Presentation of the Draft Final Report by personnel each other. Discussion on economic evaluation financial analyses, construction schedule and future study.

Meeting of training schedule and item of technical transfer.

1.3.2 List of Participants

The EGAT and MEA people, and JICA study team member involved in this study are as listed below.

EGAT

Mr. Bhisit Anantasanta	Deputy General Manager, Transmission System Operation
Mr. Viroj Nopkhun	Assistant General Manager, Policy and Planning
Mr. Kraidej Ansusinha	Assistant General Manager, Transmission System Development
Mr. Siriwadh Sribhibhadh	Assistant General Manager, Transmission System Maintenance

SYSTEM PLANNING DEPARTMENT

Mr. Sridat Glankwahmdee	Director
Mr. Prakob Dhienhirunya	Chief, System Planning Division
Mr. Prutichai Chonglertvanichkul	Assistant Chief, Power System Planning Division
Mr. Kittipon Chuangaroon	Head, Power System Analysis Section
Mr. Sahust Pratuknokul	Head, Transmission System Planning Section
Mr. Kijja Sripattangkura	Assistant Head, Transmission System Planning Section
Mr. Varavoot Siripol	Head, Power System Cost Estimation Section
Mr. Pairoj Amornsart	Engineer Level 9
Mr. Thawat Pinta	

TRANSMISSION SYSTEM ENGINEERING DEPARTMENT

Mr. Banyat Phathramai	Director
Mr. Banjerd Janjerdsak	Assistant Director

Mrs. Thermtip Rugsachart	Project Superintendent
Mr. Harnjate Likitsinsopon	
Mr. Somsak Sakdhnagool	Chief, Substation Design, Bangkok Ring Project
Mr. Khunthon Boonpragob	
Mr. Dilok Hemyakorn	Chief, Data Analysis and Administration Project Division
Mr. Prasit Karajangpan	Assistant, Project Superintendent (Greater Bangkok Area)
Mr. Thawat Vadjanapornsithi	Chief, Project Engineering Division
Mr. Wirach R. Pithyakorn	500 kV Transmission System Project

SYSTEM OPERATION DEPARTMENT

Mr. Uthai Songtis	Assistant Director
Mr. Phaiboon Pipattanasomporn	Assistant Director
Mr. Nopporn Boonyaprasit	
Mr. Amorndej Viryasiri	Head, Power Generation and Transmission Analysis Section
Mr. Khunthon Boonpragob	
Mr. Udom Jirakajornjaritkul	Engineer
Mr. Sompol Uthaichalanonta	
Mr. Sompong Jontrakhao	
Mr. Butdha Bornbianlerdskul	
Mr. Suhit Kirthboonrong	
Mr. Vichai Pothiratana	Engineer Level 11
Miss Wanassara Khatanyachareon	Engineer

TRANSMISSION SYSTEM MAINTENANCE DEPARTMENT

Mr. Pipat Hongladarom	Assistant Director
Mr. Siripat Chitvibool	Engineer Level 11
Mr. Gunchat Sangmanee	Head, System Analysis Section
Mr. Wirash Kanghanapibul	
Mr. Boonmarg Smitthileela	
Mr. Chatchai Treewittayapoom	Engineer Level 9
Mr. Vich Piputvat	Engineer Level 9

TRANSMISSION SYSTEM CONSTRUCTION DEPARTMENT

Mr. Prasert Srisakulvan	Director
Mr. Voravudh Jotikasthira	Assistant Director
Mr. Thawal Photikaew	
Mr. Thermtip Rugsacharj	
Mr. Krisada Chiwaprecha	Engineer Level 11

SURVEY AND ECOLOGY DEPARTMENT

Mr. Wuthi Poonudom	Director
Mr. Prasit Niratsayakul	Assistant Director
Mr. Manop Manowattana	
Mrs.Supawan Klaipongpan	
Mr. Kitti Kumpeera	
Mr. Anupan Komkrichwarakool	
Mr. Wilailux Sangtaksin	
Mr. Anuchart Palakawongse	
Mr. Prakit Ongkananantlert	Head, Environmental Pollution Section
Mr. Treechae Ampunanda	

REGION 1

Mr. Tongtom Tepboon	Assistant Director, Region 1 Department(Operation)
Mr. Choochat Sae Tae	Assistant Chief, Substation Operation Division
Mr. Kakna Thamkasem	
Mr. Pirapol Tongyoon	Chief, Transmission System Maintenance Division

MEA

Mr. Siri Klaimongkol	Assistant Governor
Mr. Nares Amornlaksananon	Deputy Director, Electrical Design Division
Mr. Unggoon Mondhatuplin	Deputy Director
Mr. Surachai Asawaprecha	Director, Electrical Planning Division
Mr. Nopadol Putarungsri	Chief, Long Term Planning Section
Mr. Bovorn Juramongkol	
Mr. Tosak Tananutariya	
Mr. Pisanu Peannont	
Mr. Sonsak Thriyanurux	
Mr. Nipon Chirataweewoot	Deputy Chief, Short Term Planning Section
Mr. Warachai Chaturasathaporn	Engineer

JICA STUDY TEAM

Mr. Takuya Takaoka	Team Leader
Mr. Mitsuru Omori	Power System Planning
Mr. Masao Koike	Transmission Line Planning
Mr. Shigekatsu Soejima	Substation Planning
Mr. Vichien Virapanish	Environmental Study

Mr. Hiroto Inabe	Power System Analysis
Mr. Takashi Masuo	Economic Analysis
Mr. Hideaki Morishita	Secretary

1.4 Provision of Equipment

To promote the power system analyses using computer in this study, the following equipment was provided by JICA to EGAT.

Item	Q'ty	Unit	Type
Computer	1	set	ACER Frame 1000,1750
Laser Printer	1	set	HP Laser Jet III
X-Y Plotter	1	set	Roland DXY-1300
Power Stabilizer	1	set	

1.5 Technology Transfer to the Counterparts

The technology transfer to the counterparts from EGAT was performed in Japan during this study period as follows:

(1) Transmission Line and Substation Design

a) Counterpart : Mr. Kijja Snipatthamgkura

b) Schedule : November 29 to December 23, 1992 (25 days)

(2) Power System Analysis

a) Counterpart : Mr. Kittipon Chuanagaroon

b) Schedule : July 13 to August 7, 1993 (26 days)

CHAPTER 2

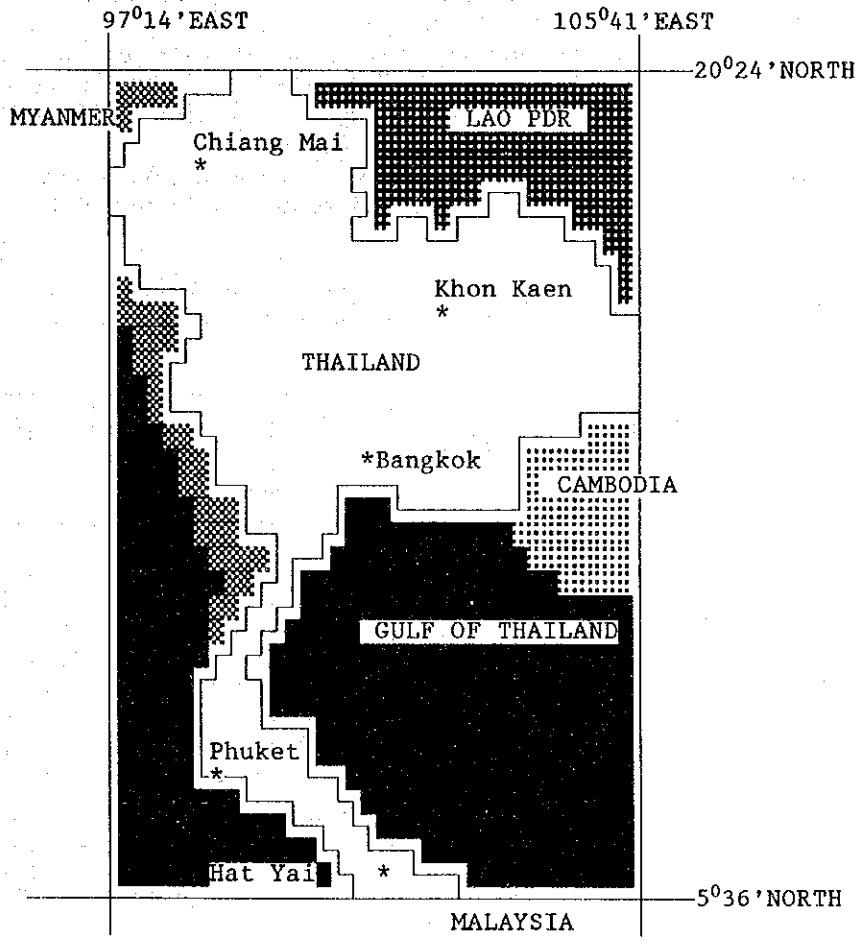
GENERAL DESCRIPTION OF THE KINGDOM OF THAILAND

CHAPTER 2 GENERAL DESCRIPTION OF THE KINGDOM OF THAILAND

2.1 General

(1) Location and Land Area

The Kingdom of Thailand neighbours Lao PDR at the border in the north and east,the Cambodia in the east, the Federation of Malaysia in the south and the Union of Myanmer in the west.
The teritory lays between $5^0$36' and $20^0$24' north in latitude and between $97^0$14' and $105^0$41' east in longitude, land area of which is 513,115 km^2.



(2) Climate

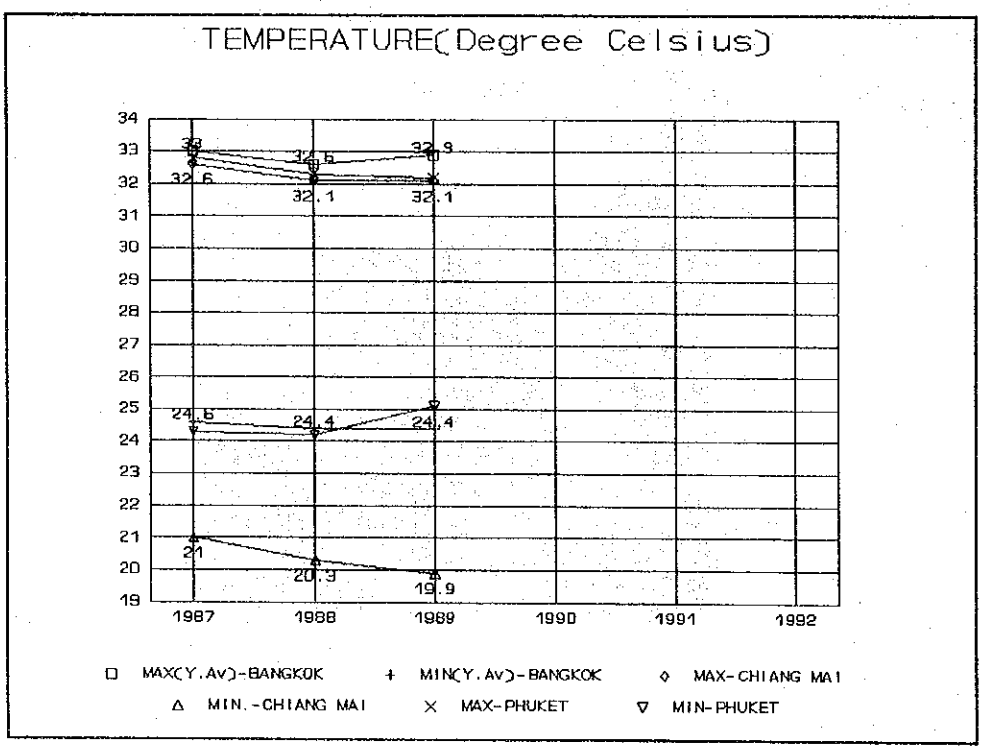
Three seasons of rainy, cool and hot are observed in Thailand.

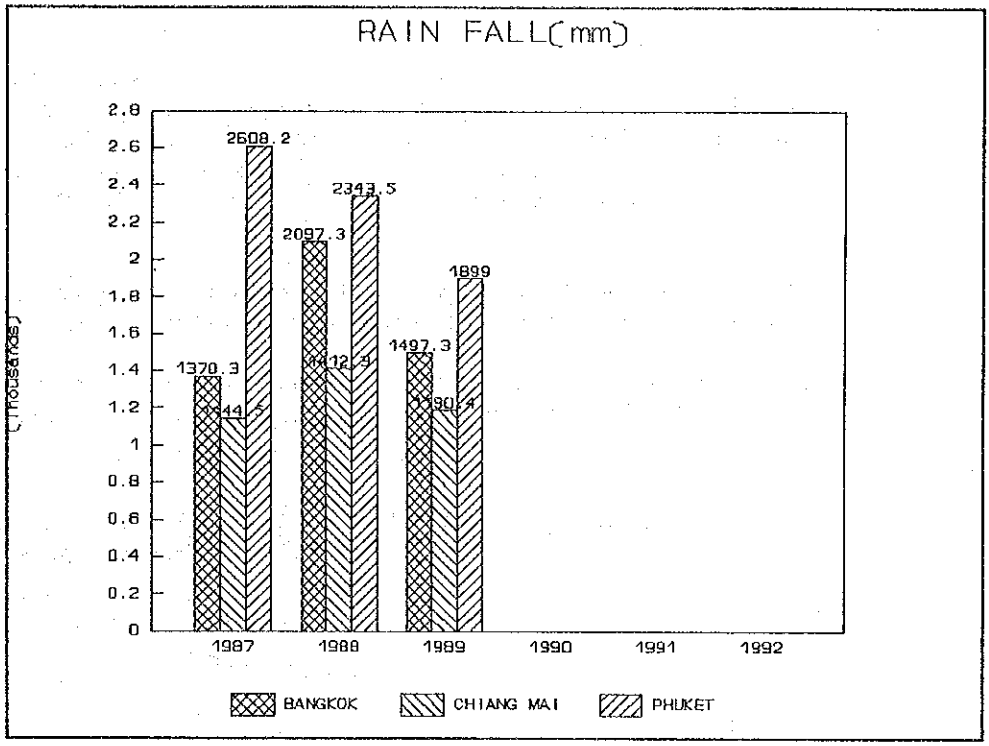
The rainy season starts from the middle of May when the south-west monsoon starts to blow, and ends the middle of October in northern region and November in southern region.

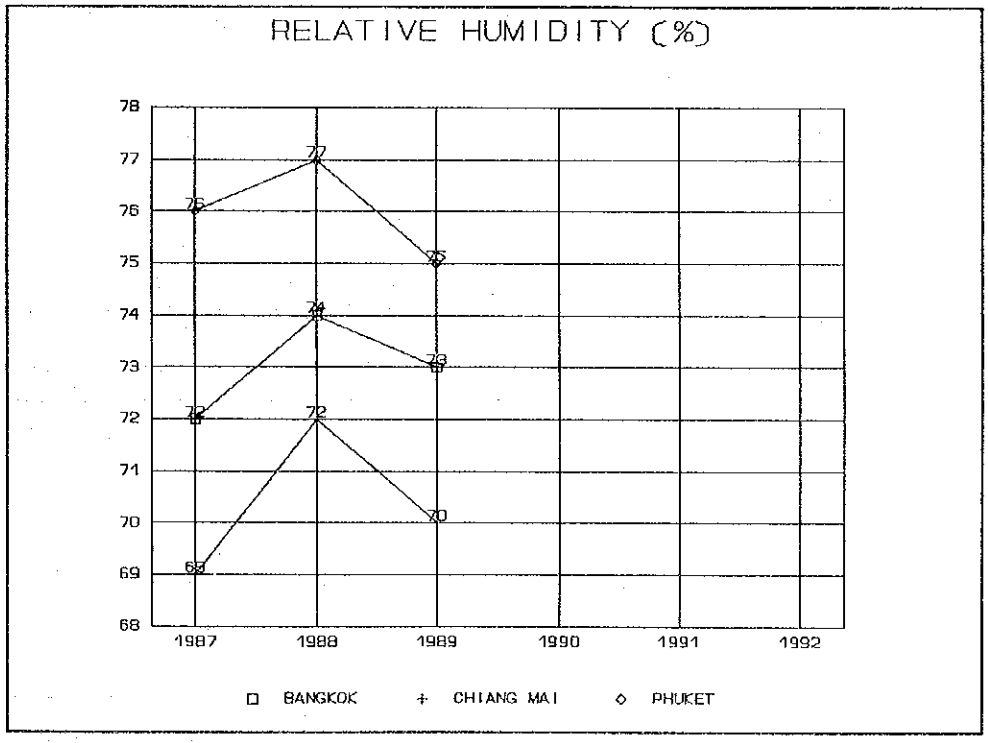
The season from the middle of November to February is called as the cool season when the north-east monsoon blows in whole country, during which the temperature in Bangkok falls down to 15^0C at night.

The season from March to May is called as the hot season while it is the hottest through the year.
As the north-east monsoon weakens in this season and the sun moves from the equator to above Thailand, the temperature rise becomes very high in April, reaching almost 40^0C in Bangkok.

Annual rainfall is around 1,300 mm in Bangkok, 1,200 mm in Chiang Mai, 1,100 mm in Khon Kaen and 2,000 mm in Hat Yai.







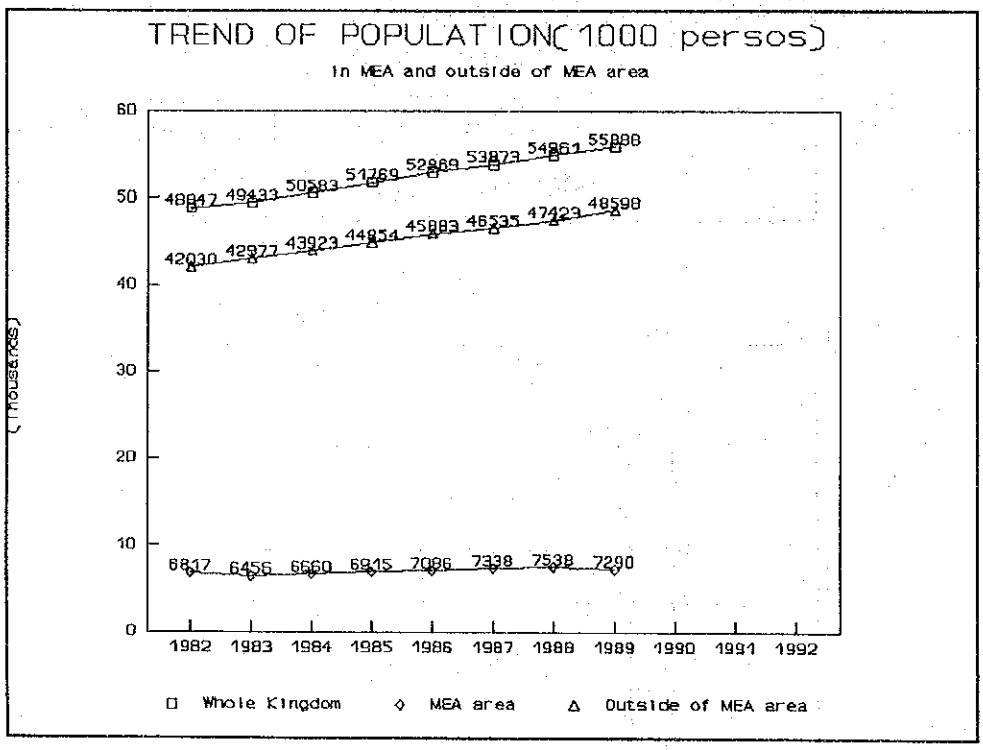
SOURCE:Meteorological Ovservatory of Thailand

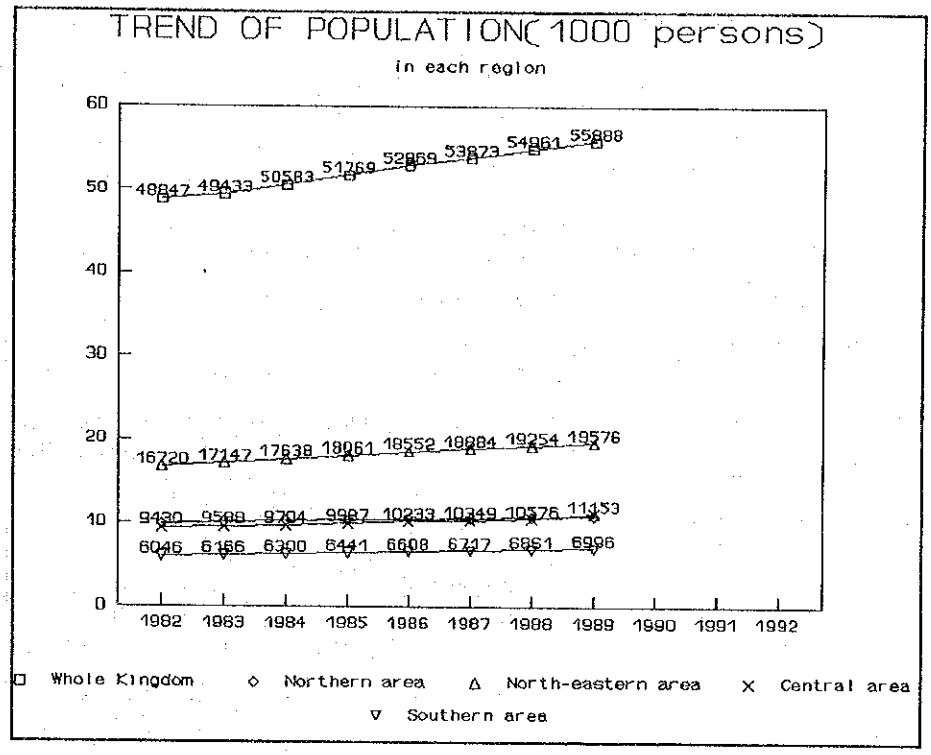
(3) Population

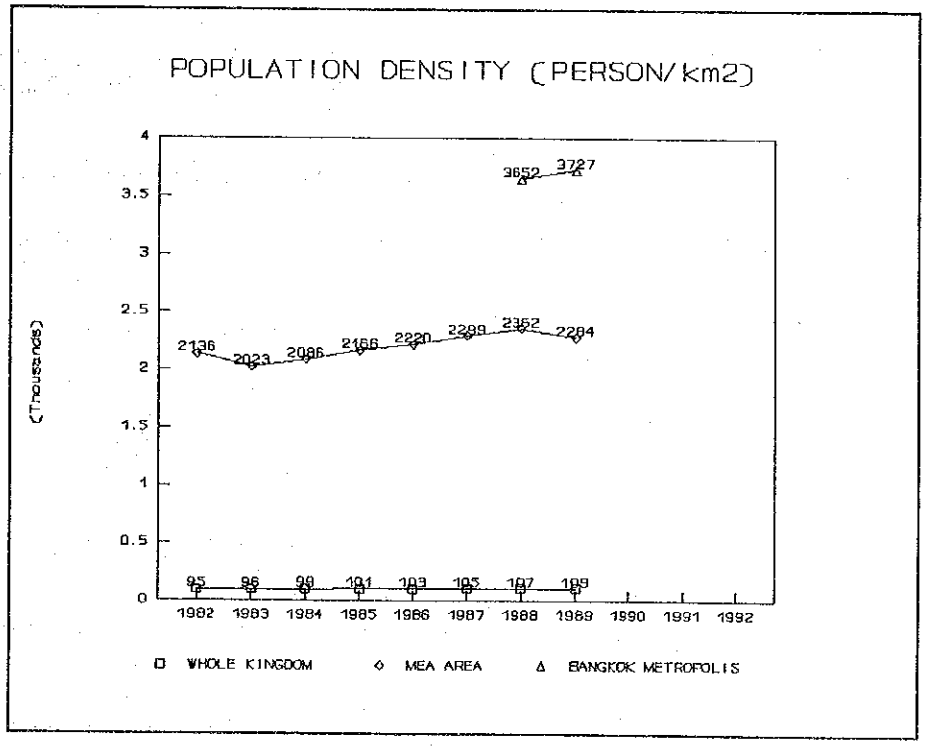
The Metropolitan Bangkok, the center of commerce and industry, and it's neighbouring privinces dense population year by year. The population of the Bangkok area accounts for 10.4% of the total in 1989 instead it was 8.6% in 1970, the figure of which including neibouring 5 provinces is 15.6% in 1989 instead 12.7% in 1970.

The population density was 3,727 persons/km^2 in the Bangkok area and 109 persons/km^2 in the whole country in 1989.

Province Administration Bureau of Ministry of Interior made public the past trend of the population as follows:







SOURCE:Department of Local Administration, Ministry of Interior

(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:

*Thaialnd is a Kingdom having a King as sovereign

*Sovereignty rests with the people

*Freedom of relegion, 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, relegion, King and Constitution

*Parliament with two-chamber system
Member of Upper House : appointed
The Lower House : publicly-elected

*Promotion of party politics
(Members of 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.

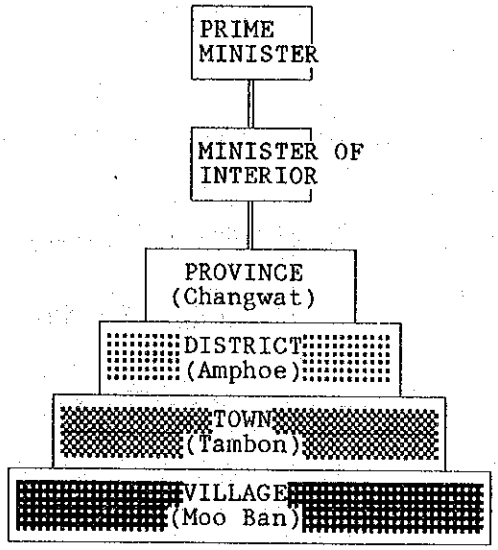
The organization of the local government mainly consists of "Provice(Changwat)", "District(Amphoe)", "Town(Tambon)"and "Village(Mo Ban)".

These are under the supervision of the Central Government.

Governers of the provinces are appointed by the Minister of Interior.

However, the Governor of the Bangkok metropolitan area has been publicly-elected since 1985.

ORGANIZATION CHART OF LOCAL GOVERNMENT



Region and Changwat:

*Bangkok Metropolitan and Vicinity:

Bangkok Metropolis, Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan, Samut Sakhon

*Central Region:

Chai Nat, Phra Nakhon Si Ayuttaya, Lop Buri, Saraburi, Sing Buri, Ang Thong

*Eastern Region:

Chanthaburi, Chachoengsao, Chon Buri, Trat, Nakhon Nayok, Prachin Buri, Rayong

*Western Region:

Kanchanaburi, Prachuap Khiri Khan, Phetchaburi, Ratchaburi, Samut Songkhram, Suphan Buri

*Northeastern Region:

Kalasin, Khon Kaen, Chaiyaphum, Nakhon Phanom, Nakhon Ratchasima, Buri Ram, Maha Sarakham, Mukdahan, Yasothon, Roi Et, Loei, Si Sa Ket , Sakon Nakhon, Surin, Nong Khai, Udon Thani, Ubon Ratchathani

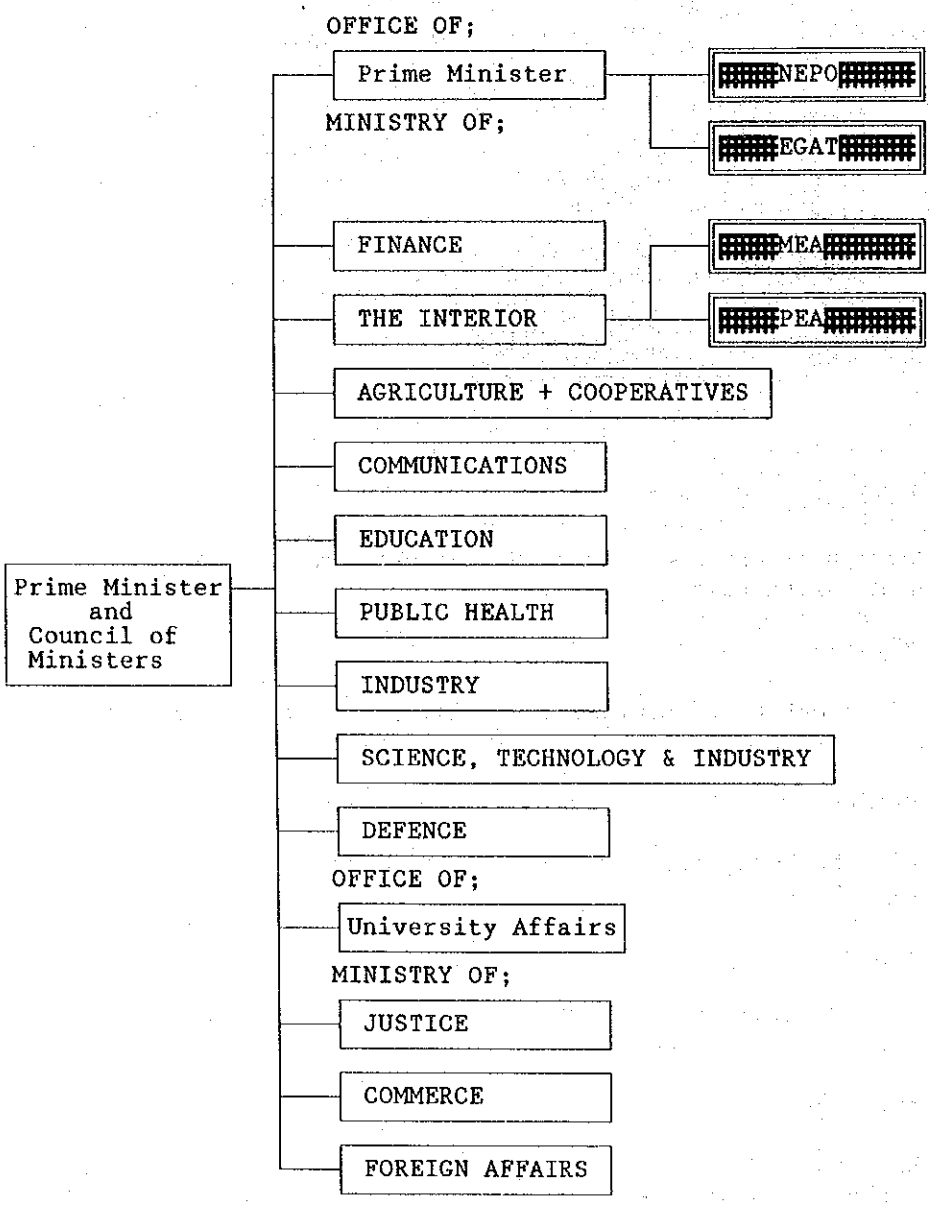
*Northern Region:

Kamphaeng Phet, Chiang Rai, Chiang Mai, Tak, Nakhon Sawan, Nan Phayao, Phichit, Phitsanulok, Phetchabun, Phrae, Mae Hong Son, Lampang, Lamphun, Sakhothai, Uttaradit, Uthai Thani

*Southern Region:

Krabi, Chumphon, Trang, Nakhon Si Thammarat, Narathiwat, Pattani, Phangnga, Phatthalung, Phuket, Yala, Ranong, Songkhla, Satun, Surat Thani

ORGANIZATION CHART OF CENTRAL GOVERNMENT

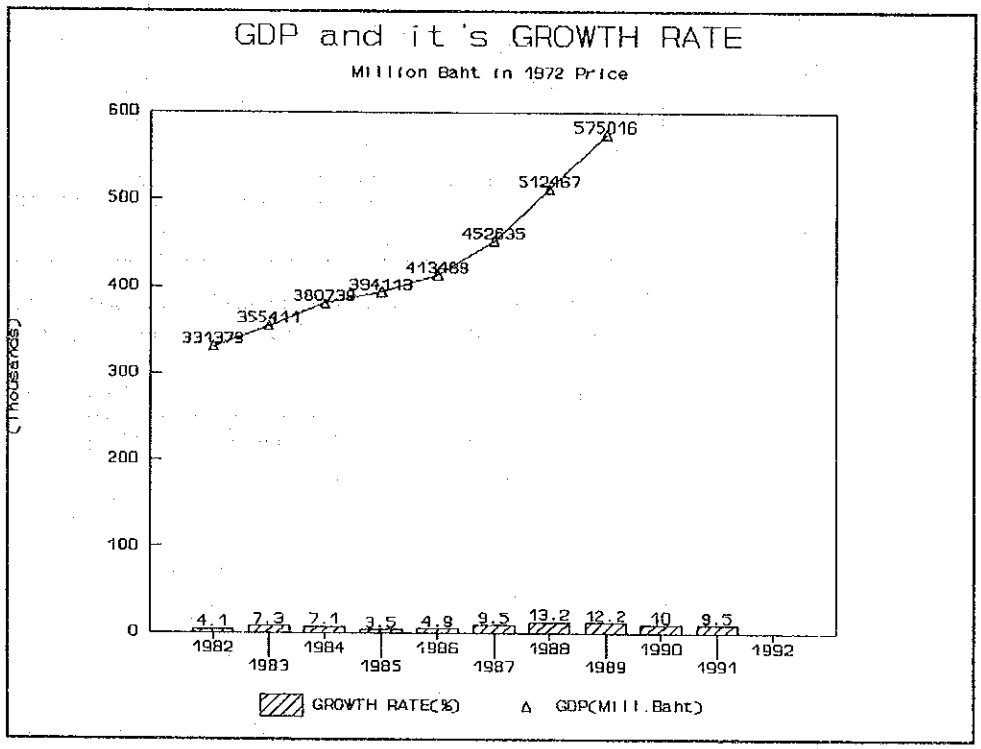


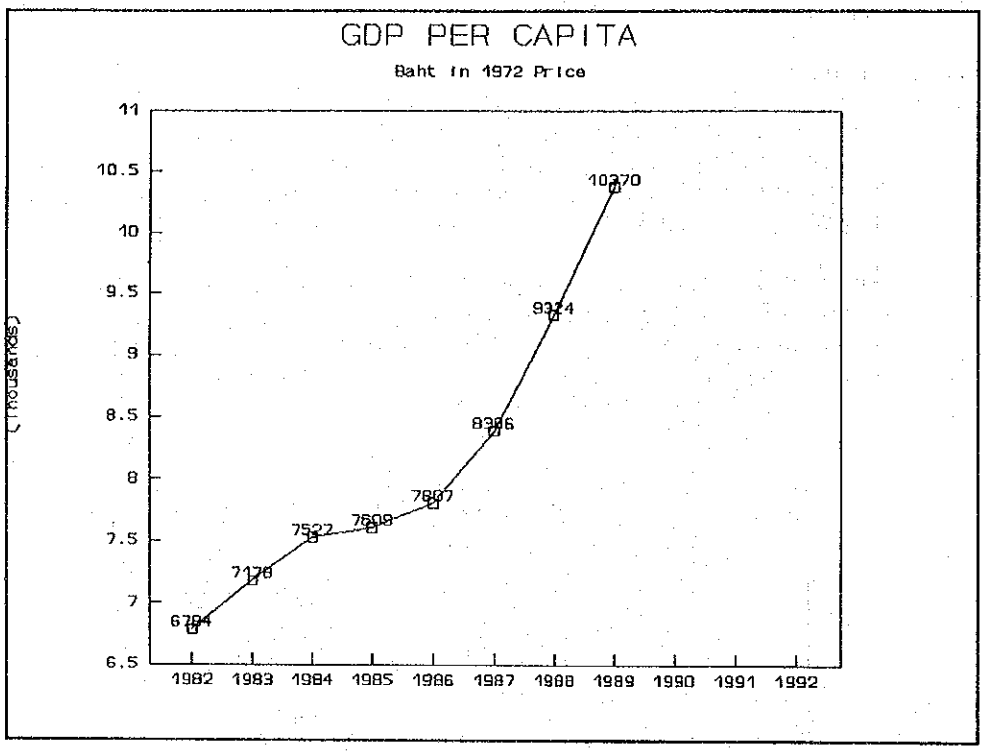
2.2 Economics

2.2.1 General

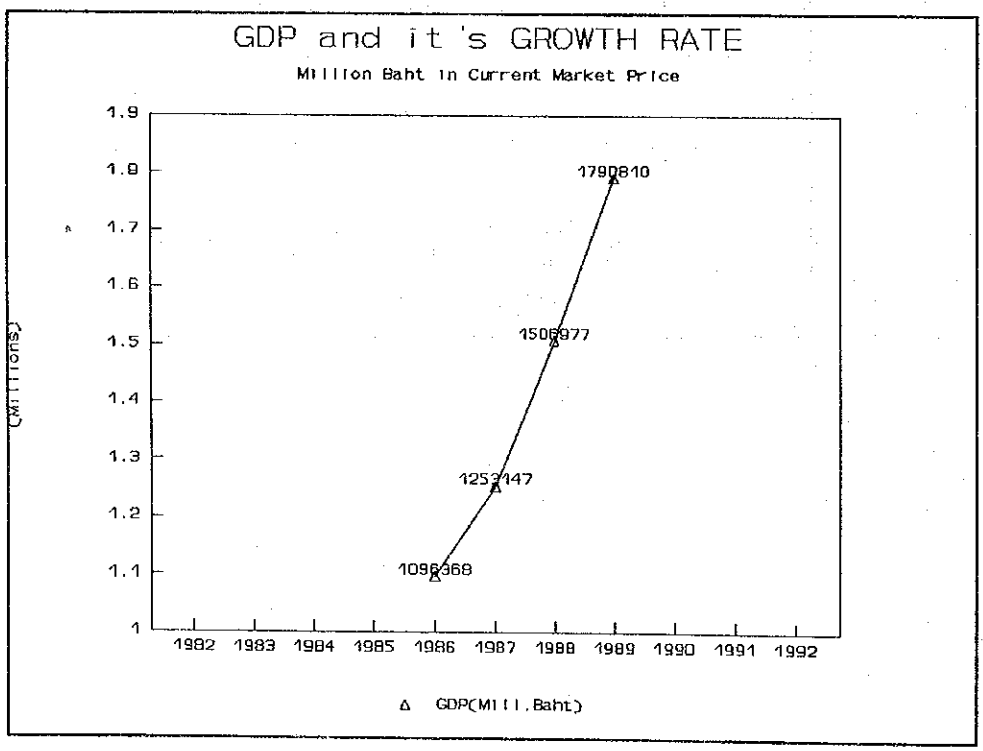
The economic performance of Thailand in the recent years has been an upward swing, with a 3.5% growth rate for 1985 and 4.9% for 1986 in terms of real GDP, thanks mainly to the expansion of exports which began in mid-1986.

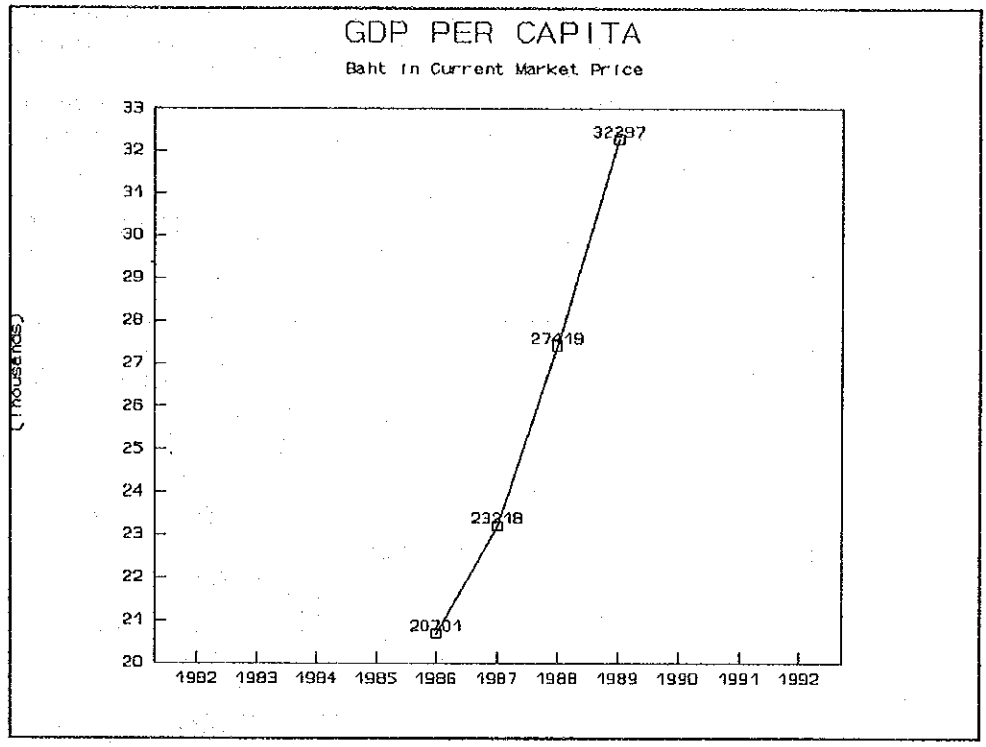
For 1987, 1988 and 1989, real GDP grew by 9.5%, 13.2% and 12.2% respectively and, of the GNE(Gross National Expenditure), both exports and the formation of fixed capital being considerably up from the preceding year.





SOURCE: NESDB (Office of National Economic and Social development Board, Office of the Prime Minister)



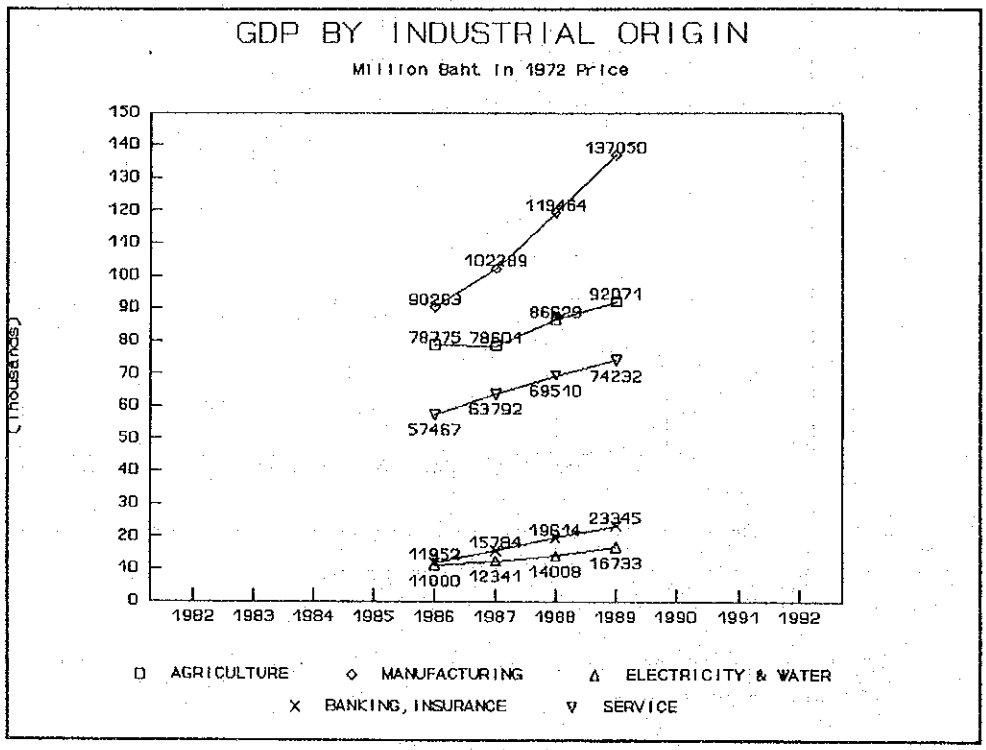


SOURCE:NESDB

Imports expanded by a large bound, because of increasingly strong domestic demand.

Agricultural output grew only a little, however, owing to the drought but manufacturing industry resistered a growth of as much as over 10%.

Tertiary, industries, electric power, water supply, financial business, insulance and services, have all fared well.

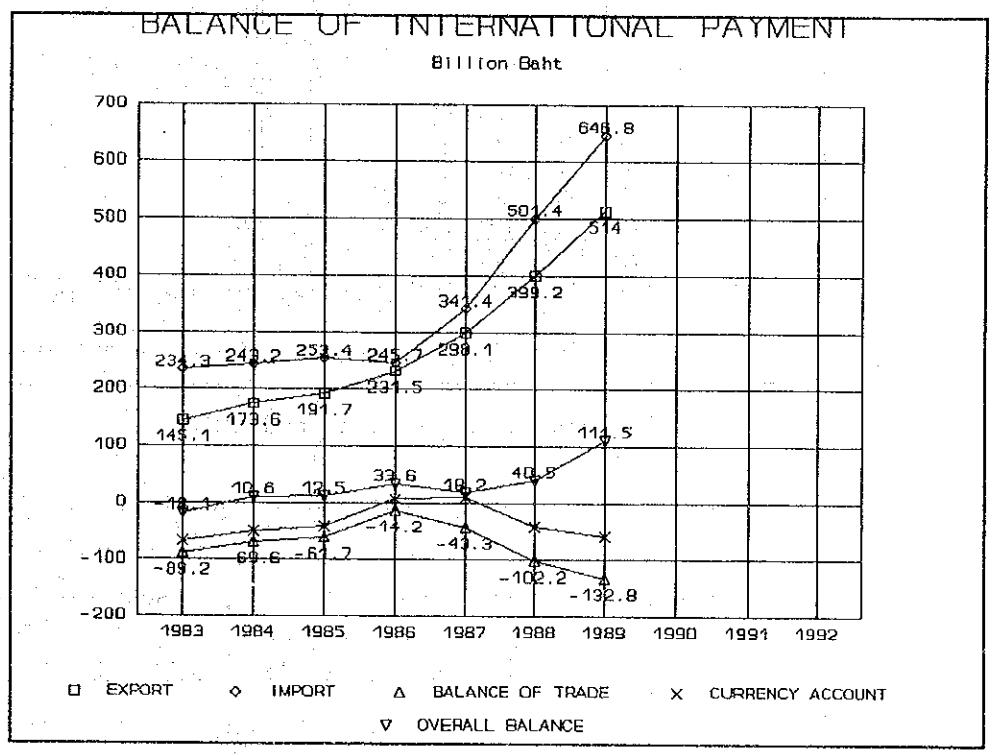


SOURCE:NESDB

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 is small.

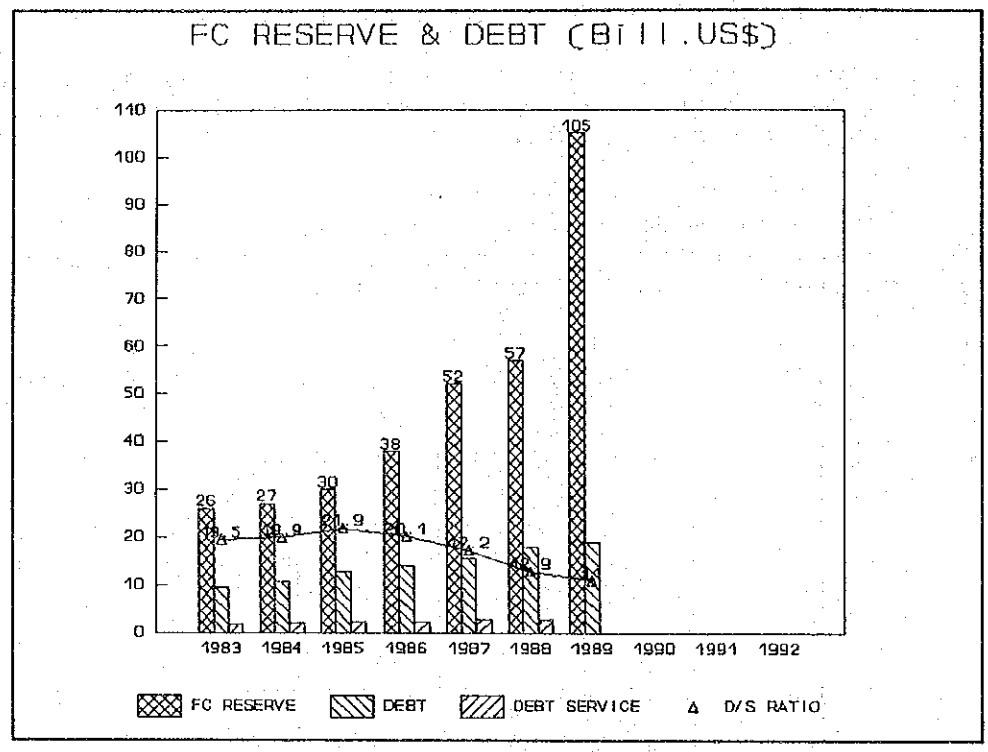
Since then, imports have increased because of recovery of business at home and exceeded exports to drive both trade balance and current account into the red while capital inflow kept increasing so as to hold the overall balance of payments in favor of Thailand.



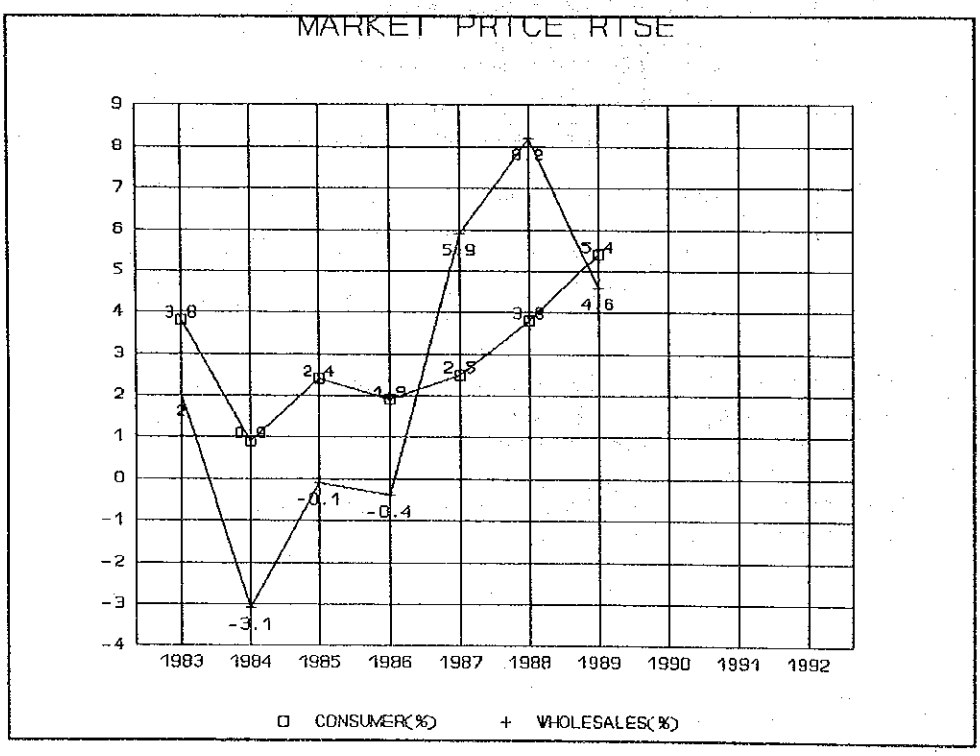
SOURCE:Thai Central Bank and NESDB

Therefore, it's foreign currency reserve has been growing steadily and, moreover, its debt service ratio, once hovering at a high level, shrank to 11.0% at the end of 1989.

Recently, the consumer price level is gradually raising and it is over 6% at present.



SOURCE:Thai Central Bank and NESDB



SOURCE:Bureau of Commerce and Economy, Ministry of Commerce

MAJOR ECONOMIC INDICATORS

	1985	1986	1987	1988	1989	1990	1991
Real GDP growth rate (%)	3.5	4.9	9.5	13.2	12.2		
Consummer price rise (%)	2.4	1.9	2.5	3.8	5.4		
Wholesales price rise(%)	-0.1	-0.4	5.9	8.2	4.6		
Foreign currency reserves (US$ billion)	30	38	52	71	105		
Debt to foreign lenders (US$ billion)	12.8	14.1	15.7	17.9	19.0		
Government finance balance (Baht billion)	-39.4	-34.2	-8.9	36.1	65.3		

SOURCE:Thai Central Bank and NESDB

BALANCE OF INTERNATIONAL PAYMENT

(Unit: Billion Baht)

Item of Balance	1985	1986	1987	1988	1989	1990	1991
Exports	191.7	231.5	298.1	399.2	514.0		
Imports	253.4	245.7	341.4	501.4	646.8		
Balance of trade	-61.7	-14.2	-43.3	-102.2	-132.8		
Current account	-41.9	6.5	9.3	-41.8	-58.0		
Overall balance of payment	12.5	33.6	18.2	40.5	111.5		
Baht per US$ (average)	27.13	26.27	25.71	25.27	25.60		

SOURCE: Thai Central Bank and NESDB

2.2.2 Basis of Economic Growth

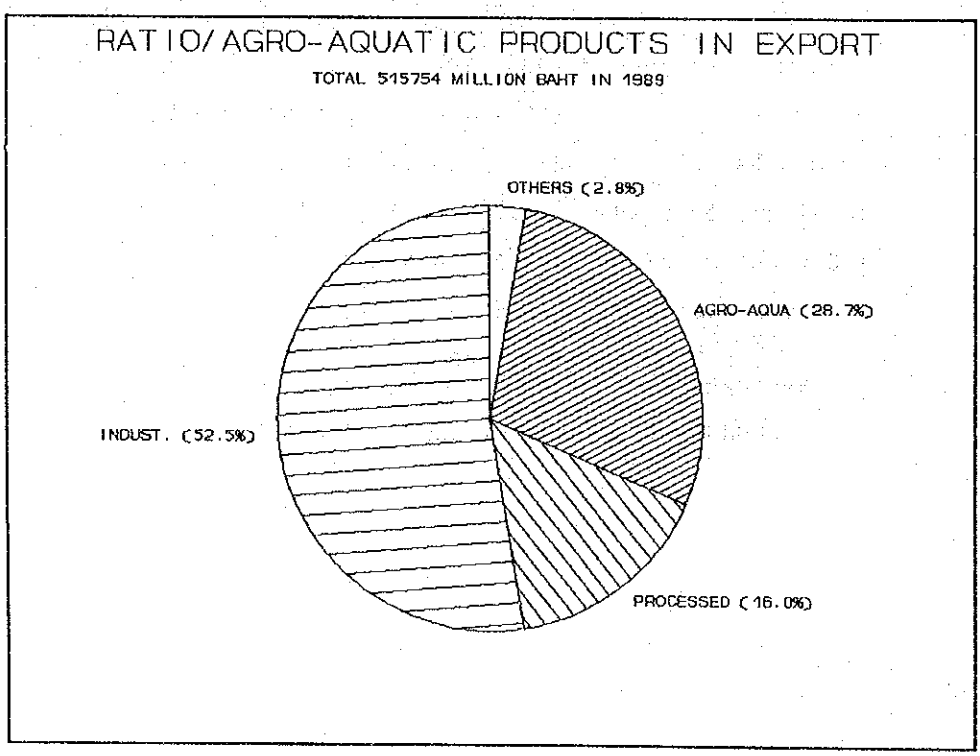
The Thai economy, maintaining the high growth rate, is steadfastly supported by eight underpinnings as follows.

1st-Thai Agriculture

Thailand has been one of the major exporters of primary products: *rice, rubber, tin, and teak wood* have been traditional export items.

The new export items added to these after World War 2 are, *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 agro-aquatic products in the tital export volume is at a level of over 50% and signifies the large weight of agro-aquatic industry in the national economy of Thailand.



SOURCE:Bank of Thailand

2nd-Diversification of Production Output

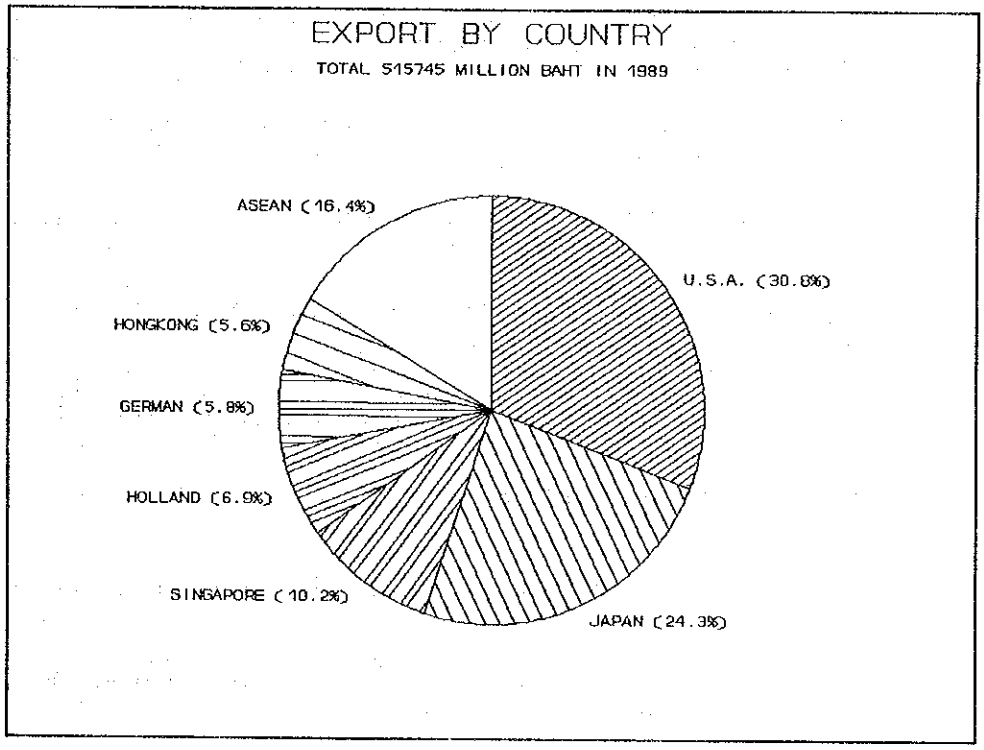
Not only agriculture has been expanding rapidly to take on a new outlook.

In addition to such manufactured products as *processed foods* and

textiles, new export products are emerging in increasing quality 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*, *woodworks* 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.



SOURCE:Bank of Thailand

3rd-Government Self-restraint on Public Spending and Monetary Policy

It improved Thailand's position markedly in regard to fiscal balance and international finance, and helped sustain the stability of domestic economy.

Comparing Thailand with those developing countries currently struggling under a heavy debt burden, 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 6th economic development plan to limit the annual borrowing from overseas to US$ 1.5 billion.

4th-Innovation Worked into the Administration Mechanism

It streamlined administrative decision-making prcesses.

It lies mainly in the introduction of the committee system into governmental organs.

Many committees have been instituted to stimulate co-operation between governmental organs and private sector businesses.

5th-Integrity of Economic Policy

Commings and goings of cabinet members in the executive branch do not affect the economic policy once charted.

Even the new remote chance of coup d'etat can not swerve or alter the general tenor of economic policy.

This means that rolling continues to run on the charted course once a policy is set.

6th-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.

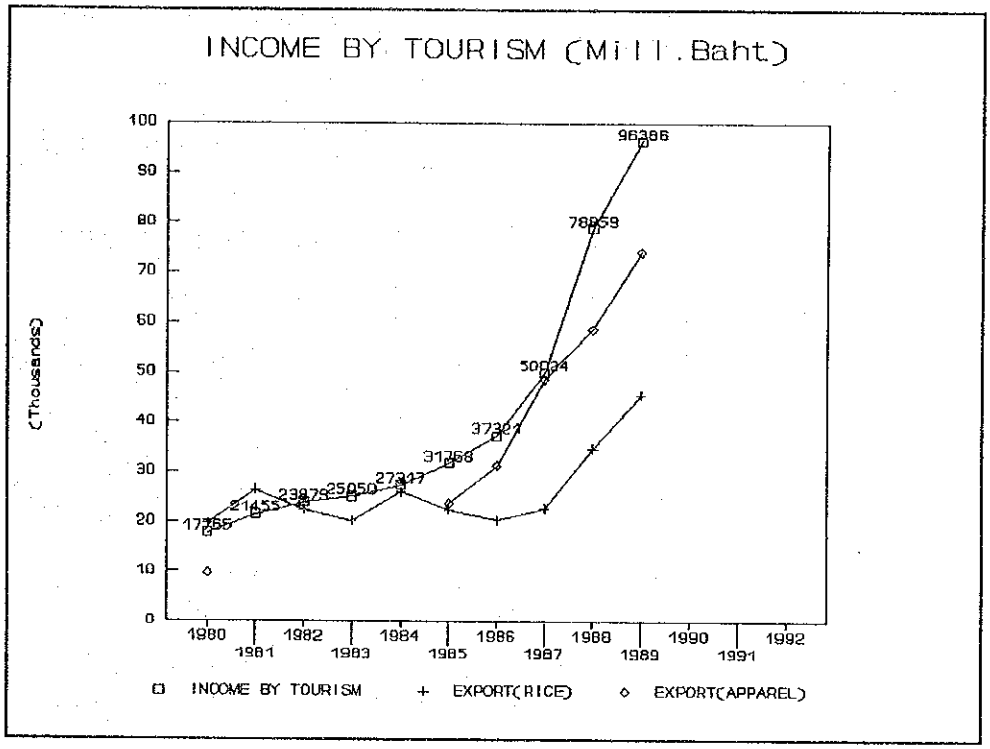
For another, agriculture, as the bedrock of social stability, is steadfast.

The land is expansive (513,000 km^2), with a large enough population(55.8 million), to promise a potentially non-existent as compared to other Asian countries.

Ethnic minorities are well assimilated and blended with the Thais.

7th-Large Income from Tourists of Foreign Countries

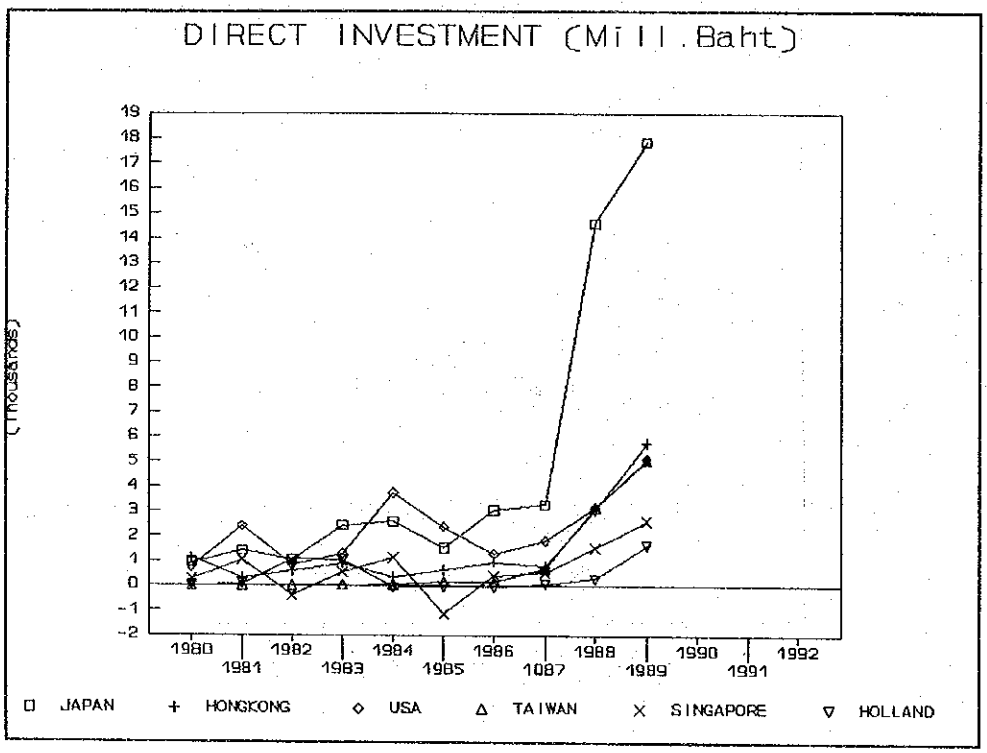
This income in 1989, 96.4 billion Baht, was larger than that of apparel which was the top export item.



SOURCE:Tourism Authority of Thailand

8th-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.
Obviously, direct investment from overseas is a prominent factor in the continuing growth of Thai economy.



SOURCE: Bank of Thailand

2.2.3 Outline of Social and Economic Development Plan in Thailand

(1) Targets and accomplishment of 1st (1961-1966) to 6th (1987-1991) plan

During the period of 1st to 6th economic development plan, 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 large scale 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.

Growth Item	1st Plan (1961-1966)		2nd Plan (1967-1971)		3rd Plan (1972-1976)	
	Target	Reached	Target	Reached	Target	Reached
Economic Growth Rate(%)	6	8.1	8.5	7.8	7.0	7.1
Agriculture	4.5	5.0	4.3	4.1	5.1	3.9
Manufacture	-	10.5	10.9	9.2	8.0	8.6
Income per Capita(Baht)	-	2,787	-	3,835	-	7,330
Population Increase(%)	3.0	3.3	3.3	3.2	2.5	2.6
Balance of Trade(M Baht)	-	-2,167	-	-10,484	-	-13,047
Commodity Price Rise(%)	-	-	-	-	10.0	12.0

4th Plan (1977-1981)		5th Plan (1982-1986)		6th Plan (1987-1991)	
Target	Reached	Target	Reached	Target	Reached
7.0	7.1	6.6	4.4	5.0	-
5.0	3.5	4.5	2.1	2.9	-
9.6	8.7	7.6	5.1	6.6	-
-	17,200	35,700	21,935	27,783	-
2.1	2.2	1.5	1.7	1.3	-
-17,940	-45,000	-78,400	-54,000	-35,900	-
6.0	11.6	10.6	2.7	2.3	-

SOURCE:NESDB

(2) 7th plan (1992-1996)

The 7th Social and Economic Development plan was approved by cabinet in August 1990, and started from October in 1991.

Following is an outline of the 7th national economic and social development plan (1992-96), which was approved by the cabinet meeting of August 1990 and started in October 1991.

Objectives

* To maintain an adequate level of economic growth while maintaining the stability of both economy and finance.

* To distribute income and the results of economic developments to local regions.

* To promote further developments of human resources, living standards, environments, and natural resources.

Targets

To achieve these objectives, the following targets in terms of quantity and quality have been established:

a) Economic growth

* Yearly economic growth rate of 9% on the average

* Increase of income per capita to 75,000 bahts (about US$ 3,000), in the last year of this plan, from 32,400 bahts in 1989, which means that an average annual growth rate of 7.6% must be achieved.

* Average annual growth rate of more than 2.7% in agricultural production.

* Average annual growth rate of 17% in export revenues and of 12% in export volume on the assumption that the world economy grows at an annual rate of 3%.

b) Targets of economic stability

* Inflation rates should not exceed an annual average of 5.5%.

* Trade deficits should not exceed an annual average of 7% in terms of ratio of GDP.

* The current account should be balanced by the last year of this plan. The deficit ratio of the current account to GDP should not exceed an annual average of 2%.

c) Targets of income distribution

* Target groups for income distribution should clearly be

defined for people who belong to these categories: poor farmers, employed farmers, people who run small businesses in city areas, and low-wage workers employed by private enterprises.

* The population ratio of those below the poverty level should be reduced to less than 20% by the last year of this plan, thereby reducing the number of poor people.

* While curtailing the income gap by region and occupation, efforts should be made to raise the income levels of the target groups, especially of poor self-employed farmers and those employed in farming industries.

* Proprietorship of assets should be distributed with special emphases on farmers' income from land and on the housing supply for low-income workers.

d) Targets of human resources, living standards, environments, and natural resources development

* The population growth rate should be lowered to 1.2% annually by the last year of this plan.

* Through the continued efforts to promote and improve lifelong education in the overall education systems (both formal and informal), the quality of the Thai people should be raised to provide them with flexibilities that allow them to cope with changing environments. Also, active participation by the general public in the development programs should be encouraged on a much wider scale, and the profits gained from participation should be protected and secured for the investors.

* Efforts should be made so that all the Thai people can enjoy good health within 10 years.

* To promote the progress of our societies and to preserve and maintain the identity and the precious traditional values of Thailand, it is necessary to bring up the type of people who have a sense of morality and ethics to go along with good health and skills.

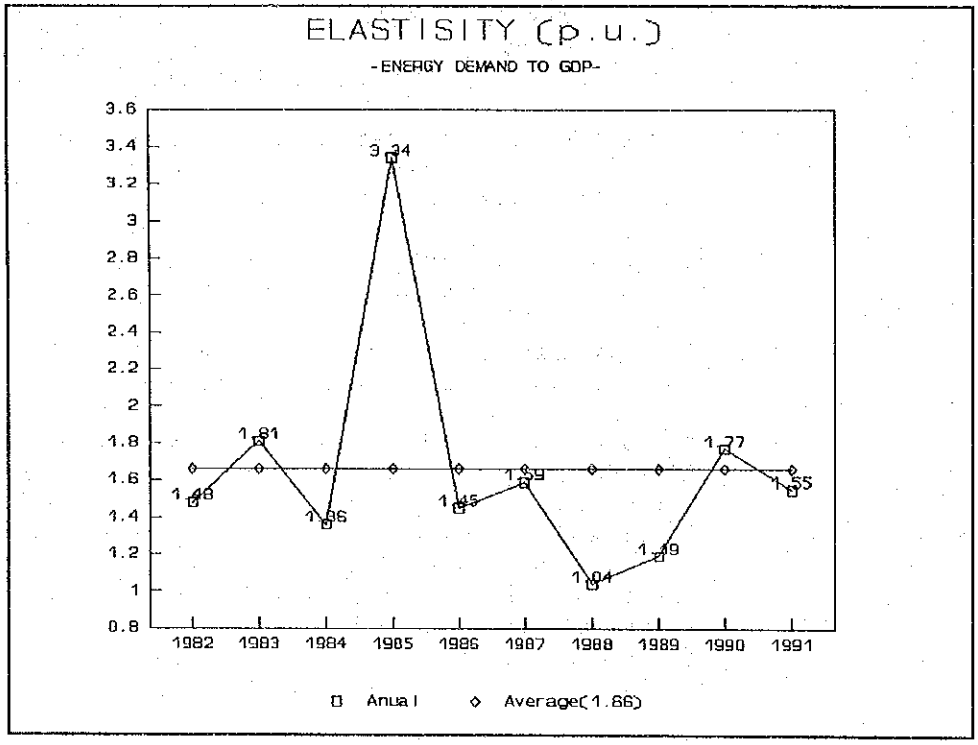
* Efficiency concerning the protection of life, properties, and consumer interests should be raised so that people from rural and urban areas alike can benefit from high-quality lifestyles and peaceful societies.

* Living standards should be raised through efforts to reduce the levels of water and air pollution, noise, solid wastes, and harmful wastes and also through efforts to check the worsening situation of environments overall. Recreational areas should be provided. Harmful contaminants in the air, such as sulfur dioxide, carbon monoxide, nitrogen dioxide, and from gasoline, should be reduced to levels that will not harmfully affect people in both city and rural regions.

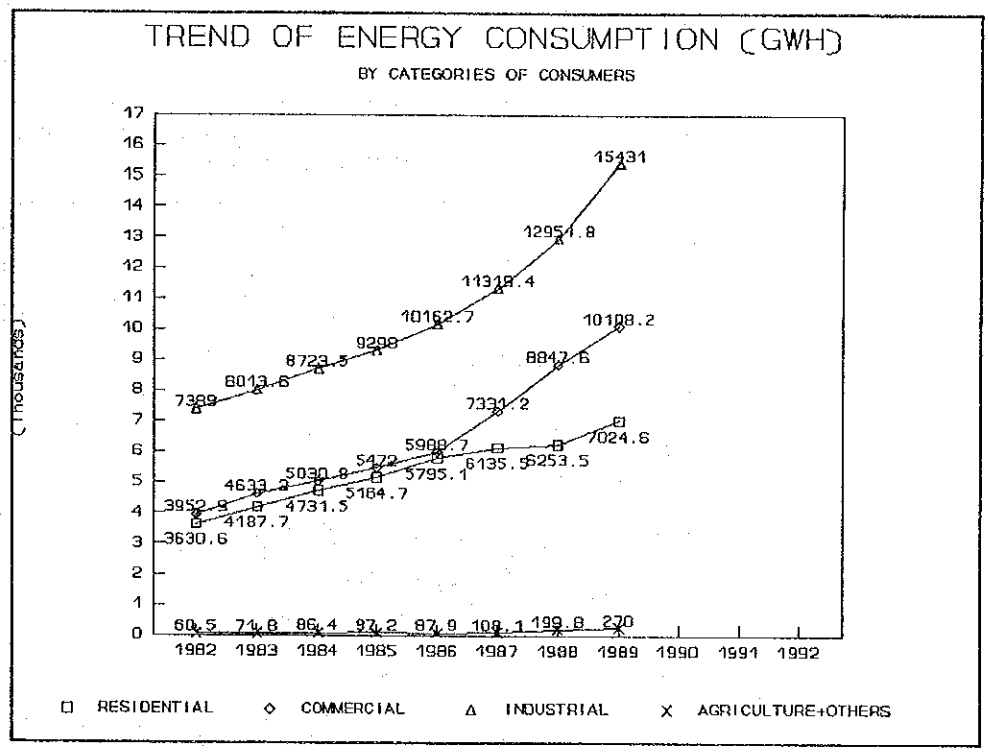
2.3 Economics and Parameters of Electric Power

(1) GDP and Electric Energy Consumption

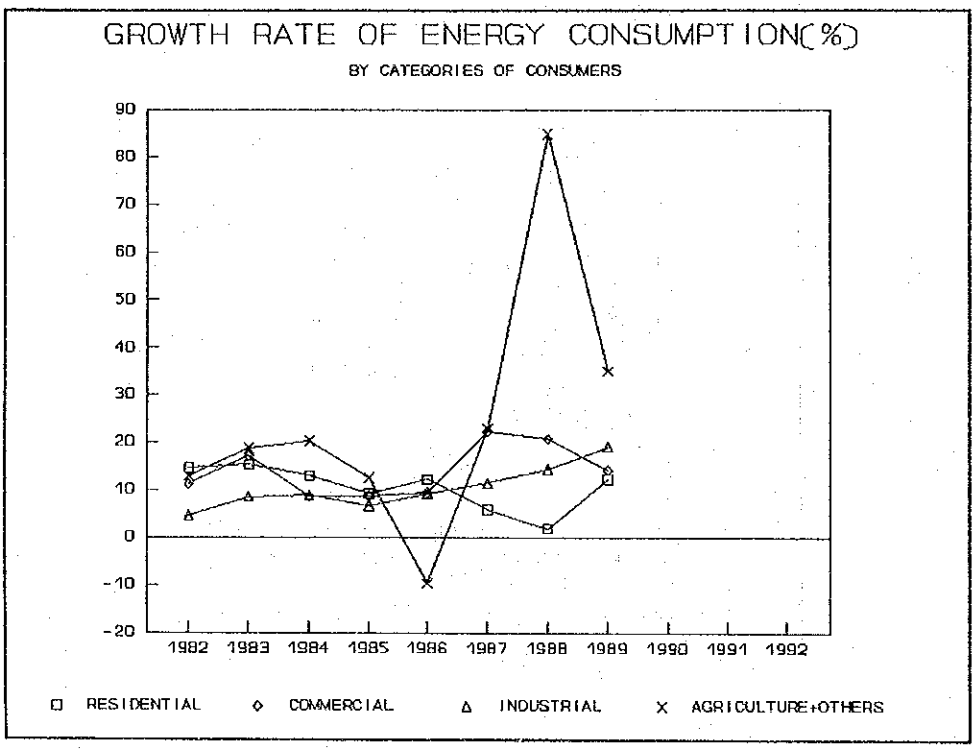
The elastisity of the electric energy demand (electric energy consumption) to GDP is approximately 1.66.
The elastisity is defined as the ratio of growth rate of electric energy demand to that of GDP.



(2) Electric Energy Consumption by Categories of Consummers

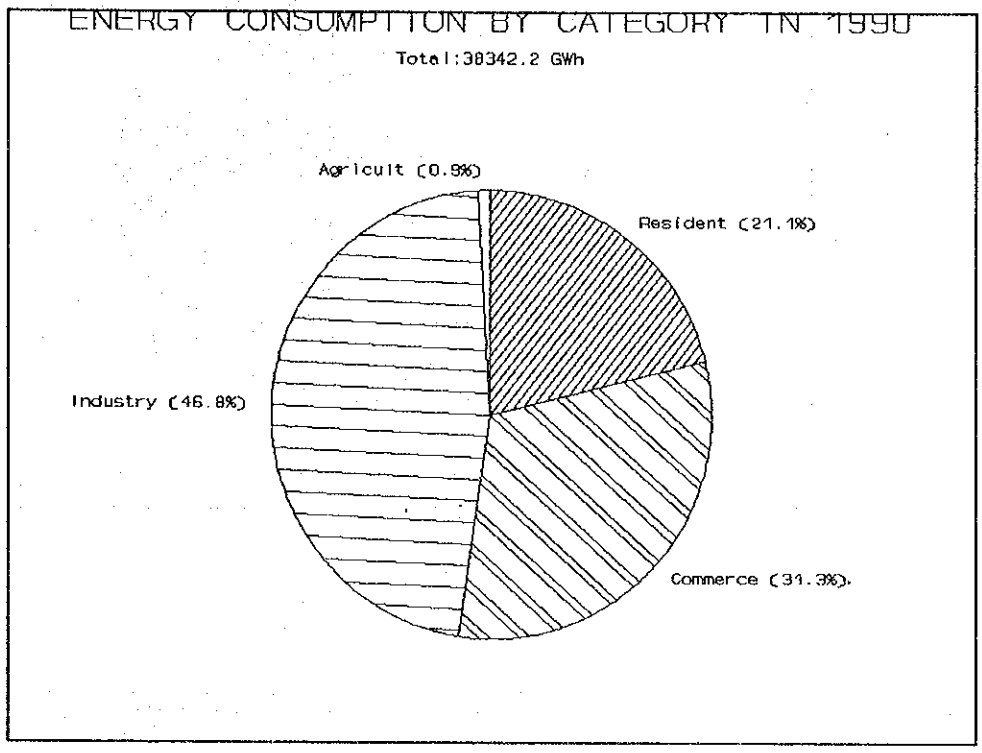


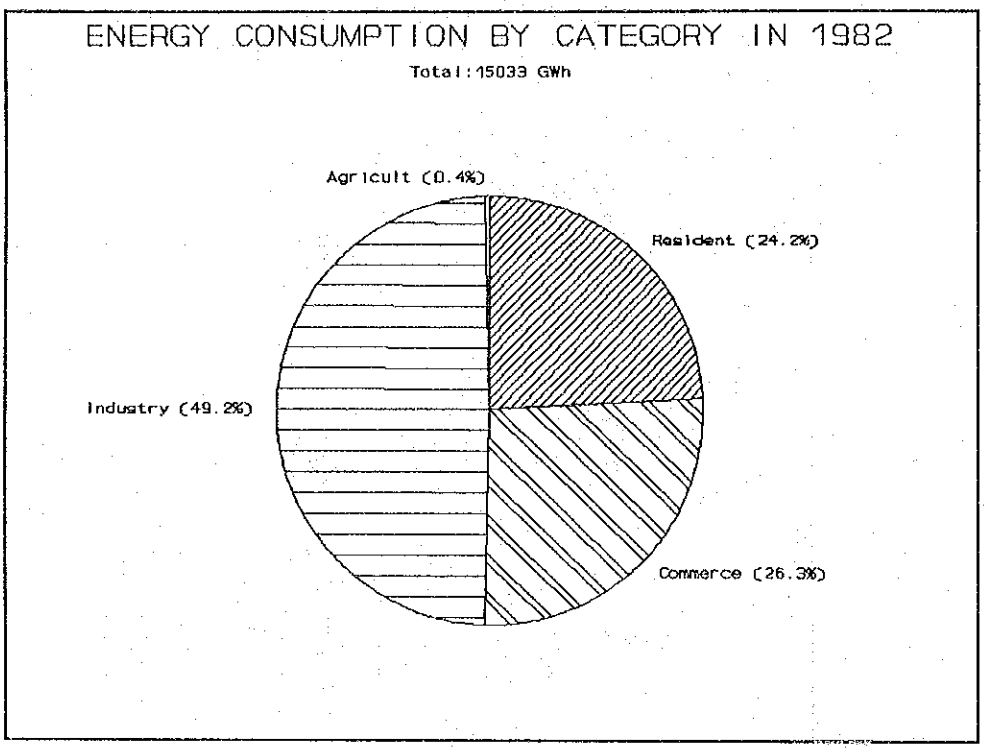
Consumers of each category, residential, commercial and industrial keep a high growth rate of energy consumption at a level of 10% in average in the past decade. (Agriculture and others are small consumers)

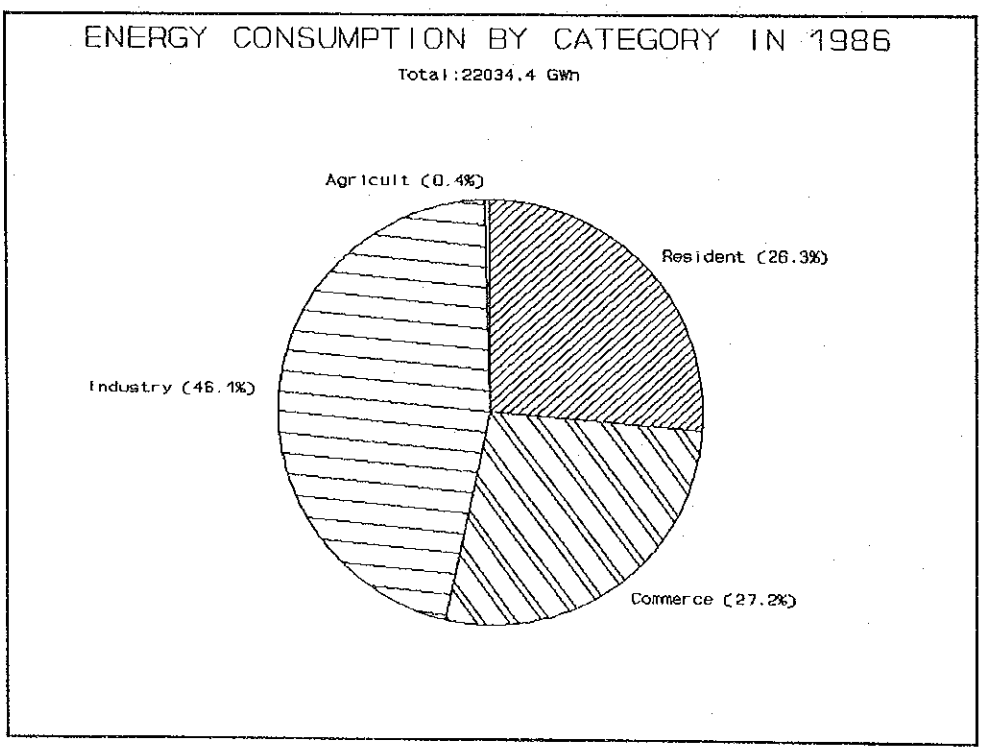


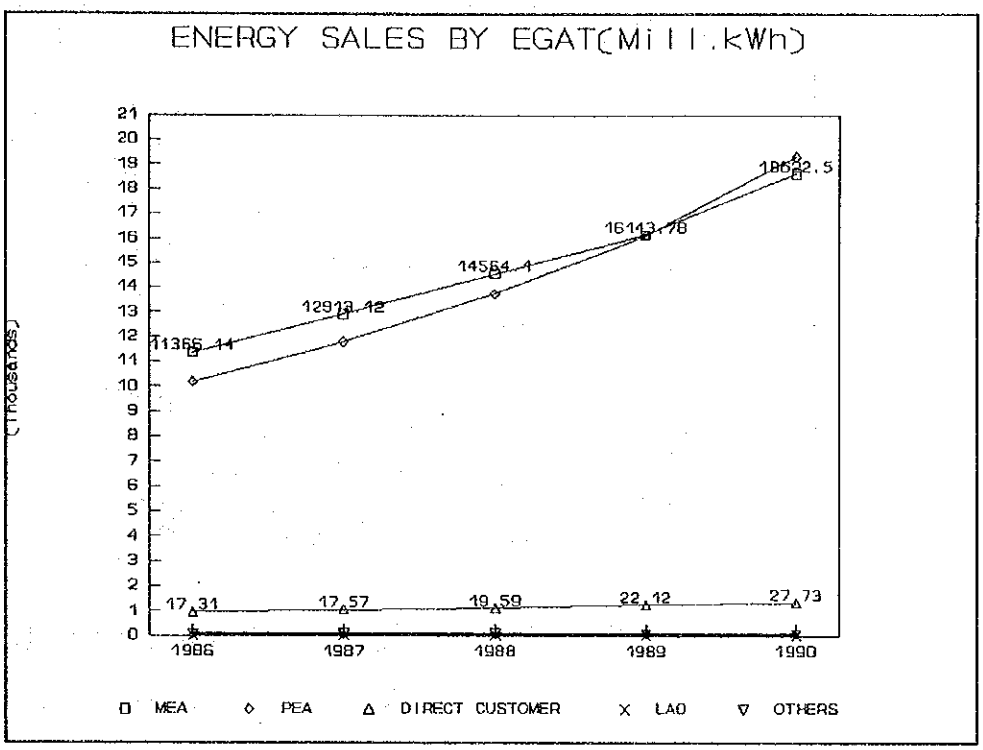
In 1990, energy consumtion by industrial sector was 46.8% of the total, commercial sector of 31.3% and residential sector of 21.1%.

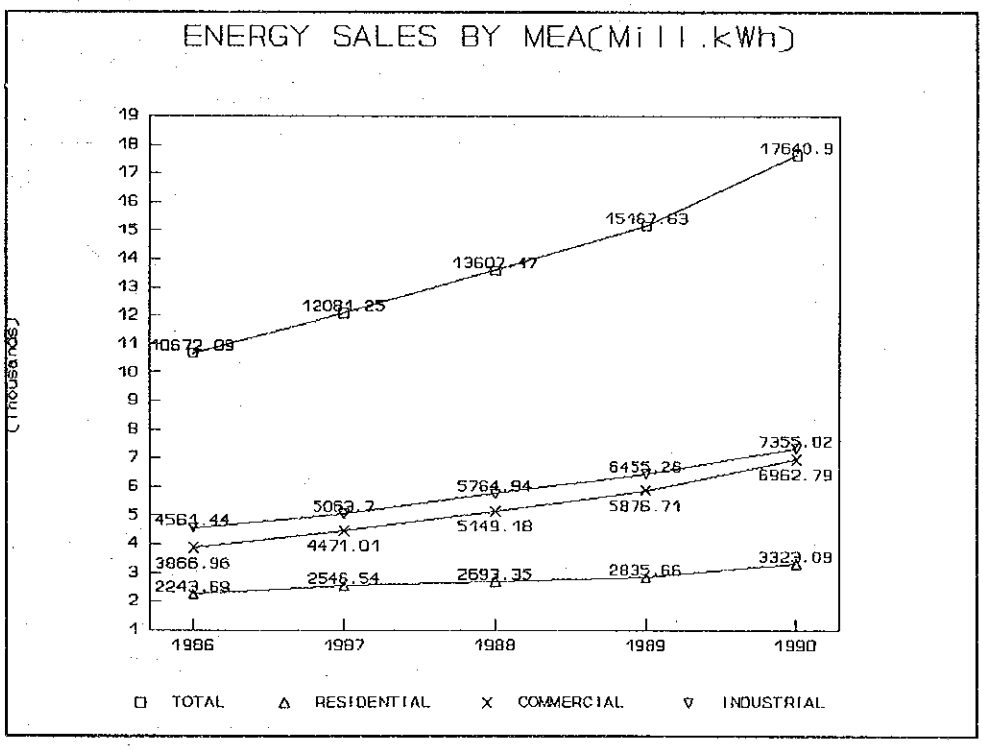
Ratio of energy consumption by category in 1990 remains almost the same as those in 1982 and 1986.



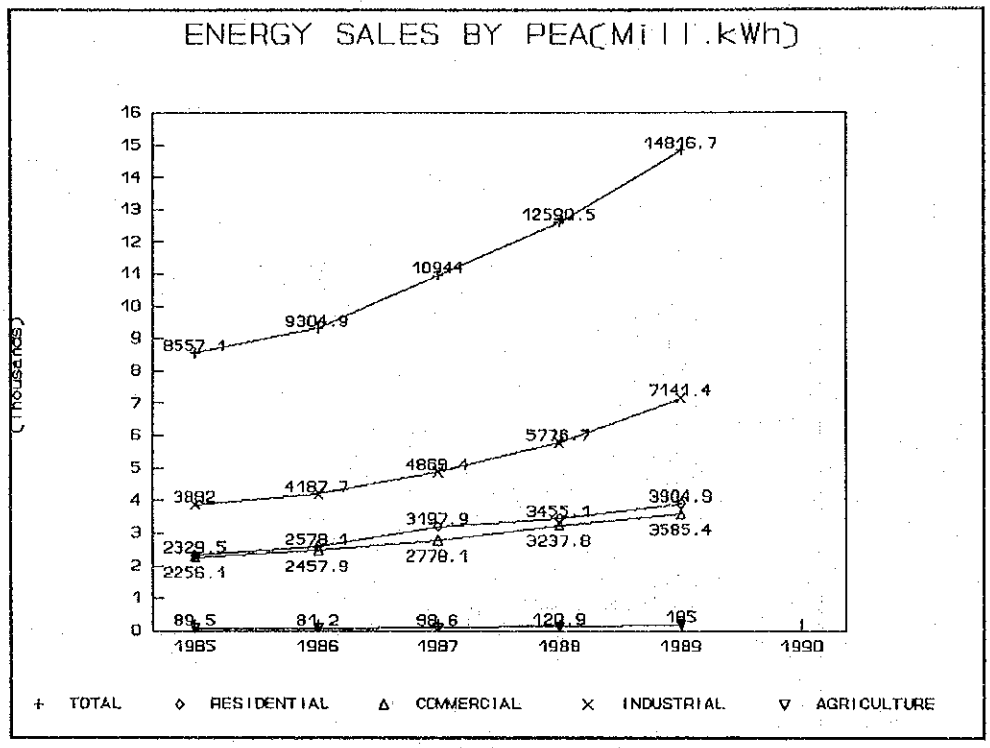

ENERGY CONSUMPTION BY CATEGORY IN 1982
Total:15033 GWh
Agricult (0.4%)
Resident (24.2%)
Industry (49.2%)
Commerce (26.3%)


ENERGY CONSUMPTION BY CATEGORY IN 1986
Total:22034.4 GWh
Agricult (0.4%)
Resident (26.3%)
Industry (46.1%)
Commerce (27.2%)

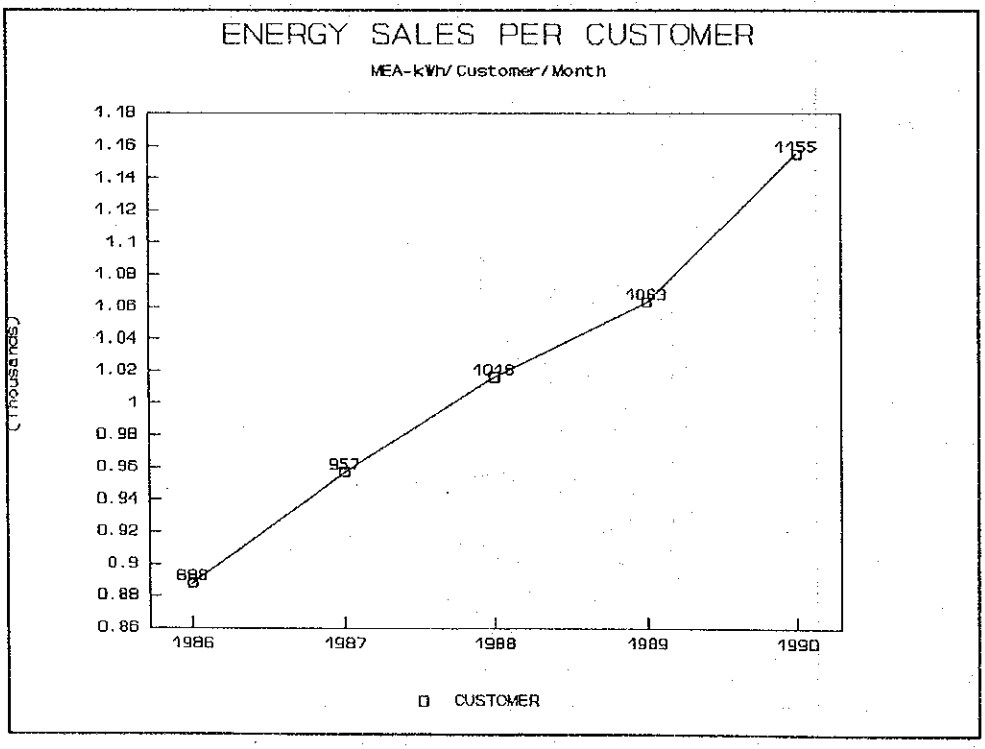




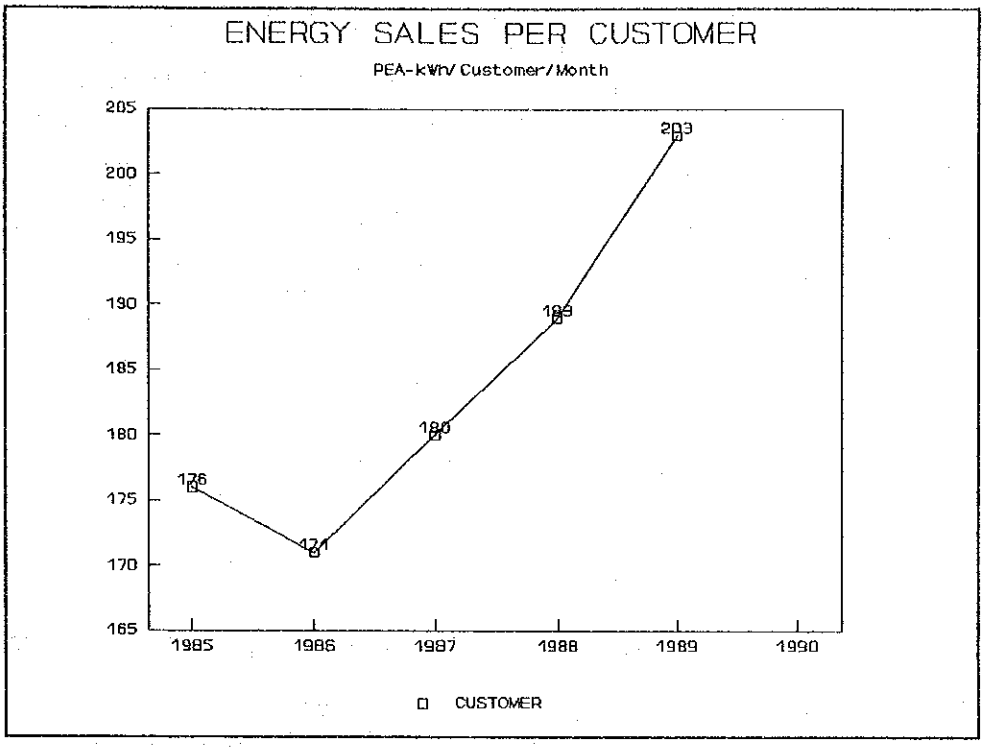
SOURCE:MEA ANNUAL REPORT



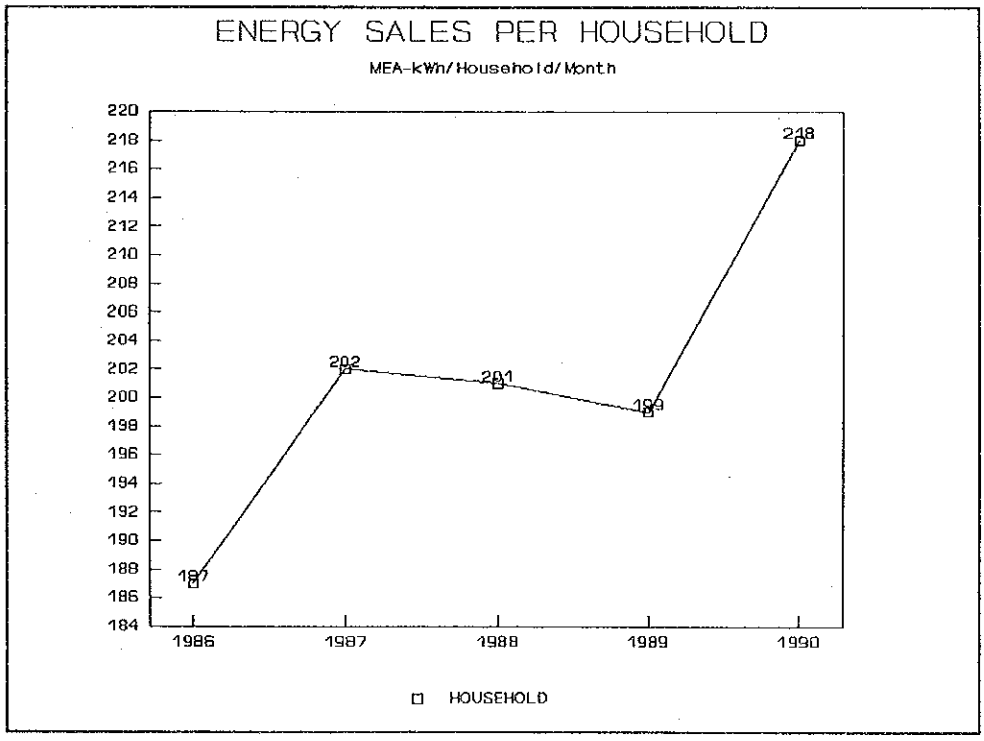
SOURCE:PEA ANNUAL PEPORT



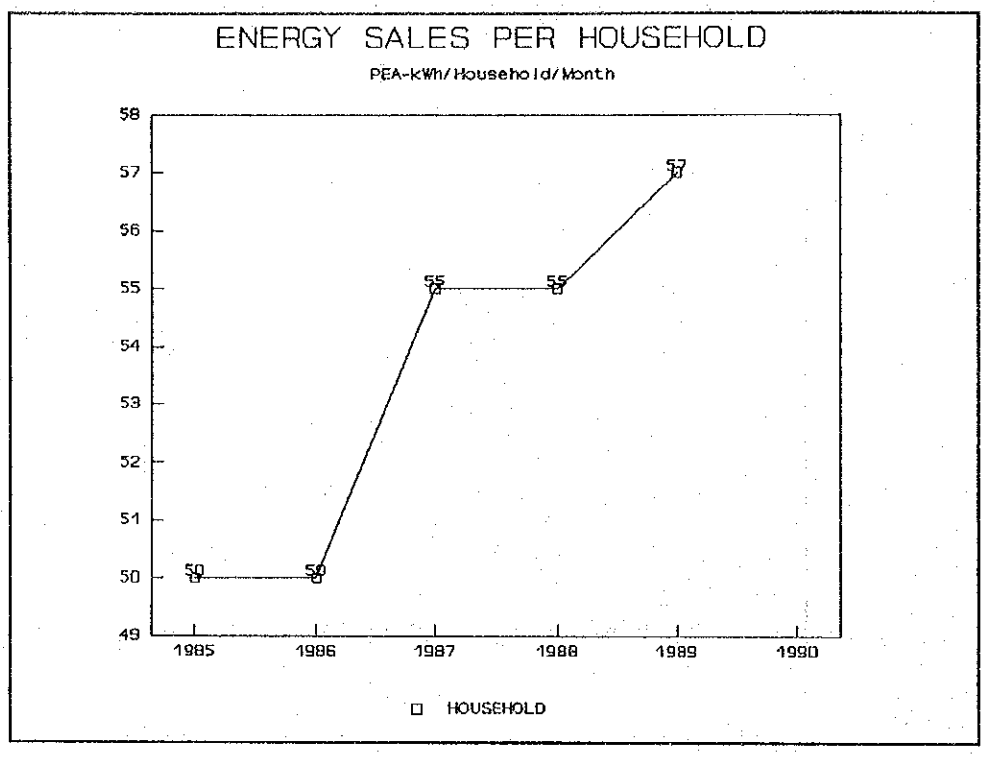
SOURCE:MEA ANNUAL REPORT



SOURCE:PEA ANNUAL PEPORT



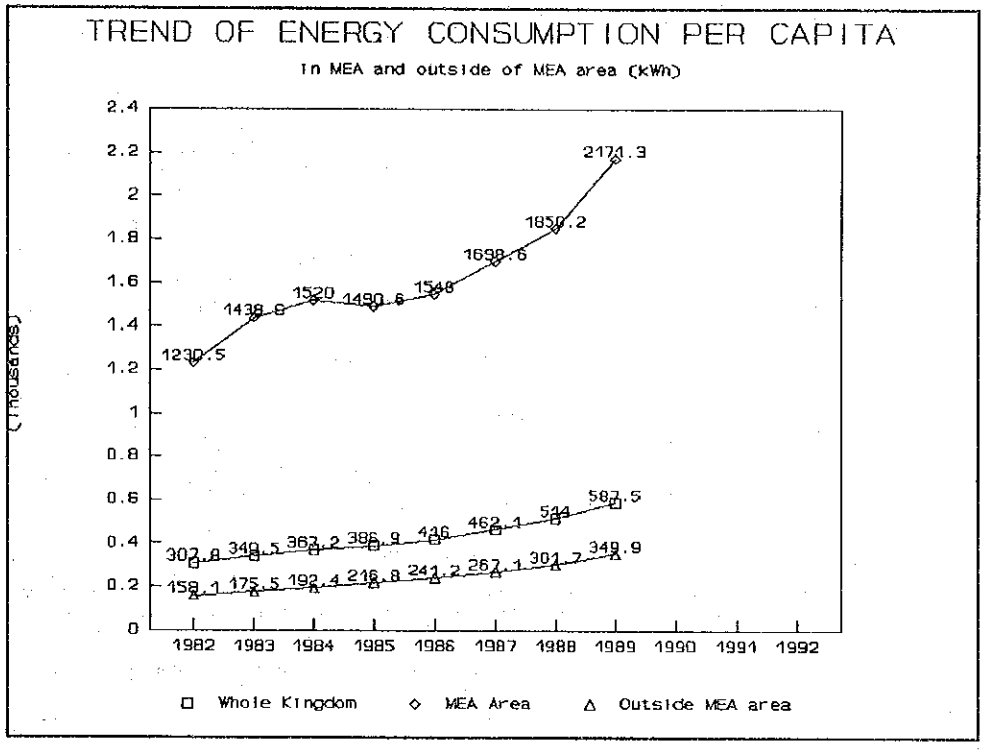
SOURCE:MEA ANNUAL REPORT



SOURCE:PEA ANNUAL REPORT

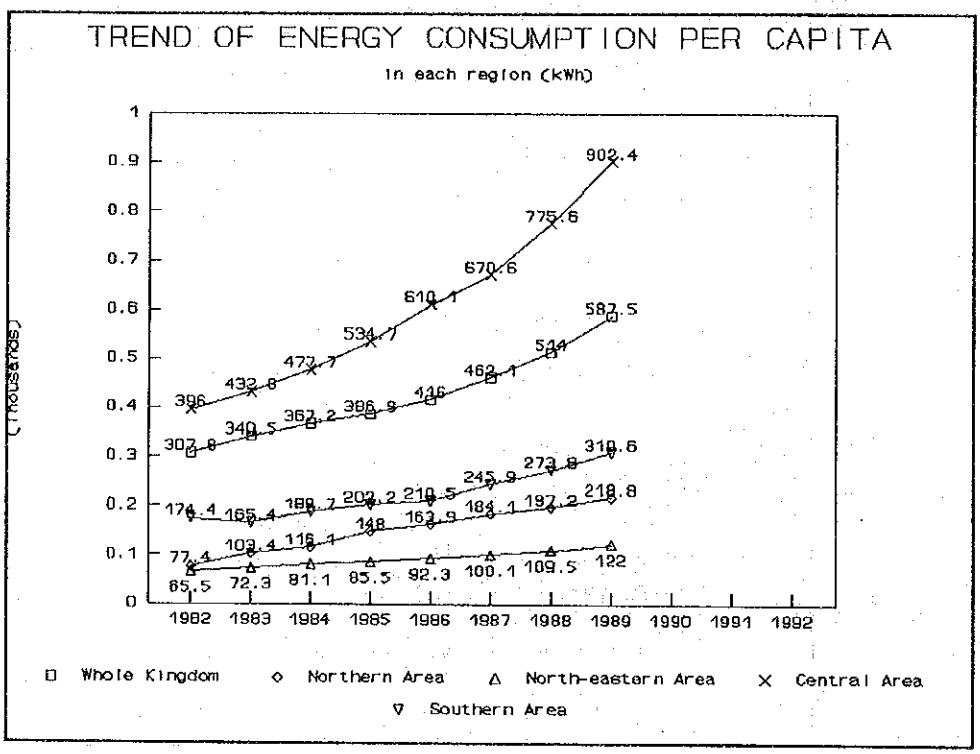
(3) Electric Energy Consumption per Capita

The difference of electric energy consumption per capita between MEA area and outside of MEA are grows year by year.

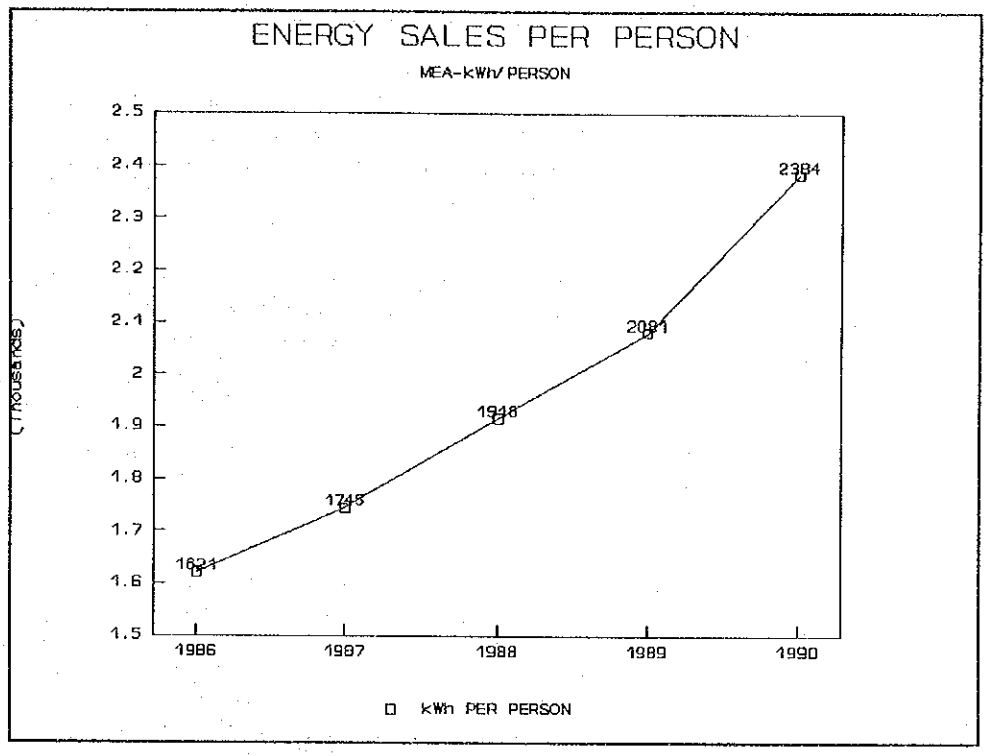


SOURCE:EGAT,MEA,PEA,POF,Department of Local Administration

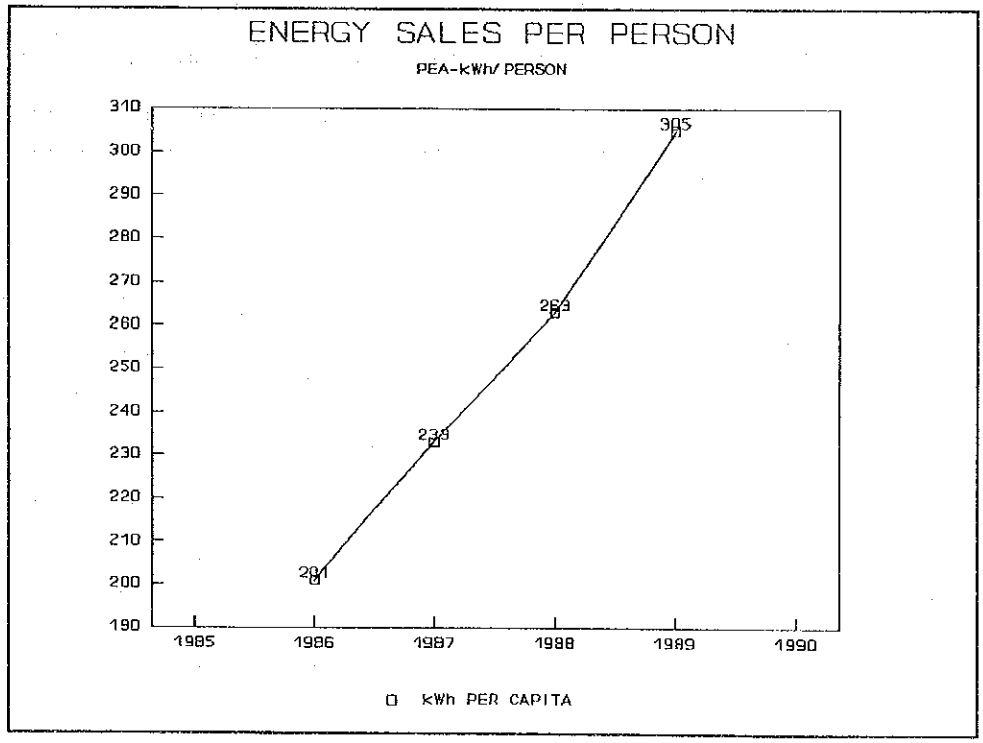
Overviewing energy consumption per capita in each region, the figure is low in the decending order of Central area, North-eastern area, North area and Southern area.



SOURCE:EGAT,MEA,PEA,POF,Department of Local Administration



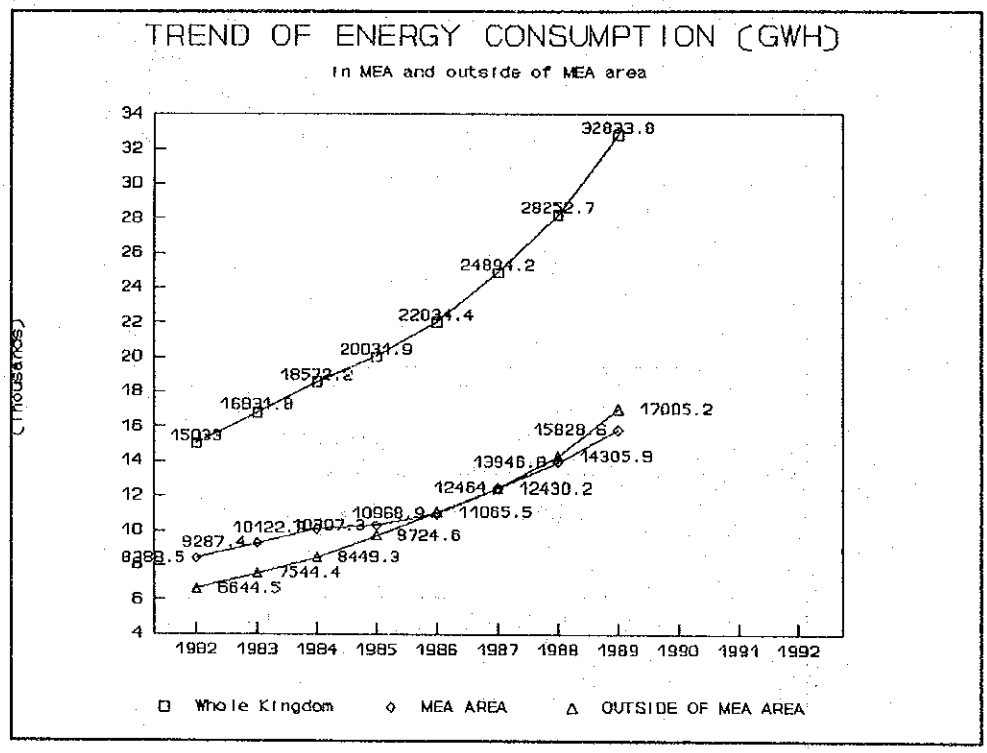
SOURCE: MEA ANNUAL REPORT

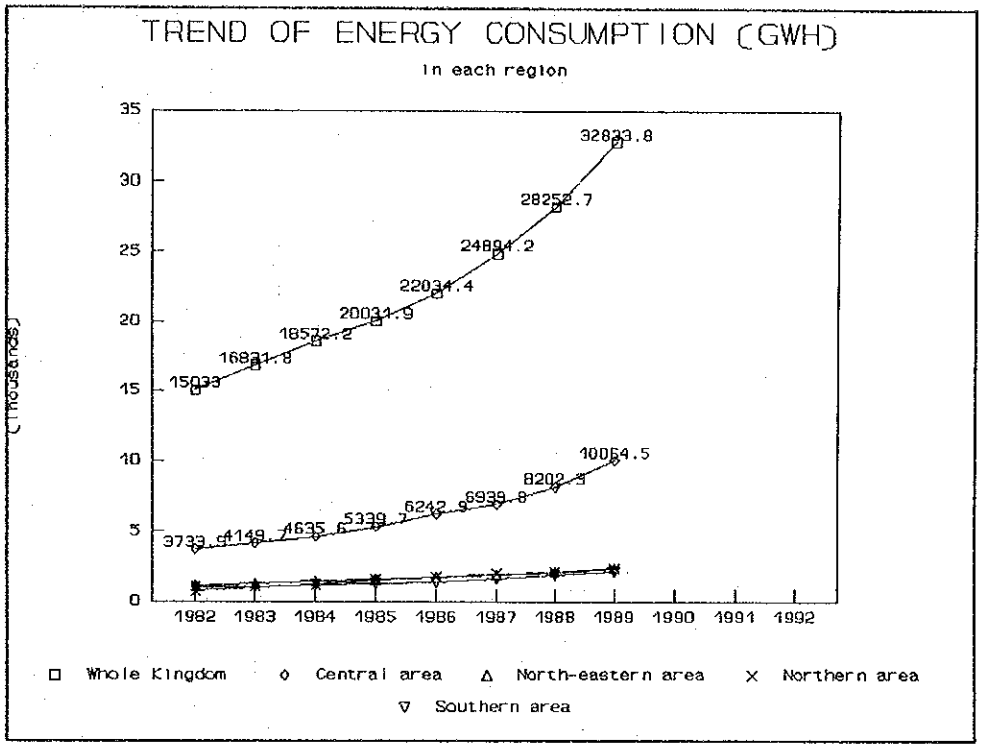


SOURCE: PEA ANNUAL REPORT

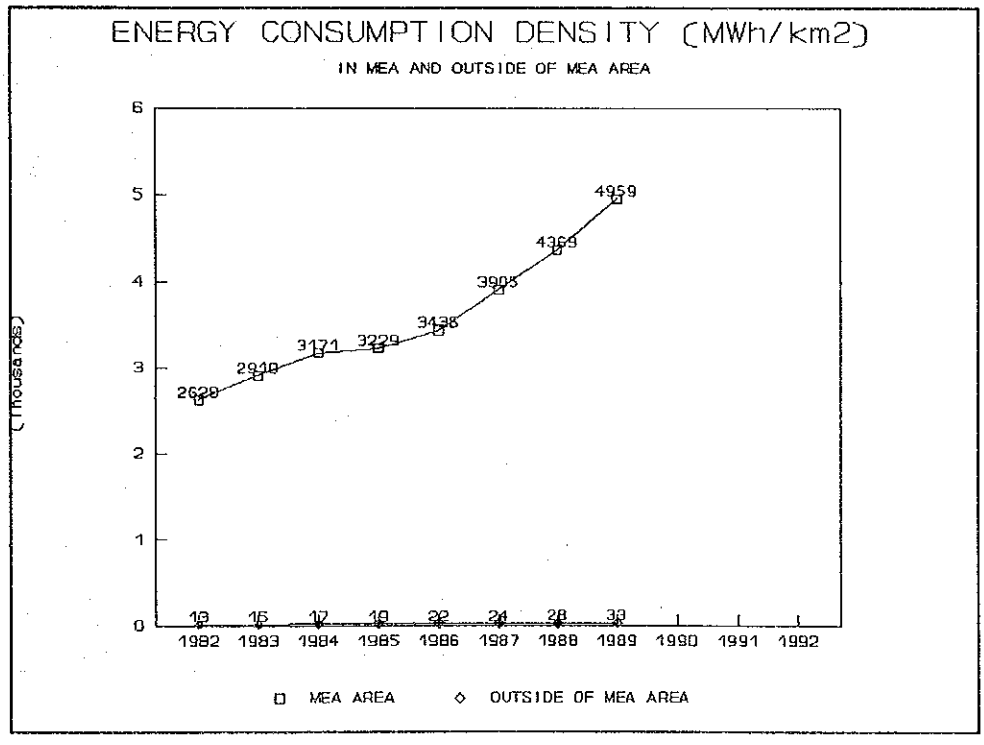
(4) Electric Energy Consumption in the Greater Bangkok Area and in Province

The enrgy consumption growth has sharpened in recent years. The energy consumption in the Greater Bangkok Area is remarkable, while that in the other regions of North-eastern, North and Southern area keep a slow pace.

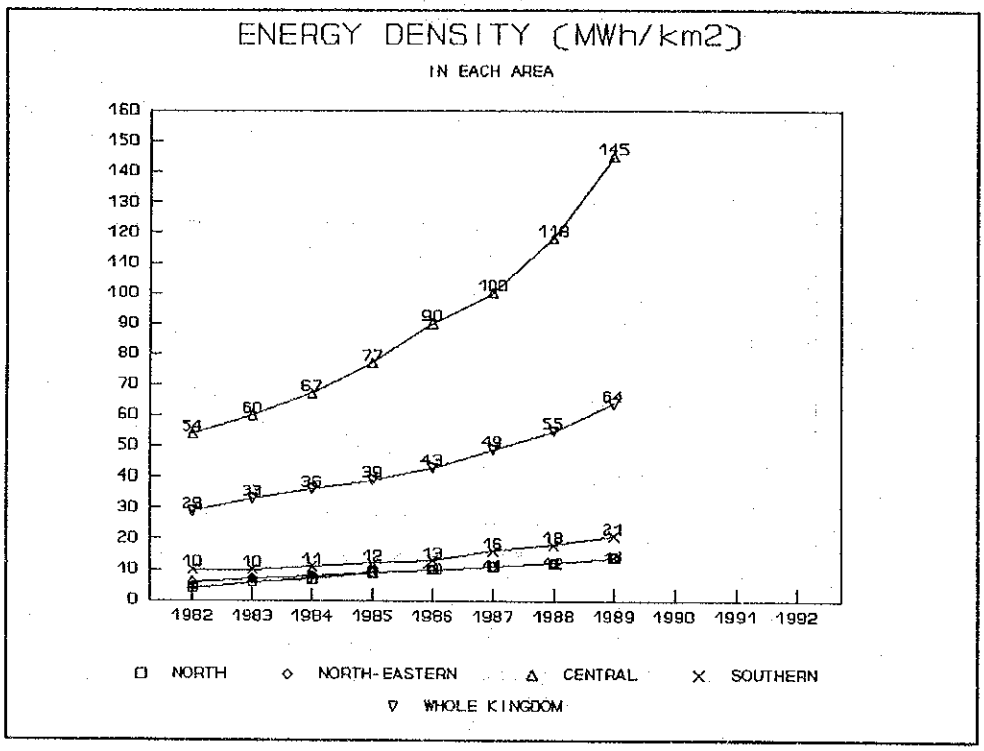




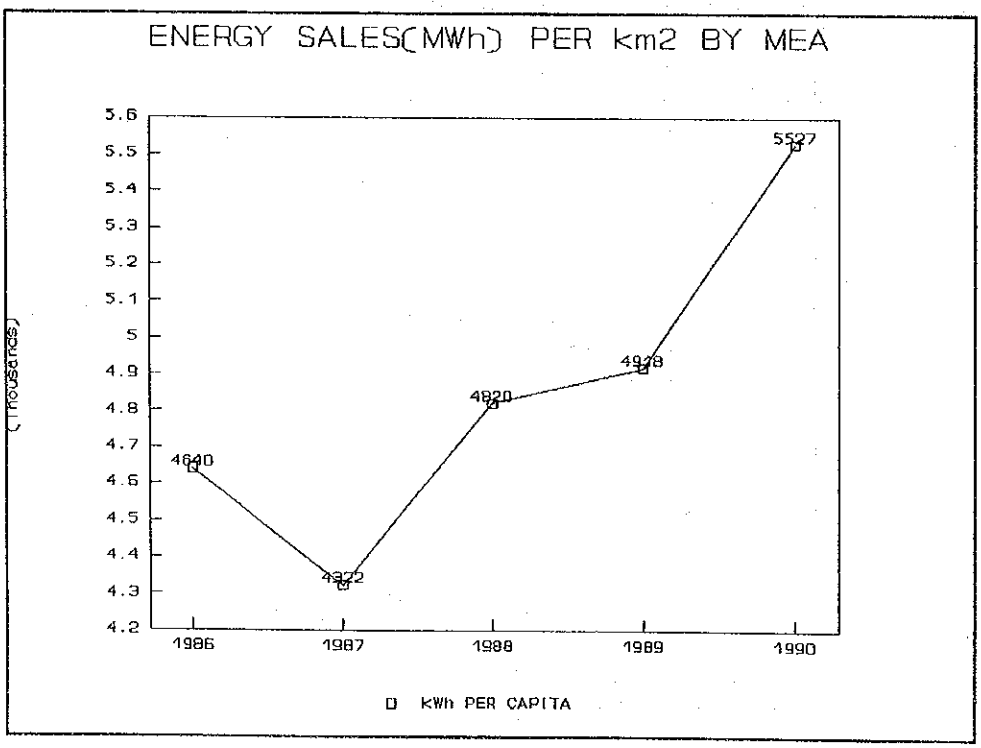
Energy sale by EGAT to MEA per km^2 of the service area is as follows.



Energy sales by EGAT to PEA per km^2 in each region are as follows.



Energy sale per km^2 in MEA service area is as follows.



SOURCE:MEA ANNUAL REPORT

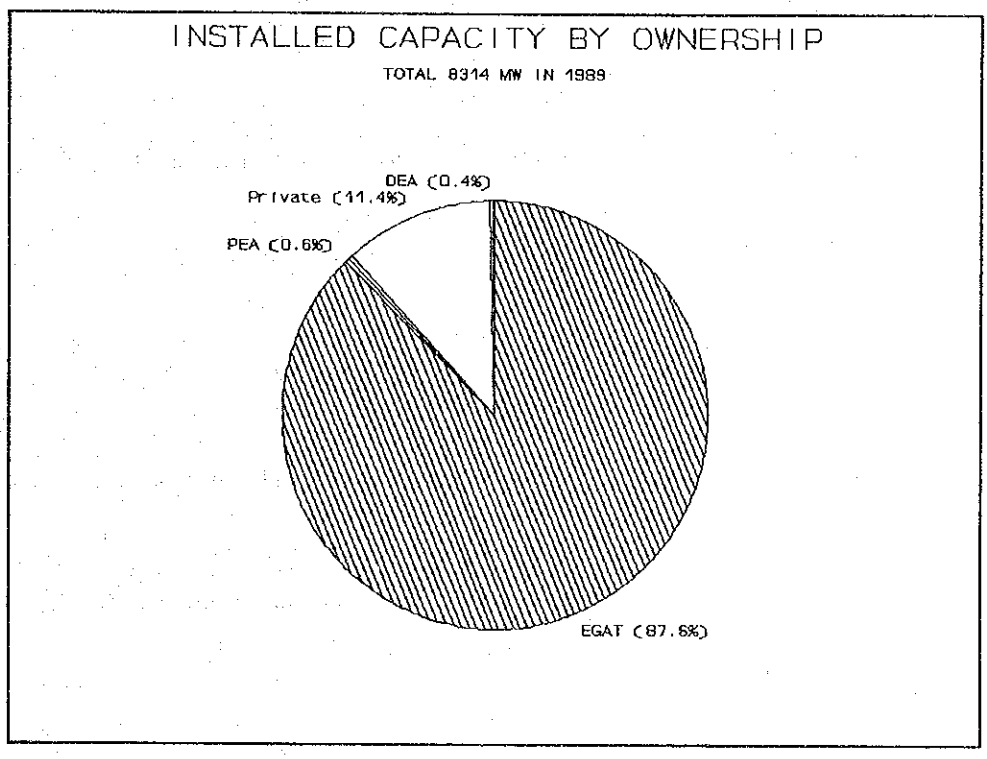
CHAPTER 3

CURRENT STATUS OF ELECTRIC POWER UTILITY INDUSTRY

CHAPTER 3 CURRENT STATUS OF ELECTRIC POWER UTILITY INDUSTRY

3.1 Organization of Electric Power Sector

The electric power enterprises in Thailand are for the most part under the management of the Government,while the installed capacity of generating facility owned by private companies accounts for about 11% of the entire generating capacity.



The responsibility for comprehensive administration concerning electric power comes under the jurisdiction of National Energy Policy Council (NEPC), chaired by the prime minister.

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

NEPO (National Energy Policy Office)

The National Energy Policy Office (NEPO) is the secretariate office of NEPC (National Energy Policy Council) which is responsible for managing energy policies for all of Thailand.

The electric power development plan prepared by the electric power utilities will be reviewed by NEPO and submitted to NEPC.

The plans have to receive the approval from NEPC and endorsed by the Cabinet.

EGAT (Electricity 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).

The EGAT, who come under the jurisdiction of the Prime Minister Office, 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:

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

b) Other electricity consumers as direced by a Royal Decree;

c) 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 undertake business concerning electric energy and other business concerning continuity with activities of EGAT, or collaborate with other persons for the said activities.

-To produce and commmercialize 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 concerned 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 establish a limited company or a public company limited for undertaking business concerning electric energy and other business concerning or continuity with the activities of EGAT

-To collaborate any activities with other entities whether internal or external entities of the private or of state or with international organizations, to hold shares in any limited company or public company limited for the benefit of the activities under EGAT's objectives

-To undertake other activities concerning on continuity with the achievement of EGAT's objectives

-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, the 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.

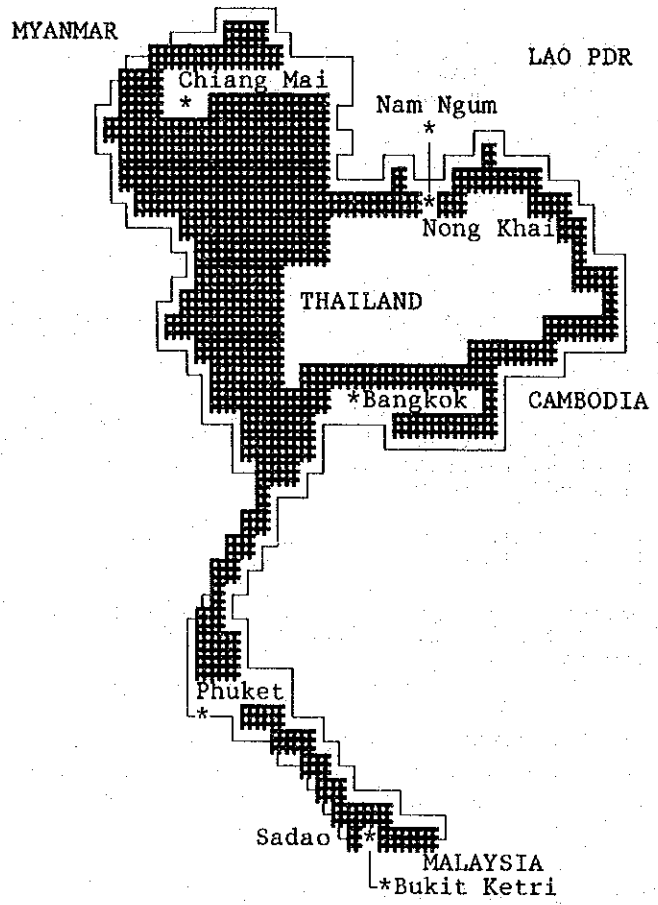
The EGAT, as a self-supporting organization, has an independent authority in the management of the organization.

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 and transmission.

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

The 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 the EGAT is shown in Fig. 3-1.

MEA (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 the 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).

PEA (Provincial Electricity Authority)

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

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

OAEP (Organization of Atomic Energy for Peace)

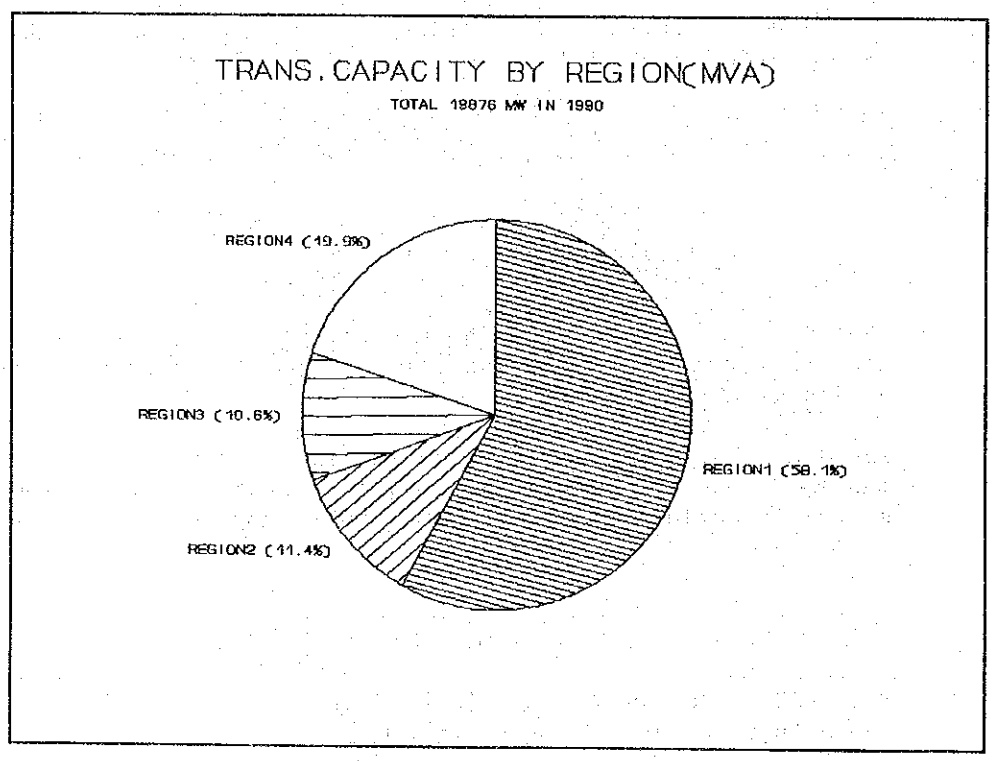
The OAEP comes under the jurisdiction of the Ministry of Science, Technology and Energy, administratively.

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.

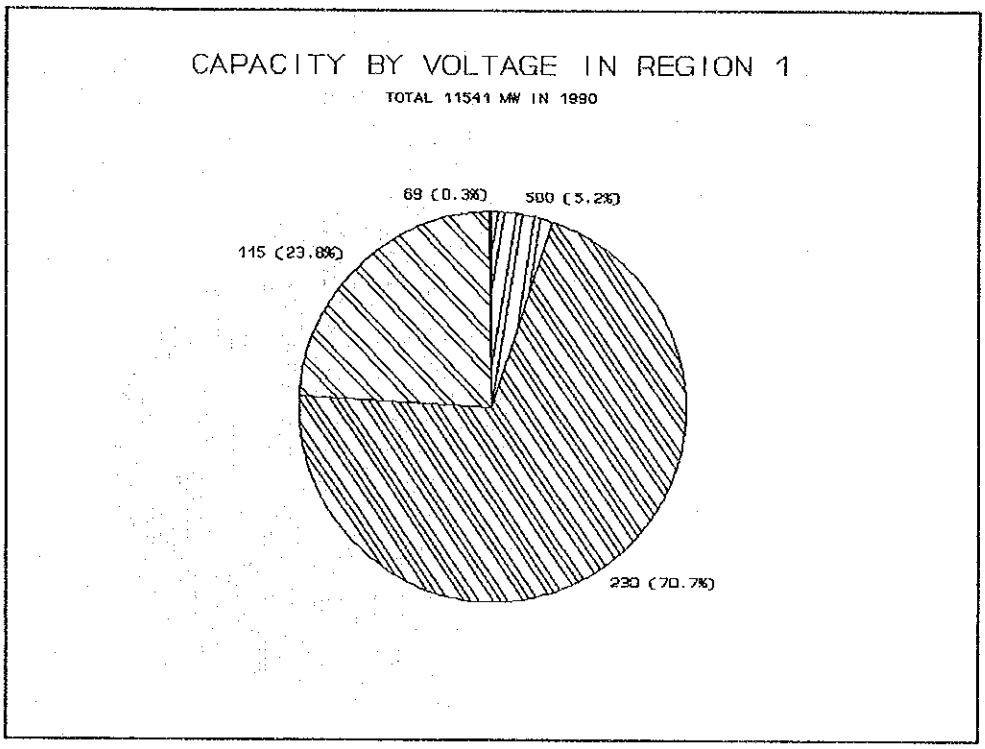
3.2 Electric Power Facilities

3.2.1 Transmission System

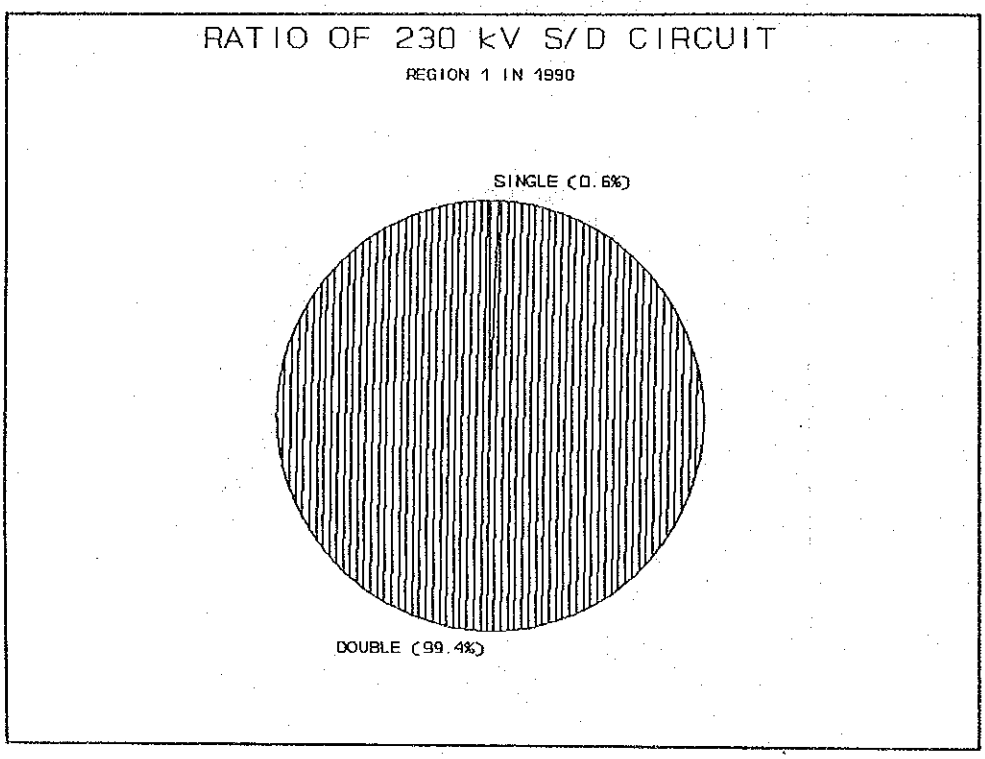
In terms of transformer capacity sum up in each region, 58.1% of the total (19,675 MW) is installed in Region 1 as of 1990, which indicates the demand concentration to Region 1.
Next coming is Region 4, in which area the second largest city of Chiang Mai is located.

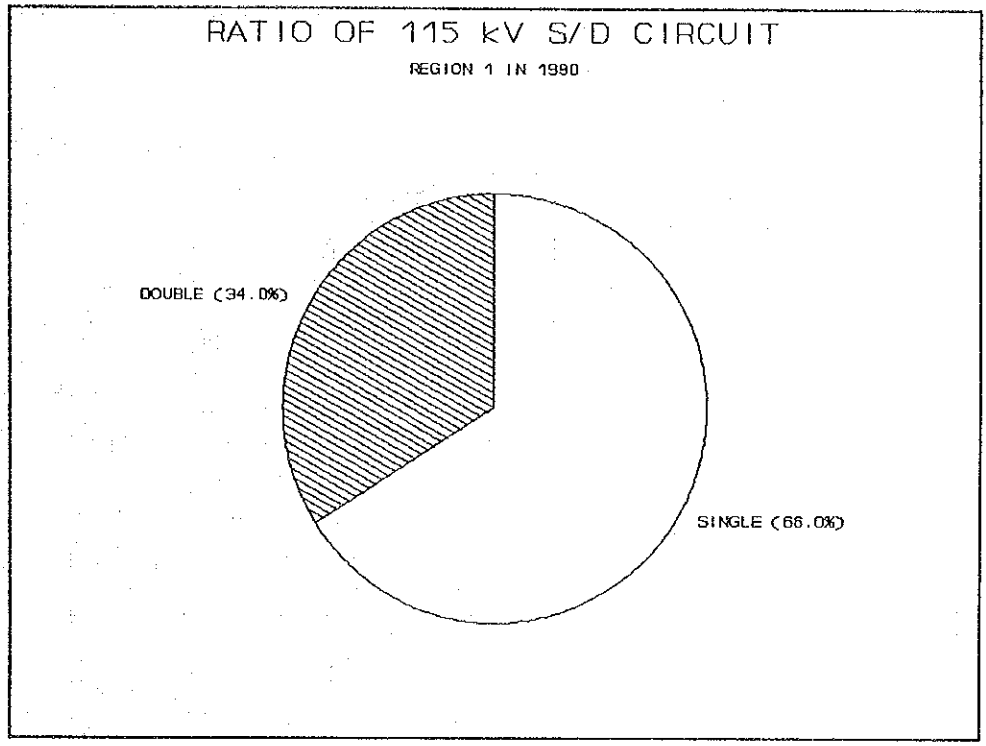


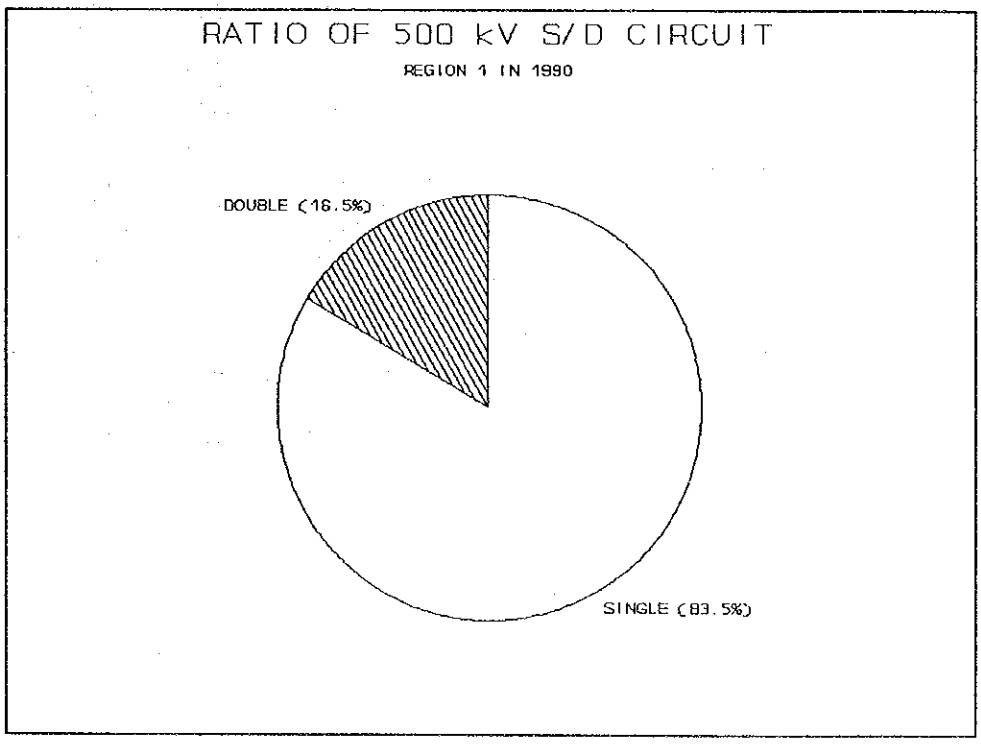
In Region 1, 70.7% of the total (11541 MW in terms of transformer capacity) is sent by 230 kV transmission line as of 1990. As for 500 kV line, only one line between Tha Tako and Nong Chok is in operation.



Almost 100% of 230 kV lines are composed of double circuit in Region 1 on account of capacity and reliability , which indicates that 230 kV line plays an important roll as trunk line.
To respond the future increse of power flow in Region 1, reconstruction of transmission line with 4-circuit steel tower, use of multi-conductor or step-up transmission voltage will be required.




RATIO OF 115 kV S/D CIRCUIT
REGION 1 IN 1990
DOUBLE (34.0%)
SINGLE (66.0%)


RATIO OF 500 kV S/D CIRCUIT
REGION 1 IN 1990
DOUBLE (16.5%)
SINGLE (83.5%)

EXISTING INSTALLED TRANSMISSION LINES AND SUBSTATIONS
(AS OF 1 SEPTEMBER 1990)

Region and System Voltage		Substation		Transmission Lines (Circuit-kilometers)		
		Number	Trans. Capacity (MVA) a/	Double-cct	Single-cct	Total
Region 1	500 kV	1	600	26	132	158
	230 kV	18	8160	2953	18	2971
	115 kV	46	2750	758	1473	2231
	69 kV	1	31	0	99	99
	Total	66	11541	3737	1722	5459
Region 2						b/
	230 kV	2	1000	519	0	519
	115 kV	30	1225	1894	1674	3568
	69 kV	4	41	0	327	327
	Total	36	2266	2413	2001	4414
Region 3						
	230 kV	6	1000	1274	0	1274
	115 kV	19	1109	1173	c/ 1137	2310
	Total	25	2109	2447	1137	3584
Region 4	500 kV	2	1800	0	375	375
	230 kV	6	850	2040	218	2258
	115 kV	24	1179	764	1270	2034
	69 kV	2	131	0	77	77
	Total	34	3960	2804	1940	4744
All Regions						
	500 kV	3	2400	26	507	533
	230 kV	32	11010	6786	236	7022
	115 kV	119	6263	4589	5554	10143
	69 kV	7	203	0	503	503
Total EGAT		161	19876	11401	6800	18201

a/Station service and generator unit transformers are excluded.
b/Presently energized at 115 kV (230 circuit-km)
c/Including 9 circuit-km of 132 kV transmission line.

3.2.2 Distribution System

The electric power supplied by EGAT is transmitted to MEA substations at 230 kV, 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 of PEA, distribution lines of 33 kV, 22 kV, 11 kV, etc., are being used and electric power is supplied to general users at 220 V.

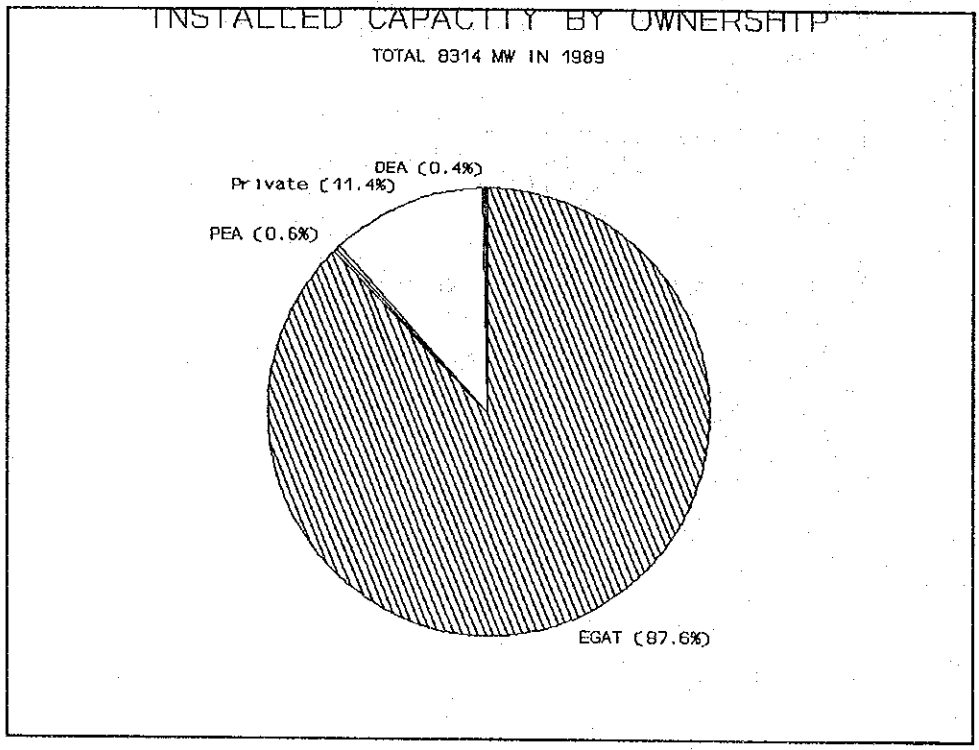
Total lengh of the distribution line in circuit-km as of 1988 is shown below.

Voltage (kV)	Circuit-km	
33	20,819	(PEA)
24/12	6,169	(MEA)
22	105,284	(PEA)
11	55	(PEA)

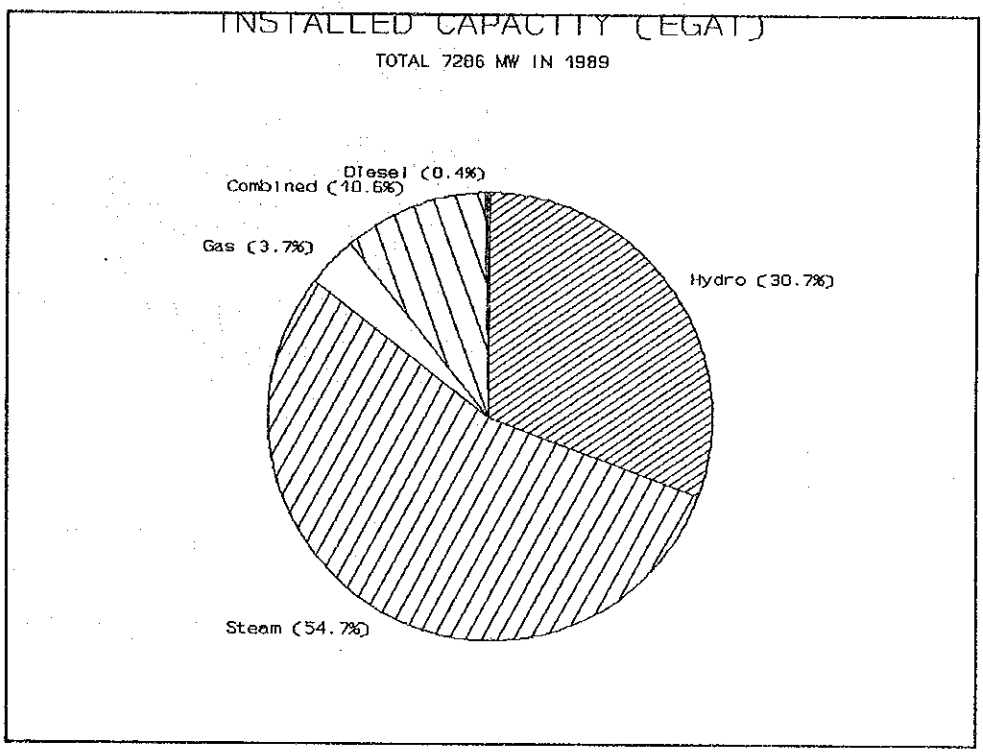
3.2.3 Generating Facility

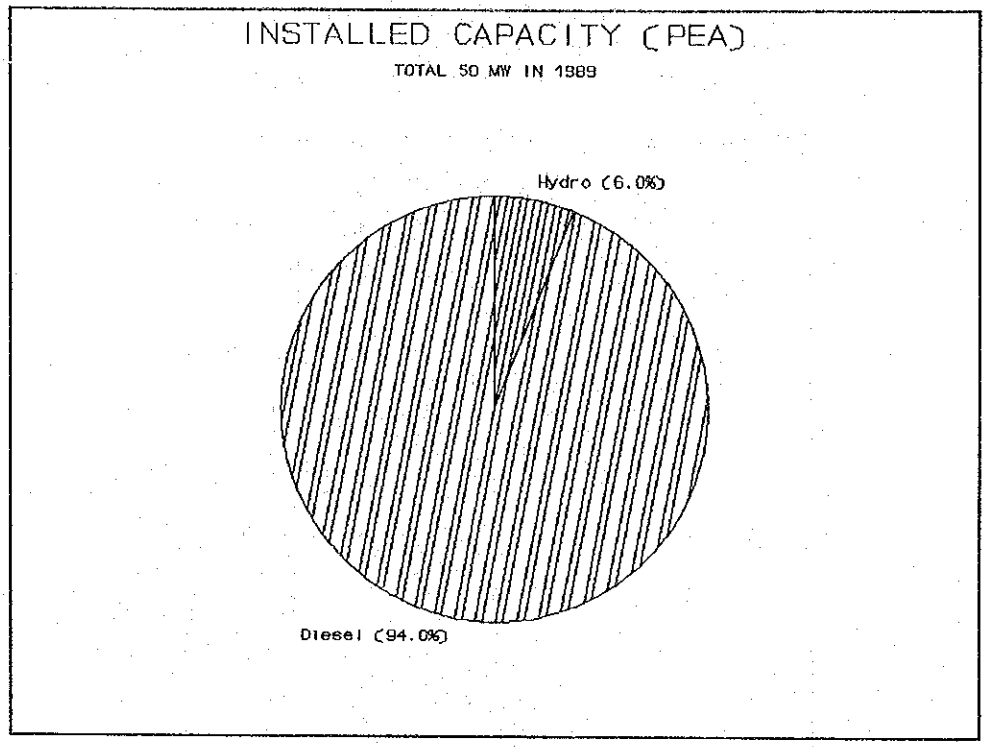
(1) Whole Country

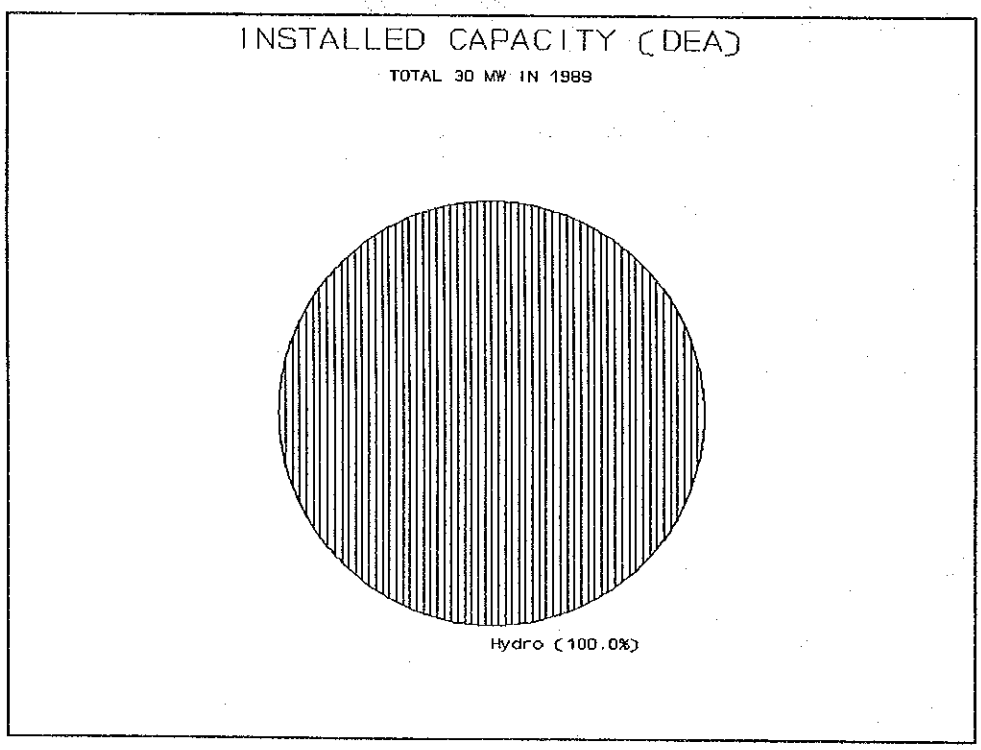
The total installed capacity in Thailand as of 1989 was 8,314 MW, of which 87.6%(7,255 MW) belongs to EGAT's ownership, 0.5%(50 MW) to PEA's, 0.4%(30 MW) to DEA's and 11.4%(946 MW) to private sector's.

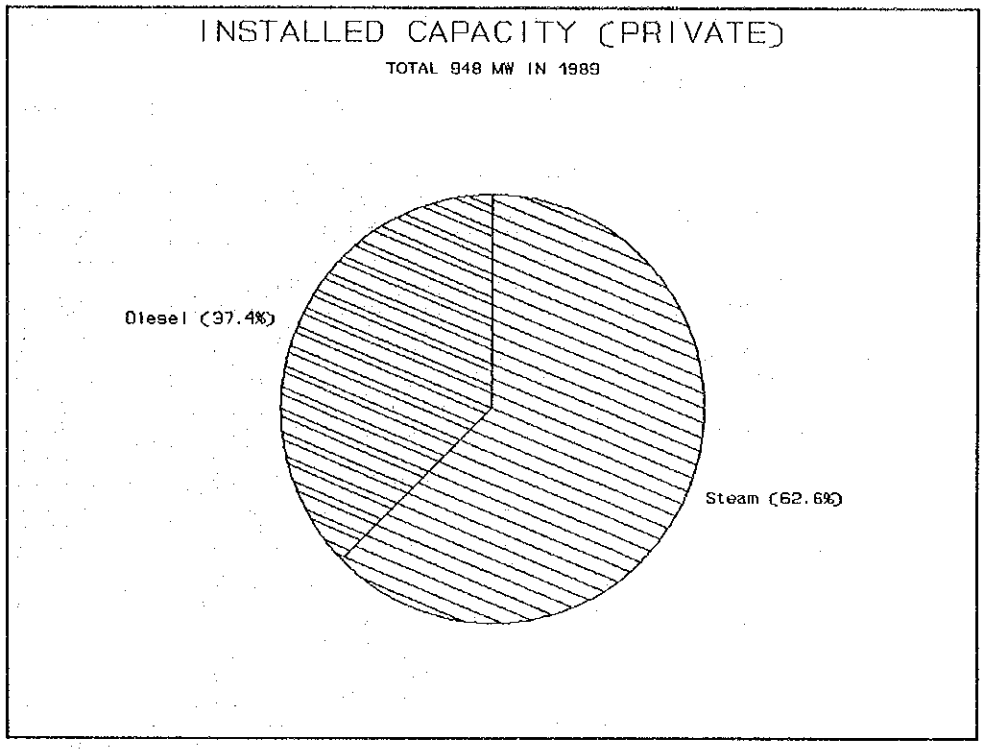


Of EGAT's facility, steam and combined cycle facility which contribute base load occupies 65.3% of the total (7,286 MW) blessed with abundant indigeneous lignite and natural gas as of 1989.
Hydro facility which contribute peak load occupies 30.7%.




INSTALLED CAPACITY (PEA)
TOTAL 50 MW IN 1989
Hydro (6.0%)
Diesel (94.0%)


INSTALLED CAPACITY (DEA)
TOTAL 30 MW IN 1989
Hydro (100.0%)


INSTALLED CAPACITY (PRIVATE)
TOTAL 948 MW IN 1989
Diesel (37.4%)
Steam (62.6%)

(2) Power Supply by EGAT

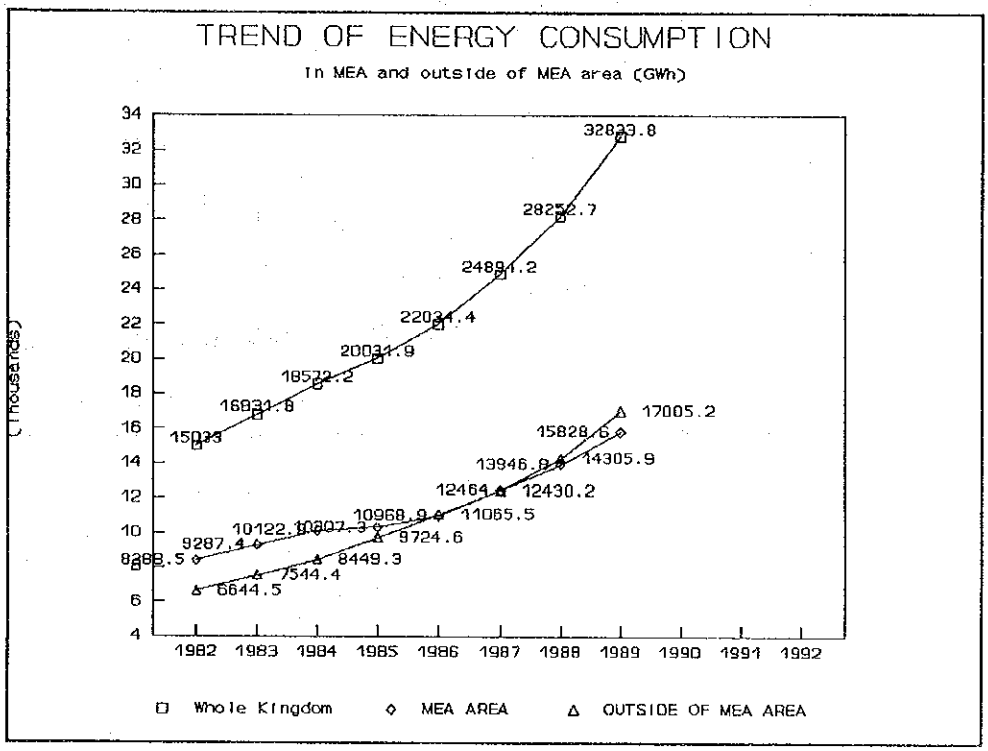
EXISTING INSTALLED GENERATING CAPACITY
(AS OF SEPTEMBER 1991)

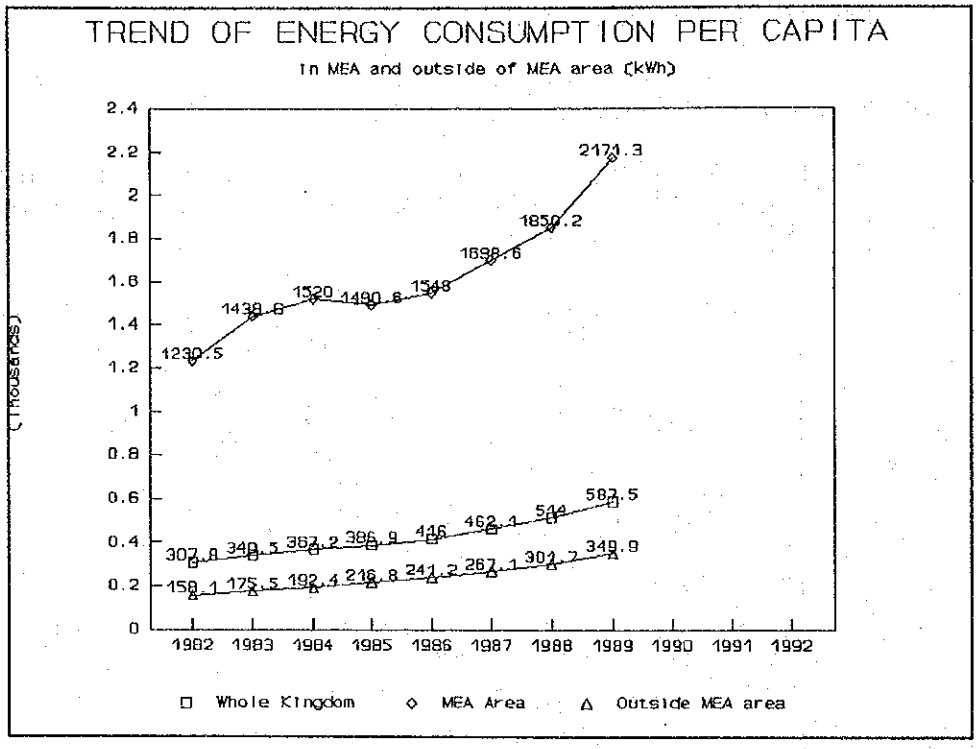
Plant Type	Number of Unit	Capacity (MW)		Average Energy Capability (GWh/year)
		Installed	Ultimate	
HYDRO	50	2429.16	2729.16	5408.0
Bhumibol	7	535.0	710.0	1200.0
Sirikit	3	375.0	500.0	1000.0
Ubolratana	3	25.2	25.2	56.0
Sirindhorn	3	36.0	36.0	86.0
Chulabhorn	2	40.0	40.0	93.0
Kang Kracharn	1	17.5	17.5	78.0
Nam Pung	2	6.0	6.0	15.0
Srinagarind	5	720.0	720.0	1140.0
Bang Lang	3	72.0	72.0	200.0
Tha thung Na	2	38.0	38.0	165.0
Kao Laem	3	300.0	300.0	760.0
Huai Kum	1	1.06	1.06	2.0
Ban Santi	1	1.275	1.275	6.0
Mae Ngat	2	9.0	9.0	29.0
Kiridharn	2	12.7	12.7	27.0
Rajjaprabha	3	240.0	240.0	550.0
Miscellaneous	7	0.428	0.428	1.0
THERMAL	26	4906.5		32990.0
North Bangkok	3	237.5		1250.0
South Bangkok	5	1330.0		9320.0
Mae Moh	11	2025.0		13310.0
Krabi	2	34.0		180.0
Surat Thani	1	30.0		170.0
Khanom	2	150.0		1050.0
Bang Pakong	2	1100.0		7710.0
COMBINED CYCLE	23	2036.6		13028.0
Bang Pakong				
Block1&2	10	760.6		4664.0
3&4(GT)	4	416.0		2734.0
Rayong				
Block1-3	6	618.0		4040.0
Nam Phong Block1	2	242.0		1590.0
GAS TURBINE	15	238.0		1019.0
Nakhon Ratchasima	1	14.0		31.0
Udon Thani	1	14.0		31.0
Hat Yai	3	42.0		92.0
Surat Thani	3	42.0		92.0
Lan Krabu	7	126.0		773.0

3.3 Power Demand and Supply

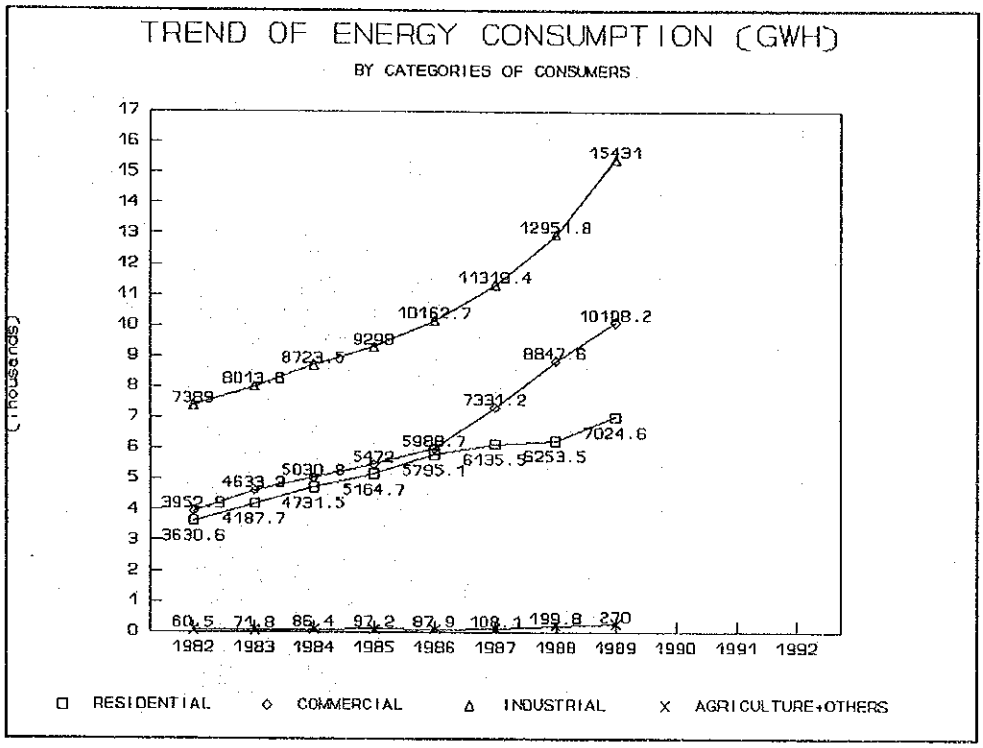
3.3.1 Historical Trend of ENERGY Demand (GWh)

Energy consumption outside of MEA area overcomed that in MEA area in recent years, but energy consumption per capita in MEA area is still 6.3 times of that outside of MEA area.



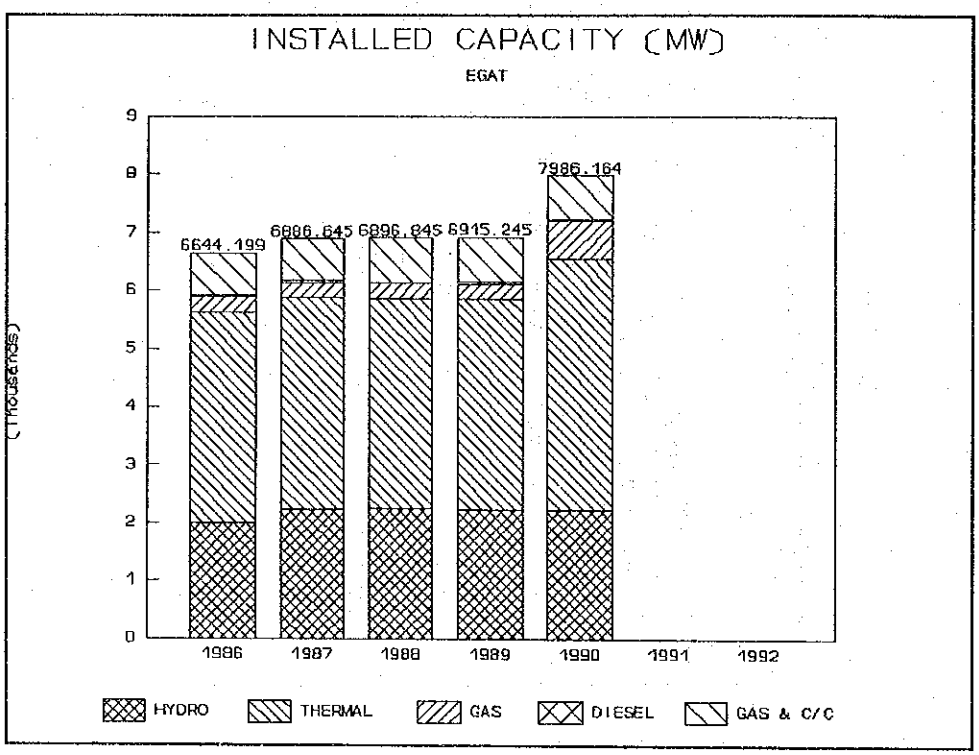

TREND OF ENERGY CONSUMPTION PER CAPITA
In MEA and outside of MEA area (kWh)
(Thousands)
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1230.5
1438.8
1520
1490.8
1548
1698.6
1850.2
2171.3
307.8
340.5
367.2
386.9
416
462.1
544
583.5
150.1
175.5
192.4
216.8
241.2
267.1
301.2
349.9
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Whole Kingdom
MEA Area
Outside MEA area

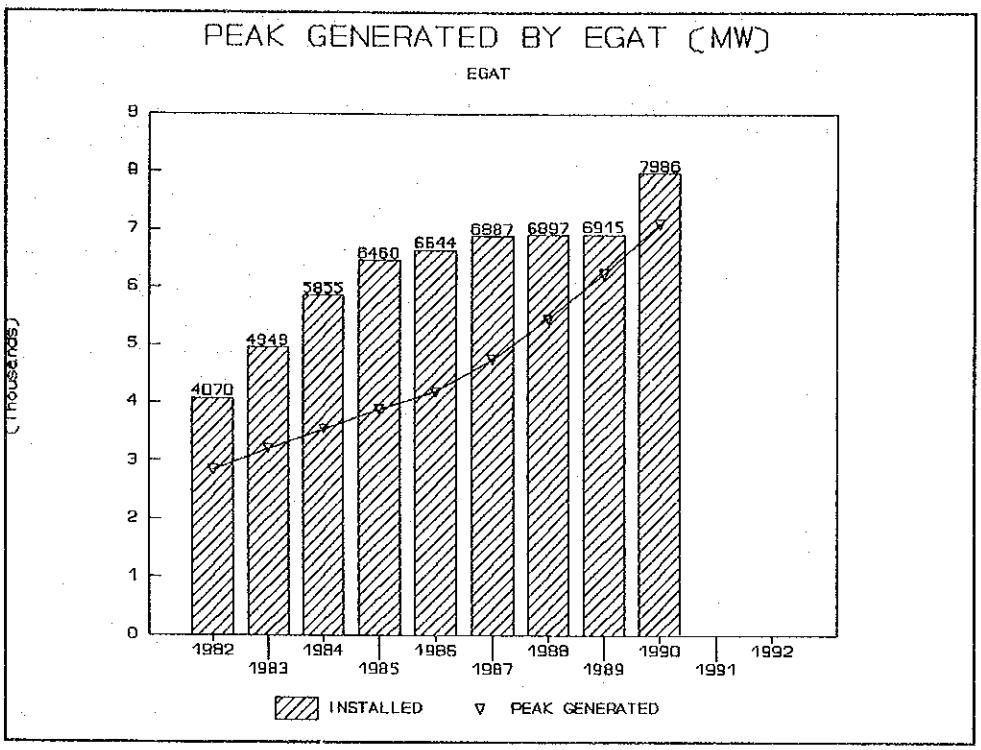
Looking into the energy consumption by categories of consumers, steady and sharp growth in residential, commercial and industrial sectors are evident.



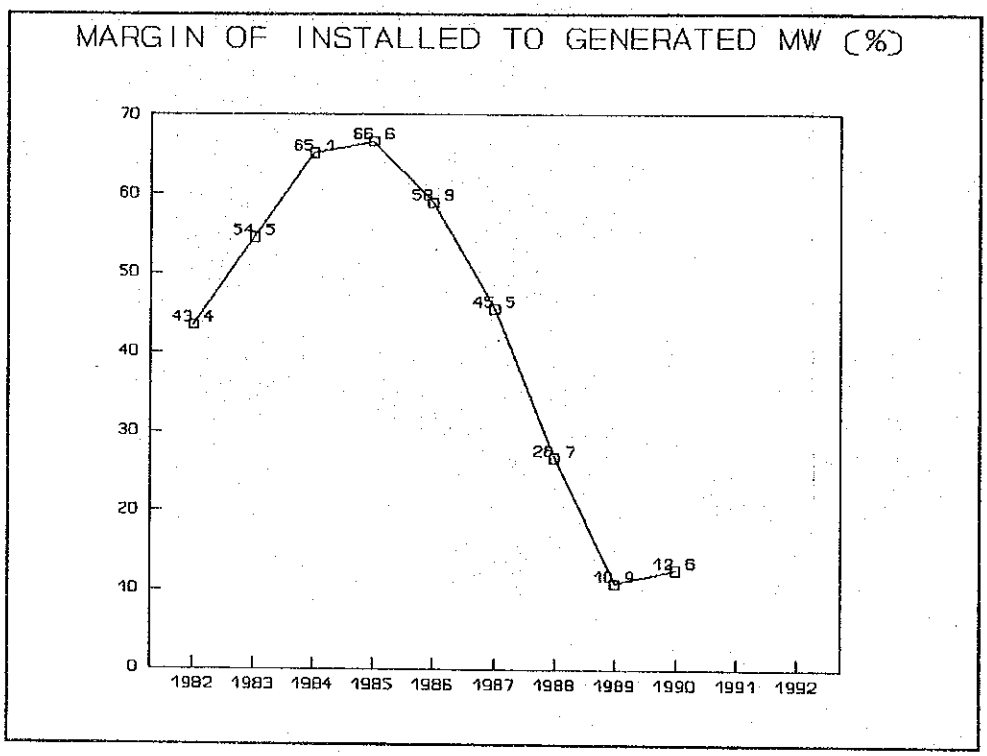
3.3.2 Maximum Power Demand, Supply and Reserve Capacity (MW)

Maximum power demand keeps it's annual growth pace at 10 to 15% in the past dacade, instead that of installed capacity leveled off in the past 5 years because of slow down of new power plant construction.




PEAK GENERATED BY EGAT (MW)
EGAT
(Thousands)
0
1
2
3
4
5
6
7
8
9
4070
4948
5855
6460
6644
6887
6897
6915
7986
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
INSTALLED
PEAK GENERATED

The reserve margin,(which is originally to be expressed as the ratio of the allowance of dependable capacity multiplied by 8,760 hours to the annual energy requirement, but as the value of dependable capacity is not available the ratio of the allowance of installed capacity to peak load of the year is used for convinience), continued to go down year by year till 1989 to the level of 12%.

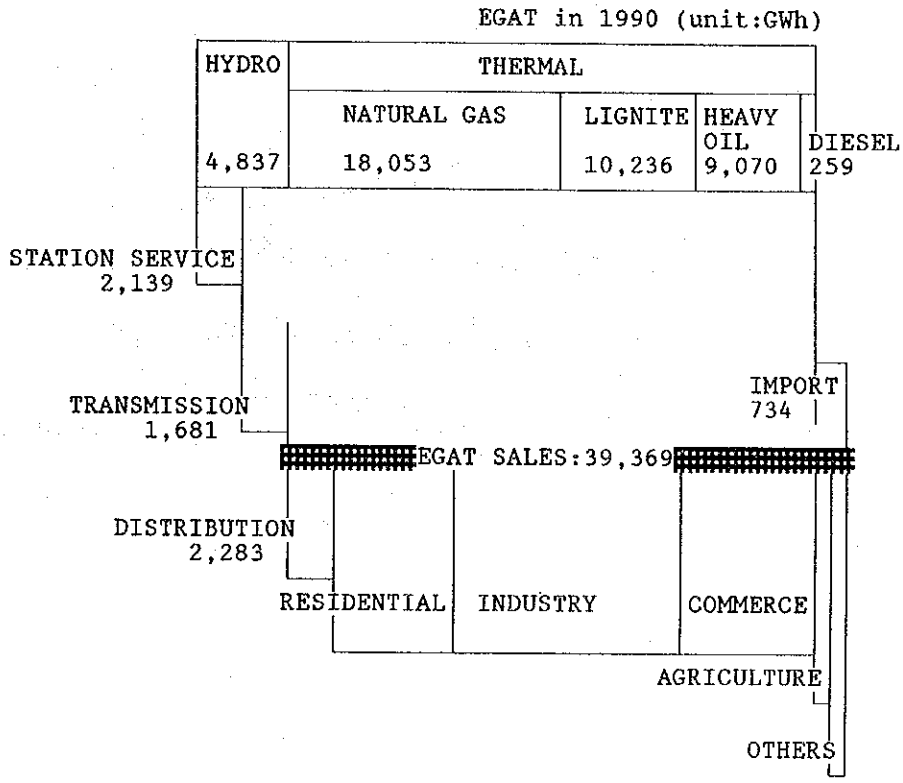


3.3.3 Power Demand and Supply Ballance

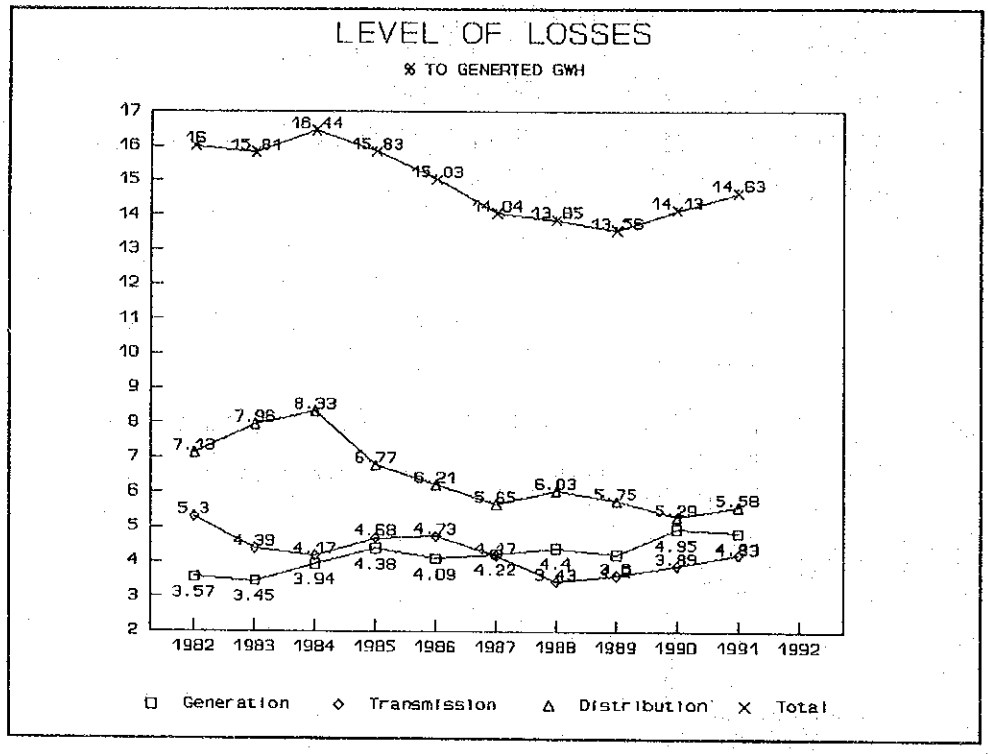
The energy generated and purchased by EGAT in fical year 1990 was 43,190 GWh, and sales amounted for 39,369 GWh.

Energy generation by power source was, 18,053 GWh by natural gas, 4,837 GWh by hydro, 10,236 GWh by lignite, 9,070 GWh by banker oil, 259 GWh by diesel oil and 734 GWh purchased.

Energy sales by each customers are, 18,622.5 GWh to MEA, 19,318 GWh to PEA, 1,335.17 GWh to direct customer, 27.73 GWh to LAO and 65.35 GWh to the other.



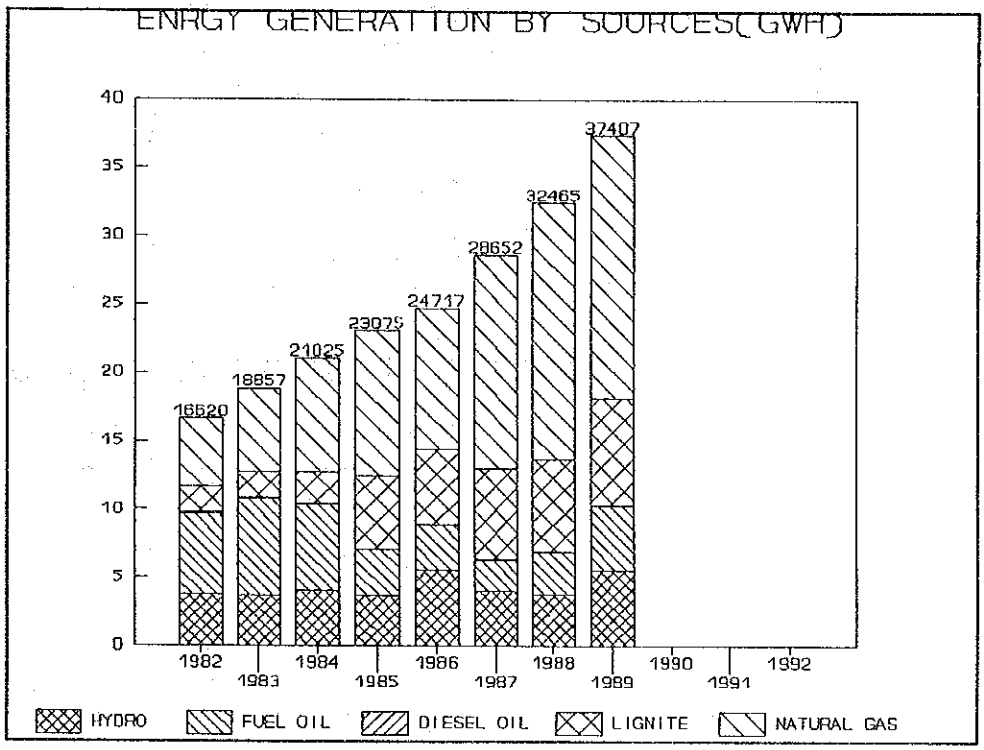
The loss level of generating (station service), transmission and substation and distribution (MEA and PEA) in 1990 was 4.95%, 3.89% and 5.29%, respectively.

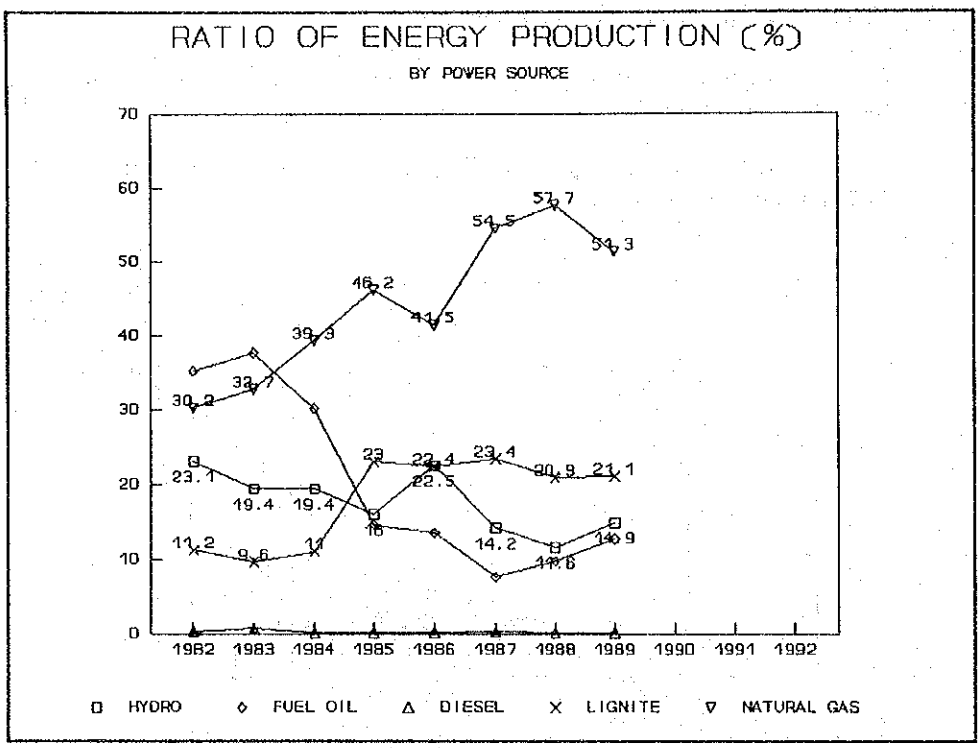


3.3.4 Electric Energy Production by Power Source

Energy production by natural gas occupies over 50% of the total generation, and lignite and hydro follow.

The use of fuel oil for energy production fell down up to and around 10% in the past decade.

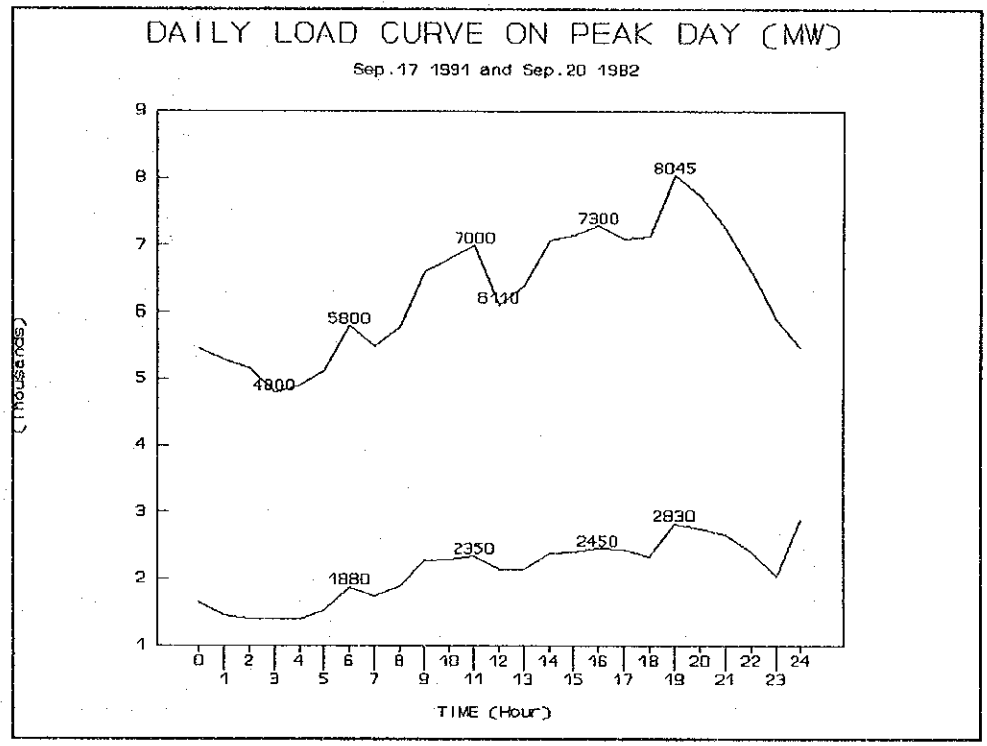



RATIO OF ENERGY PRODUCTION (%)
BY POWER SOURCE
70
60
50
40
30
20
10
0
1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992
HYDRO
FUEL OIL
DIESEL
LIGNITE
NATURAL GAS

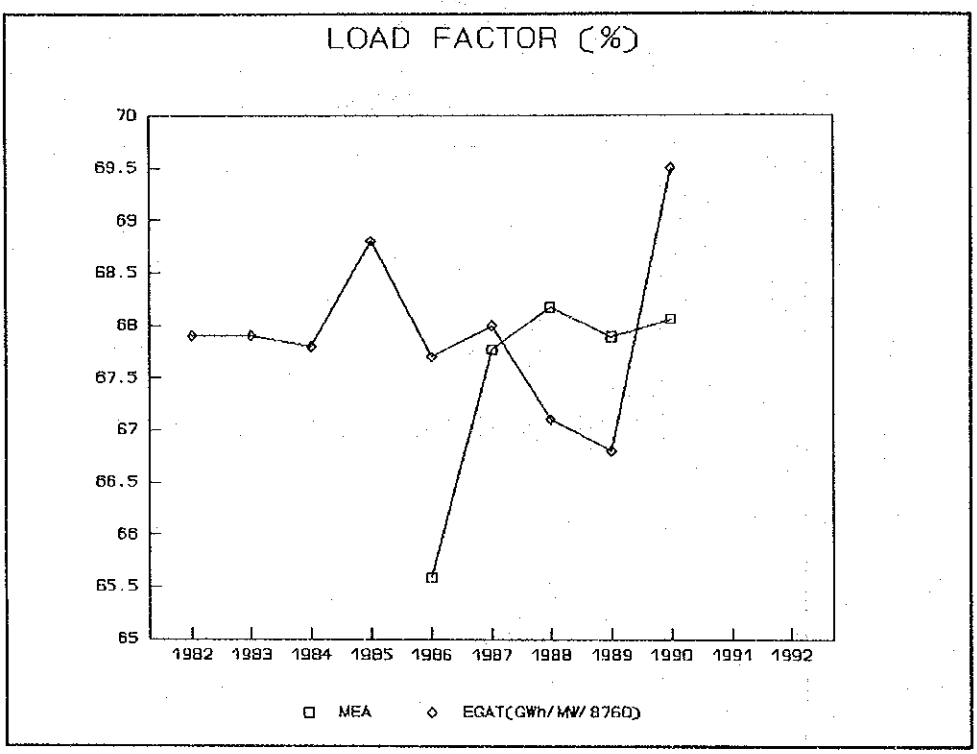
3.3.5 Daily and Seasonal Fluctuation of Power Demand

The daily fluctuation of power grew compared with a decade ago.

The maximum peak demand record was 8,045 MW on September 17, 1991, which is around 2.8 times of the record on September 20, 1982.



The annual load factor of EGAT at generating end (the ratio of annal energy generated to annual peak demand multiplied by 8,760 hours) decreased gradually which may owe to the growth of both daily and seasonal fluctuation of power demand but recovered in 1990.
The MEA's load factor continues to increase.



3.3.6 Electricity Tariff

The electricity tariff system in Thailand consists of so-called wholesalers and retail salers tariff.
The former is applicable for EGAT and the latter is for MEA and PEA.

In EGAT tariff system, tariff rate and classification of customers (effective from December 1991) are set as follows;

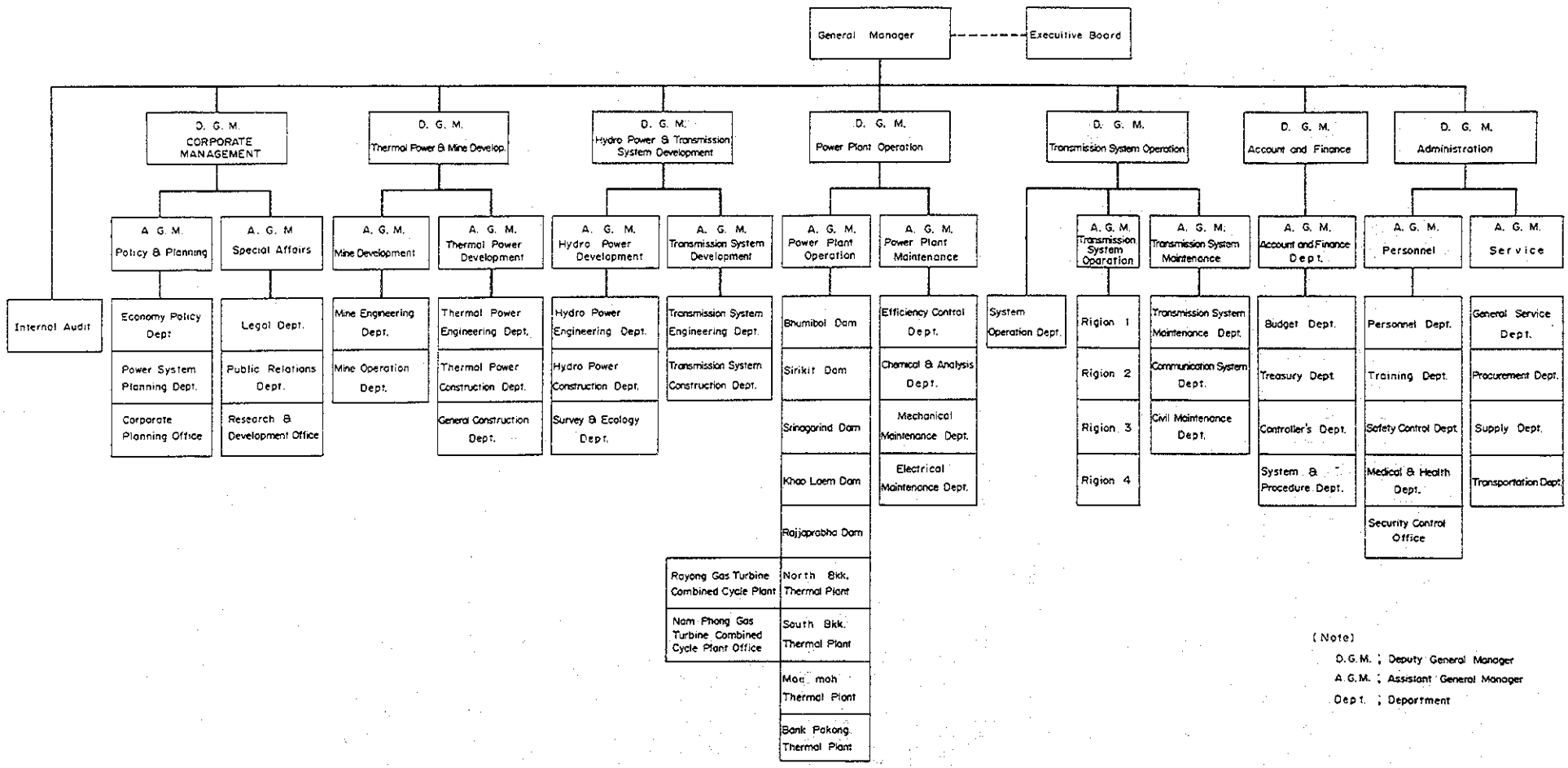
1. MEA		
Energy Charge	1.4682	Baht/kWh
2. PEA		
Energy Charge	0.9630	Baht/kWh
3. Large General Service		
Transmission Voltage (≥ 69 kV)		
Demand Charge		
Peak Period	240.00	Baht/kW
Partial Peak Period	32.00	Baht/kW
Off Peak Period	0.00	Baht/kW
Energy Charge	1.03	Baht/kWh
Primary Voltage (11 - 33 kV)		
Demand Charge		
Peak Period	305.00	Baht/kW
Partial Peak Period	63.00	Baht/kW
Off Peak Period	0.00	Baht/kW
Energy Charge	1.07	Baht/kWh

Applicable to whose power demand from 2,000 kW and over.

Time period There are three time periods:

Peak Period	6.30 p.m. - 9.30 p.m. (3 hours)
Partial Peak Period	8.00 a.m. - 6.30 p.m. (10 hours 30 minutes)
Off Peak Period	9.30 p.m. - 8.00 a.m. (10 hours 30 minutes)

The wholesales tariff for PEA is set relatively lower than that for MEA, and no demand charge is incured in the tariff for MEA and PEA.



(Note)
D.G.M. ; Deputy General Manager
A.G.M. ; Assistant General Manager
Dept. ; Department

Fig. 3-1 Organization Chart of EGAT

CHAPTER 4

ELECTRIC POWER DEMAND FORECAST

CHAPTER 4 ELECTRIC POWER DEMAND FORECAST

4.1 Current Status of Electric Power Demand in the Kingdom of Thailand

The electric power demand in Thailand has been increasing substantially due to her recent favorable economic growth and incoming rush of enterprises and factories.

Transition of power and energy generated in Thailand for the past ten years is shown in Table 4-1. Yearly average growth rates of power and energy generation during the last ten years are 12.07% and 12.74% respectively. The annual load factor at generating end, which once showed a tendency to decrease at a rate of about 0.4% per year from about 70% in 1981 reaching the lowest 66.77% in 1989, has begun to increase and recovered to the level of about 70%.

Transition of power and energy requirement from EGAT's customers, i.e. the Metropolitan Electricity Authority (MEA), the Provincial Electricity Authority (PEA) and other direct customers, is shown in Table 4-2.

MEA is an organization to distribute electric energy in the Greater Bangkok Area, Nonthaburi and Samut Prakan Provinces, whereas PEA is one to distribute in all the provinces except the MEA's area.

Ten years ago (1982), ratios of power consumption among these three parties were MEA 56.6%, PEA 40.2% and the other EGAT's direct customers 3.2% respectively. However, the growth rate of power demand from PEA has surpassed that from MEA as the result of a recent advance of the electrification programs in rural areas, and, as a consequence, the energy demand (GWh) from PEA has exceeded that from MEA and today it accounts for about 50% of the total energy supplied by EGAT.

The actual result of 1992 shows ratios of the three parties' energy consumption as MEA 45.2% PEA 51.5%, and the other direct customers 3.3%.

In respect of the maximum power demand, ratios of the three parties were as MEA 43.2%, PEA 53.6% and the other direct customers 3.2%.

Most part of the PEA demand comes from local cities, towns, and fishing and agrarian villages, and the demand is particularly high at the lighting peak time.

The load factor of PEA demand is about 57 ~ 60%, which is considerably low in comparison with MEA's 68% or so.

4.2. Authorized Electric Power Demand Forecast in the Kingdom of Thailand

Load forecasts in Thailand have been prepared by the Load Forecast Working Group which is composed of the representatives of the National Economic and Social Development Board (NESDB), the National Energy Policy Office (NEPO), the Department of Energy Affairs (DEA), the

Electricity Generating Authority of Thailand (EGAT), the Provincial Electricity Authority (PEA), the Metropolitan Electricity Authority (MEA), the National Institute for Development Administration (NIDA) and the Thailand Development Research Institute (TDRI).

The latest load forecast which was issued in September 1991 by the above working group was based on the national economic forecast used in the Seventh National Economic and Social Development Plan of Thailand. In this, Thailand GDP growth rate is forecasted to average 8.2%, 7.47% and 6.26% per year in the period of 1992 ~ 1996, 1997 ~ 2001 and 2002 ~ 2006 respectively.

In fiscal 1991 the peak generation of EGAT system was recorded at 8,045 MW on September 17, 1991 and energy generation is 49,225 GWh. The increase rates of the peak and energy generation from the previous year are 13.41% and 13.98% respectively.

The load forecast formulated by the above-mentioned organization of Thailand estimates that the average annual growth rate of the peak generation will be 10.20% in the period of 1992-1996, and for longer period the average annual growth will decline to 7.76% and 6.07% in the periods of 1997 ~ 2001 and 2002 ~ 2006 respectively.

Table 4-3 shows the load forecast for total EGAT generation requirement formulated by the said working group. The generation requirement of each party, i.e. MEA, PEA and EGAT's direct customers, estimated by the group is shown on Table 4-4.

4.3 Power Demand Forecast Made by The JICA Team

4.3.1 Method of Power Demand Prediction

The JICA team forecast the future values of energy consumption, energy demand and maximum power demand at sending end, based on such data of Thailand as actual energy consumption, past GDP, future GDP and population predicted by the Thai government agencies.

Fig. 4-1 shows the method of predicting future power and energy demand.

(1) Past Energy Demand, maximum Power Demand and Load Factor at Sending End

The past energy demand at sending end (h) was estimated from the actual past values of generated energy (c) and consumed energy at the EGAT's power station (d).

The past maximum power demand at sending end (i) was estimated from the actual past values of maximum generated power (e) and the kW station service rate (k) which is assumed as 90% of the kWh station service rate (d).

The load factor of the past power demand at sending end (j) was estimated from the energy demand at sending end (h) and the maximum power demand at sending end (i).

Energy demand at sending end (GWh)
= Generated energy (GWh) - Energy for station service (GWh)

Maximum power demand at sending end (MW)
= Maximum generated power x (1-kW station service rate)

Load factor at sending end
= Energy demand at sending end (GWh) x 1,000/8,760 x 1/Maximum power demand at sending end (MW)

(2) Past Transmission Losses

Past transmission losses (g) were acquired from the estimated past energy demand at sending end (h) and the actual past energy consumption (b). The average rate of transmission losses of the recent five years is 10.0%.

(3) Forecast of Energy Consumption in Future

Investigation of the actual past values of energy consumption and GDP of Thailand showed that the value of energy consumption per GDP Unit has increased approximately in straight line.

Future energy consumption (r) was forecasted from the elasticity of electricity per GDP (% GWh increase per % GDP increase), the growth rate of the energy consumption per GDP Unit (m) and the forecasted future values of GDP (l) which were formulated by NESDB in Thailand.

The elasticity was assumed in this forecast as 1.3 for the first four years starting in 1992 and reducing by degrees year after year to 1.1 of the year 2002.

(4) Forecast of Transmission Losses and Energy Demand at Sending End

The energy demand at sending end (s) was forecasted from the following formula by taking the rate of transmission losses (n) into consideration to the energy consumption in future (r) estimated in the previous section (3).

Energy demand at sending end (GWh)
= Energy consumption (GWh)/(1-rate of transmission losses)

The rate of transmission losses increases in proportion to power demand if appropriate measures for power system reinforcement is not implemented. In reality, the increase of transmission losses will be curbed and the rate of transmission losses could be expected to decrease, if reinforcement and expansion programs on the transmission and distribution system are pushed forward to cope with increasing power demand.

In this forecast, 10.0%, the average value for the previous two years, was used for the estimation of transmission and distribution losses of the power system in 1992, and for the future the

loss rate is assumed to be decreased gradually at a rate of 0.1% a year, reaching 9.0% in 2002.

Incidentally, nowadays the transmission and distribution losses in Japan account for about 5.7% of the total sending energy.

(5) Forecast of Annual Load Factor and Maximum Power Demand at Sending End

The maximum power demand at sending end (t) was calculated from the energy demand at sending end (s) and the annual load factor at sending end (o), using the following formula.

Maximum power demand at sending end (MW)
= Energy demand at sending end (GWh) x 1,000/8,760 x 100/Annual load factor (%)

In general, an increase of power demand makes the peak portion of the daily load curve become acute and the annual load factor shows a tendency to decrease.

It is generally said that the annual load factor decreases as power demand increases from residential loads and commercial loads such as office buildings, department stores, other general stores and shops, hotels and small scale factories.

In Thailand, besides the increase of demand from the above customers, demand from the industries such as the machine work, assembling, textile, food, etc. is also expected to increase in future as well as before. Demand from these industries has an annual load factor lower than that from high energy consumption type industries, e.g. the steel and chemical.

However, in spite of the increase of such loads with relatively low load factors, the annual load factor at generating end showed to increase for the last two years. It is thought that this is due to the increase of the portion of PEA demand which differs from MEA demand in the peaking time.

In the forecast, the annual load factor at sending end was assumed to be 69.5% for 1992, and to be gradually increased afterwards to reach 70% in 2000, in accordance with an increase of portion of PEA demand. 70% is assumed for the year after 2000.

Incidentally, the annual load factor at sending end is about 59% nowadays in Japan.

(6) Forecast of Energy Demand and Maximum Power Demand at Generating End

The energy demand and the maximum power demand at generating end, (u) and (v), are predicted by adding the energy and power consumed for station services to the energy and maximum power demand at sending end respectively.

A station service rate, that is, ratio of the power or energy consumed at a power station to the generated power or energy, depends on the type of power plant. According to the actual records of plant operation in 1988, the kWh station service rates of the power plants owed by EGAT were as follows:

Oil and gas fired plant	4 - 5%
Lignite fired plant	4 - 9%
Combined cycle	1.5%

It is also shown by the past record that the total energy consumed by all the power stations of the EGAT power system has been gradually increased, and in 1990-91 it accounts for about 5% of the total generated energy in the whole system.

In EGAT power system, especially at the second half of the 1990s, the rate of the portion of supply capability by coal and lignite fired power plants is to be increased, so it is thought that the rate of energy consumed for station use will be increased.

In this forecast the kWh station service rate to the total generated energy for 1992 is set at 4.89%, the average value of the two previous years, and the rate is supposed to be increased afterwards to reach 5.0% in 1995. 5.0% is assumed for the year after 1995.

The kW station service rate is assumed at 90% of the kWh station service rate.

(7) Forecast of Power Demand in MEA Area

As of 1990, energy requirement of MEA accounted for 47.3% of the total, PEA for 49.1% and EGAT's direct customers for 3.6%. The portion of MEA's energy requirement to the total has been decreasing year by year and this situation will continue in the future as well due to a prominent increase of requirement from PEA area by carrying out electrification program of the country and introduction of industries into its area. In this forecast, the JICA team assumed that MEA's portion of the energy requirement will be decreased 0.4 ~ 0.5% a year, whereas that of PEA's portion will increase 0.6% for 1992 ~ 1996, 0.5% for 1997 ~ 20001, 0.4% for 2002 ~ 2006 and 0.03% for 2007 ~ 2011 each year.

4.3.2 Result of Load Forecast

Table 4-5 and 4-6 show the power demand of Thailand in future forecasted by the JICA team.

(1) Energy Consumption

The GDP of Thailand in future is forecasted to grow at an average rate of 8.61% from 1992 to 1996 and 7.48% from 1997 to 2001.

Based on these data, the JICA team predicted that the energy consumption will increase at the average annual growth rate of 11.1% from about 42,560 GWh in 1991 to about 71,800 GWh in 1996, and increase at the average rate of 8.9% from 1997 to 2001, 6.9% from 2002 to 2006 and 5.4% from 2007 to 2011. The energy consumption will reach about 109,600 GWh in 2001, which is about 2.6 times as much as that in 1991.

Energy consumption per capita in 2001 is predicted to be 1,681 kWh, which is about 2.26 times as much as 744 kWh at the present time.

(2) Energy Demand, Power Demand and Annual Load Factor at Sending End

The energy demand at sending end was calculated from the above mentioned energy consumption by assuming that the transmission losses would be decreased at a rate of 0.1% each year from 10.0% in 1992 by measures taken for power system strengthening.

It is predicted that the energy demand at sending end will increase at an average annual rate of about 9.9% from the present value of some 46,800 GWh and reach about 120,500 GWh in 2001.

The power demand at sending end, on the other hand, is predicted to increase at an average annual rate of about 10.1% from the estimated present value of about 7,700 MW and reach some 19,800 MW in 2001.

The annual load factor at sending end is predicted to rise a little from the estimated present value 69.5% to 70.0% in 2000 and this value is assumed to be maintained.

(3) Energy Demand, Maximum Power Demand and Annual Load Factor at Generating End

Energy demand at generating end was acquired by adding energy consumed at power stations to the above mentioned energy demand at sending end.

A rate of station service was estimated at 4.9 to 5.0% for the next ten years.

The energy demand at generating end is predicted to increase at an average rate of about 9.93% per year from the current 49,225 GWh to about 127,000 GWh in 2001.

The maximum power demand at generating end is predicted to grow at a rate of 9.8% per year on an average and reach about 20,600 MW in 2001.

The annual load factor at generating end is predicted to increase little by little from current 69.8% and to become 70.4% in 2000.

(4) Load forecast of MEA Area

MEA's energy load was forecast to increase from the present level of about 18,600 GWh (in 1990) at the average annual growth rate 10.8% to about 34,500 GWh in 1996, and then at the average rate 7.7% per year to 50,000 GWh in 2001.

Peak demand which was 3,124 MW in 1990 was forecast to increase at the average annual growth rate 10.8% to be about 5,800 MW in 1996, and then at the average rate 7.7% per year to about 8,400 MW in 2001.

For the far future period MEA's peak demand and energy demand were forecast to increase at the average rate of 5.7% per year from fiscal 2001 to 2006 reaching 11,088 MW and 66,051 GWh respectively in 2006 and to increase at the average rate of 4.1% per year from fiscal 2006 to 2011 reaching 13,569 MW and 80,825 - GWh, respectively.

4.4 Comparison between Two Forecasts

Each of Fig. 4-2 to Fig. 4-5 shows a comparison between the load forecast made by the JICA team and the Load Forecast Working Group of Thailand.

The difference between the two is exceedingly small in the energy demand at generating end and in the MEA area. Although the JICA forecast is a little higher than the forecast of the Thai Organization, they can be regarded as almost the same.

As for the maximum power demand, each forecast predicts that it will grow almost in the same way until 1995, but after that the forecast by the JICA team surpasses those predicted by the Thai Organization and the difference between them increases gradually resulting in one year ahead in the year of around 2001.

This difference can be attributed chiefly to the annual load factor which was differently predicted in its transition by both parties. The JICA team predicted that the annual load factor will increase slightly but after 2000 it will be kept at the same level, while the Thai Organization predicted that it will increase year and year at a rate higher than that of the JICA team's forecast until 2006.

In order to use facilities efficiently and restrain over-much investment in development of power sources and transmission system, it is desirable to prevent the annual load factor from decreasing and to employ some means to increase it. However, it is not recommendable to forecast an annual load factor so greatly, because a greater annual load factor leads to a power development plan having smaller capacity of power sources and to a smaller reserve margin.

Table 4-1 ENERGY AND POWER GENERATION IN THAILAND (1981 -1992)

Fiscal Year	Energy			Power			Load Factor
	Generation	Growth		Generation	Growth		
	(GWh)	(GWh)	(%)	(MW)	(MW)	(%)	(%)
1981	15,960	1,206	8.2	2,589	171	7.1	70.4
1982	16,882	922	5.8	2,838	249	9.6	67.9
1983	19,066	2,184	12.9	3,204	366	12.9	67.9
1984	21,066	2,000	10.5	3,547	343	10.7	67.8
1985	23,357	2,290	10.9	3,878	331	9.3	68.8
1986	24,780	1,423	6.1	4,181	303	7.8	67.7
1987	28,193	3,414	13.8	4,734	553	13.2	68.0
1988	31,997	3,804	13.5	5,444	710	15.0	67.1
1989	36,457	4,460	13.9	6,233	789	14.5	66.8
1990	43,189	6,732	18.5	7,094	861	13.8	69.5
1991	49,225	6,036	14.0	8,045	951	13.4	69.8
1992	56,006	6,781	13.8	8,877	832	10.3	72.0
Average Growth							
1982 - 1986	-	1,764	9.2	-	318	10.1	-
1987 - 1992	-	5,205	14.6	-	783	13.4	-

Table 4-2 REQUIREMENT OF POWER AND ENERGY FROM EGAT BY UTILITIES

Fiscal Year	Power & Energy Generated by EGAT			Requirement by MEA			Requirement by PEA			Requirement by Direct Customers		
	Power (MW)	Energy (GWh)	Load Factor (%)	Power (MW)	Energy (GWh)	Load Factor (%)	Power (MW)	Energy (GWh)	Load Factor (%)	Power (MW)	Energy (GWh)	Load Factor (%)
1981	2,589	15,960	70.4	1,388	8,496	69.9	1,115	5,569	57.0	100	505	57.6
1982	2,838	16,882	67.9	1,499	8,719	66.4	1,264	6,190	55.9	102	494	55.3
1983	3,204	19,066	67.9	1,631	9,666	67.7	1,493	7,287	55.7	125	637	58.2
1984	3,547	21,066	67.8	1,776	10,498	67.5	1,675	8,174	55.7	129	710	62.8
1985	3,878	23,357	68.7	1,823	10,910	68.3	1,918	9,391	55.9	162	963	67.9
1986	4,181	24,780	67.7	1,983	11,391	65.6	2,078	10,190	56.0	170	1,037	69.6
1987	4,734	28,193	68.0	2,178	12,930	67.8	2,375	11,792	56.7	167	1,123	76.8
1988	5,444	31,997	67.1	2,432	14,564	68.4	2,745	13,737	57.1	175	1,192	77.8
1989	6,233	36,457	66.8	2,715	16,144	67.9	3,239	16,130	56.8	206	1,337	74.1
1990	7,094	43,189	69.5	3,124	18,623	68.1	3,737	19,318	59.0	214	1,428	76.2
1991	8,045	49,225	69.8	3,519	20,777	67.4	4,252	22,493	60.4	229	1,504	74.9
1992	8,877	56,006	72.0	3,993	22,946	65.6	4,956	26,132	60.2	295	1,693	65.6
Average Annual Growth Rate (%) (1983 - 1992)	12.1	12.7	-	10.3	10.2	-	14.7	15.5	-	11.2	13.1	-

Table 4-3 LOAD FORECAST BY THE THAI ORGANIZATION

	Fiscal Year	Energy Generation		Peak Generation		Load Factor
		(GWh)	Growth Rate (%)	(MW)	Growth Rate (%)	(%)
Actual	1981	15,960	8.18	2,589	7.09	70.38
	1982	16,882	5.78	2,838	9.62	67.91
	1983	19,066	12.94	3,204	12.90	67.93
	1984	21,066	10.49	3,547	10.71	67.80
	1985	23,357	10.87	3,878	9.33	68.75
	1986	24,780	6.09	4,181	7.81	67.66
	1987	28,193	13.78	4,734	13.23	67.98
	1988	31,997	13.49	5,444	15.00	67.09
	1989	36,457	13.94	6,233	14.49	66.77
	1990	43,189	18.46	7,094	13.81	69.50
	1991	49,225	13.98	8,045	13.41	69.85
	1992	56,006	13.78	8,877	10.34	72.02
Forecast	1993	61,339	9.52	9,924	11.79	70.56
	1994	67,561	10.14	10,892	9.75	70.81
	1995	74,522	10.30	11,946	9.68	71.21
	1996	81,741	9.69	13,075	9.45	71.37
	1997	89,307	9.26	14,205	8.64	71.77
	1998	96,591	8.16	15,354	8.09	71.81
	1999	104,431	8.12	16,531	7.67	72.12
	2000	112,653	7.87	17,765	7.46	72.39
	2001	121,083	7.48	19,000	6.95	72.75
	2002	129,455	6.91	20,219	6.42	73.09
	2003	138,322	6.85	21,482	6.25	73.50
	2004	147,509	6.64	22,795	6.11	73.87
	2005	157,137	6.53	24,150	5.94	74.28
	2006	166,999	6.28	25,515	5.65	74.72
Average Growth						
1982 - 1986			9.20		10.06	
1987 - 1991		-	14.71	-	13.99	-
1992 - 1996			10.68		10.20	
1997 - 2001			8.18		7.76	
2002 - 2006			6.64		6.07	

Table 4-4 EGAT'S GENERATION REQUIREMENT BY UTILITIES (FORECAST BY THE THAI ORGANIZATION)

	Fiscal Year	MEA			PEA			Direct Customers		
		Energy (GWh)	Power (MW)	Load Factor (%)	Energy (GWh)	Power (MW)	Load Factor (%)	Energy (GWh)	Power (MW)	Load Factor (%)
Actual	1981	8,496	1,388	69.9	5,569	1,115	57.0	505	100	57.6
	1982	8,719	1,499	66.4	6,190	1,264	55.9	494	102	55.3
	1983	9,666	1,631	67.7	7,287	1,493	55.7	637	125	58.2
	1984	10,498	1,776	67.5	8,174	1,675	55.7	710	129	62.8
	1985	10,910	1,823	68.3	9,391	1,918	55.9	963	162	67.9
	1986	11,391	1,983	65.6	10,190	2,078	56.0	1,037	170	69.6
	1987	12,930	2,178	67.8	11,792	2,375	56.7	1,123	167	76.8
	1988	14,564	2,432	68.4	13,737	2,745	57.1	1,192	175	77.8
	1989	16,144	2,715	67.9	16,130	3,239	56.8	1,337	206	74.1
	1990	18,623	3,124	68.1	19,318	3,737	59.0	1,428	214	76.2
	1991	20,777	3,519	67.4	22,493	4,252	60.4	1,504	229	75.0
	1992	22,946	3,993	65.6	26,132	4,956	60.2	1,693	295	65.5
Forecast	1993	25,359	4,265	67.9	29,110	5,415	61.4	1,864	264	80.6
	1994	27,674	4,658	67.8	32,583	6,011	61.9	1,878	267	80.3
	1995	30,419	5,111	67.9	36,207	6,626	62.4	1,893	269	80.3
	1996	33,363	5,611	67.9	39,943	7,258	62.8	1,908	272	80.1
	1997	35,868	6,089	67.2	43,844	7,913	63.3	1,924	274	80.2
	1998	38,452	6,548	67.0	47,989	8,605	63.7	1,940	277	79.9
	1999	41,269	6,994	67.4	52,413	9,340	64.1	1,957	280	79.8
	2000	44,249	7,472	67.6	57,028	10,099	64.5	1,975	283	79.7
	2001	47,359	7,952	68.0	61,707	10,858	64.9	1,993	286	79.5
	2002	50,225	8,393	68.3	66,575	11,639	65.3	2,011	289	79.4
	2003	53,276	8,840	68.8	71,714	12,458	65.7	2,030	292	79.4
	2004	56,383	9,303	69.2	77,095	13,311	66.1	2,049	295	79.3
	2005	59,653	9,780	69.6	82,719	14,193	66.5	2,069	299	79.0
	2006	63,076	10,264	70.2	88,408	15,078	66.9	2,089	302	79.0
Average Growth Rate (%)										
1987 - 1991		12.77	12.16		17.16	15.40		7.72	6.14	
1992 - 1996		9.94	9.78	-	12.17	11.29	-	4.87	3.50	-
1997 - 2001		7.26	7.22		9.09	8.39		0.88	1.01	
2002 - 2006		5.90	5.24		7.46	6.79		0.95	1.09	

Table 4 - 5 POWER DEMAND FORECAST IN TAILAND (1/2)

Year	Generating End							Sending End		
	Generated Energy (GWh)	kWh Station Losses (GWh)	(%)	Maximum Power (MW)	kW Station Losses (MW)	(%)	Load Factor (%)	Energy (GWh)	Maximum Power (MW)	Load Factor (%)
1980	14,753.73	590.45	4.00	2,417.40	87	3.60	69.7	14163.28	2,330.37	69.38
1981	15,959.97	612.29	3.84	2,588.70	89	3.45	70.4	15,347.68	2,499	70.1
1982	16,881.95	602.49	3.57	2,838.00	91	3.21	67.9	16,279.46	2,747	67.7
1983	19,066.30	658.00	3.45	3,204.30	100	3.11	67.9	18,408.30	3,105	67.7
1984	21,066.44	830.10	3.94	3,547.30	126	3.55	67.8	20,236.34	3,422	67.5
1985	23,356.57	1,022.81	4.38	3,878.40	153	3.94	68.7	22,333.76	3,726	68.4
1986	24,779.53	1,013.63	4.09	4,180.90	154	3.68	67.7	23,765.90	4,027	67.4
1987	28,193.16	1,189.30	4.22	4,733.90	180	3.80	68.0	27,003.86	4,554	67.7
1988	31,996.94	1,406.49	4.40	5,444.00	215	3.96	67.1	30,590.45	5,229	66.8
1989	36,457.09	1,532.25	4.20	6,232.70	236	3.78	66.8	34,924.84	5,997	66.5
1990	43,188.79	2,139.00	4.95	7,093.70	316	4.46	69.5	41,049.79	6,778	69.1
1991	49,225.03	2,379.92	4.83	8,045.00	350	4.35	69.8	46,845.11	7,695	69.5
1992	56,006.44	2,721.00	4.86	8,876.90	388	4.37	72.0	53,285.44	8,489	71.7
1993	61,919	3,045	4.92	10,103	447	4.43	70.0	58,874	9,656	69.6
1994	68,744	3,415	4.97	11,217	501	4.47	70.0	65,329	10,715	69.6
1995	75,860	3,793	5.00	12,359	556	4.50	70.1	72,067	11,803	69.7
1996	83,576	4,179	5.00	13,616	613	4.50	70.1	79,397	13,004	69.7
1997	91,271	4,564	5.00	14,849	668	4.50	70.2	86,707	14,181	69.8
1998	99,333	4,967	5.00	16,160	727	4.50	70.2	94,366	15,433	69.8
1999	108,047	5,402	5.00	17,553	790	4.50	70.3	102,645	16,763	69.9
2000	117,093	5,855	5.00	18,995	855	4.50	70.4	111,238	18,141	70.0
2001	126,883	6,344	5.00	20,584	926	4.50	70.4	120,539	19,657	70.0
2002	135,895	6,795	5.00	22,046	992	4.50	70.4	129,100	21,053	70.0
2003	145,508	7,275	5.00	23,605	1062	4.50	70.4	138,232	22,543	70.0
2004	155,302	7,765	5.00	25,194	1134	4.50	70.4	147,537	24,060	70.0
2005	165,292	8,265	5.00	26,815	1207	4.50	70.4	157,028	25,608	70.0
2006	175,755	8,788	5.00	28,512	1283	4.50	70.4	166,967	27,229	70.0
2007	186,437	9,322	5.00	30,245	1361	4.50	70.4	177,115	28,884	70.0
2008	196,738	9,837	5.00	31,916	1436	4.50	70.4	186,901	30,480	70.0
2009	206,872	10,344	5.00	33,560	1510	4.50	70.4	196,528	32,050	70.0
2010	216,868	10,843	5.00	35,181	1583	4.50	70.4	206,025	33,598	70.0
2011	226,672	11,334	5.00	36,772	1655	4.50	70.4	215,339	35,117	70.0

Table 4 - 5 POWER DEMAND FORECAST IN TAILAND (2/2)

Transmission & Distribution Losses		Energy Consumption		GDP in 1972 price		Elasticity of GWh per GDP	Energy Consumption per GDP	Population	kWh per Capita		Year
(GWh)	(%)	(GWh)	Growth (%)	(M Baht)	Growth (%)		(Wh/Baht)	(Thousand)	(kWh)	Growth (%)	
1,156.31	8.16	13006.97		299,472			43.43	46,961	277		1980
1,978.23	12.9	13,369.45	2.8	318,440	6.3	0.44	41.98	47,875	279	0.82	1981
1,461.30	9.0	14,818.16	10.8	331,379	4.1	2.67	44.72	48,847	303	8.63	1982
2,355.61	12.8	16,052.69	8.3	355,411	7.3	1.15	45.17	49,515	324	6.87	1983
2,633.92	13.0	17,602.42	9.7	380,739	7.1	1.35	46.23	50,583	348	7.34	1984
2,674.14	12.0	19,659.62	11.7	394,113	3.5	3.33	49.88	51,796	380	9.07	1985
2,710.65	11.4	21,055.25	7.1	411,813	4.5	1.58	51.13	52,969	398	4.73	1986
2,768.53	10.3	24,235.33	15.1	446,361	8.4	1.80	54.30	53,973	449	12.96	1987
3,025.65	9.9	27,564.80	13.7	495,378	11.0	1.25	55.64	54,961	502	11.69	1988
3,410.53	9.8	31,514.31	14.3	574,355	15.9	0.90	54.87	55,448	568	13.32	1989
3,964.75	9.7	37,085.03	17.7	633,395	10.3	1.72	58.55	56,340	658	15.81	1990
4,820.04	10.3	42,559.03	14.8	693,559	9.5	1.55	61.36	57,199	744	13.04	1991
5,681	10.7	47,604	11.9	756,806	9.1	1.30	62.9	58,041	820	10.2	1992
5,812	9.9	53,062	11.5	823,547	8.8	1.30	64.4	58,876	901	9.9	1993
6,385	9.8	58,945	11.1	893,781	8.5	1.30	65.9	59,693	987	9.6	1994
6,973	9.7	65,095	10.4	968,380	8.3	1.25	67.2	60,508	1076	8.9	1995
7,605	9.6	71,792	10.3	1,048,089	8.2	1.25	68.5	61,311	1171	8.8	1996
8,222	9.5	78,485	9.3	1,129,518	7.8	1.20	69.5	62,100	1264	7.9	1997
8,859	9.4	85,508	8.9	1,213,735	7.5	1.20	70.4	62,879	1360	7.6	1998
9,540	9.3	93,105	8.9	1,303,605	7.4	1.20	71.4	63,640	1463	7.6	1999
10,235	9.2	101,003	8.5	1,399,768	7.4	1.15	72.2	64,390	1569	7.2	2000
10,980	9.1	109,559	8.5	1,502,868	7.4	1.15	72.9	65,182	1681	7.2	2001
11,642	9.0	117,458	7.2	1,601,374	6.6	1.10	73.3	66,012	1779	5.9	2002
12,341	8.9	125,891	7.2	1,705,899	6.5	1.10	73.8	66,803	1885	5.9	2003
13,040	8.8	134,497	6.8	1,811,911	6.2	1.10	74.2	67,594	1990	5.6	2004
13,740	8.7	143,288	6.5	1,921,565	6.1	1.08	74.6	68,385	2095	5.3	2005
14,464	8.7	152,504	6.4	2,036,000	6.0	1.08	74.9	69,176	2205	5.2	2006
15,189	8.6	161,926	6.2								2007
15,868	8.5	171,033	5.6								2008
16,519	8.4	180,009	5.2								2009
17,144	8.3	188,881	4.9								2010
17,739	8.2	197,599	4.6								2011

Table 4-6 POWER DEMAND FORECAST FOR MEA, PEA & EGAT'S DIRECT CUSTOMERS

Year	EGAT			MEA			PEA			EGAT's Direct Customers	
	Generated Energy (GWh)	Maximum Power (MW)	Load Factor (%)	Received Energy (GWh)	Maximum Power (MW)	Load Factor (%)	Received Energy (GWh)	Maximum Power (MW)	Load Factor (%)	Received Energy (GWh)	Maximum Power (MW)
1980	14,754	2,417	69.7	8,286	1,392	68.0	4,966	974	58.2	446	86
1981	15,960	2,589	70.4	8,496	1,388	69.9	5,569	1,115	57.0	505	100
1982	16,882	2,838	67.9	8,719	1,499	66.4	6,190	1,264	55.9	494	102
1983	19,066	3,204	67.9	9,666	1,631	67.7	7,287	1,493	55.7	637	125
1984	21,066	3,547	67.8	10,498	1,776	67.5	8,174	1,675	55.7	710	129
1985	23,357	3,878	68.7	10,910	1,823	68.3	9,391	1,918	55.9	963	162
1986	24,780	4,181	67.7	11,391	1,983	65.6	10,190	2,078	56.0	1,037	170
1987	28,193	4,734	68.0	12,930	2,178	67.8	11,792	2,375	56.7	1,123	167
1988	31,997	5,444	67.1	14,564	2,432	68.4	13,737	2,745	57.1	1,192	175
1989	36,457	6,233	66.8	16,144	2,715	67.9	16,130	3,239	56.8	1,337	206
1990	43,189	7,094	69.5	18,623	3,124	68.1	19,318	3,737	59.0	1,428	214
1991	49,225	8,045	69.8	20,777	3,519	67.4	22,493	4,252	60.4	1,504	229
1992	56,006	8,877	72.0	22,946	3,993	65.6	26,132	4,956	60.2	1,693	295
1993	61,919	10,103	70.0	26,230	4,403	68.0	29,201	5,377	62.0	1,717	280
1994	68,744	11,217	70.0	28,849	4,843	68.0	32,820	5,854	64.0	1,820	297
1995	75,860	12,359	70.1	31,549	5,296	68.0	36,653	6,538	64.0	1,929	315
1996	83,576	13,616	70.1	34,460	5,785	68.0	40,872	7,290	64.0	2,045	333
1997	91,271	14,849	70.2	37,292	6,260	68.0	45,142	8,052	64.0	2,147	350
1998	99,333	16,160	70.2	40,214	6,751	68.0	49,661	8,858	64.0	2,254	368
1999	108,047	17,553	70.3	43,345	7,277	68.0	54,594	9,738	64.0	2,367	386
2000	117,093	18,995	70.4	46,560	7,816	68.0	59,789	10,500	65.0	2,485	405
2001	126,883	20,584	70.4	50,003	8,394	68.0	65,451	11,495	65.0	2,610	426
2002	135,895	22,046	70.4	53,041	8,904	68.0	70,746	12,425	65.0	2,714	443
2003	145,508	23,605	70.4	56,261	9,445	68.0	76,452	13,427	65.0	2,823	460
2004	155,302	25,194	70.4	59,484	9,986	68.0	82,328	14,459	65.0	2,936	479
2005	165,292	26,815	70.4	62,713	10,528	68.0	88,380	15,522	65.0	3,053	498
2006	175,755	28,512	70.4	66,051	11,088	68.0	94,765	16,643	65.0	3,175	518
2007	186,437	30,245	70.4	69,304	11,634	68.0	101,471	17,821	65.0	3,270	533
2008	196,738	31,916	70.4	72,396	12,153	68.0	107,975	18,963	65.0	3,368	549
2009	206,872	33,560	70.4	75,345	12,648	68.0	114,461	20,102	65.0	3,469	566
2010	216,868	35,181	70.4	78,161	13,121	68.0	120,942	21,240	65.0	3,574	583
2011	226,672	36,772	70.4	80,825	13,569	68.0	127,385	22,372	65.0	3,681	600