THE STUDY

ON

POWER GENERATION & TRANSMISSION

IN THAILAND

SUBMITTED TO

COMMERCIAL DIVISION

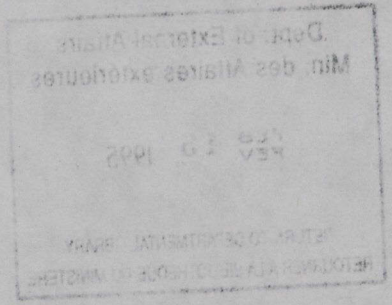
CANADIAN EMBASSY

FORWARD

The project team has been commissioned by the Commercial Division, Canadian Embassy to conduct a Study on Power Generation and Transmission in Thailand. The study covers the overall power generation and transmission industry emphasizing in the marketing aspect, and provides the information to the Canadian investors who is interesting to invest in the power generation and transmission in Thailand.

The success of this study is a result of the cooperation and generosity of many people in both government and provate sectors. Especially the officers from the EGAT, PEA and MEA who gave worthy assistance and advices.

The Commercial Division, Canadian Embassy is appreciated for her honourary permission provided to us to undertake this study. It is hoped that this report will be able to help promote the Canadian investment in power generation and transmission in this country.



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ABBREVIATIONS

ACSR	Aluminum Conductor Steel Reinforced
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BOI	Board of Investment
cct-km	circuit-kilometer
EHV	Extra High Voltage
EGAT	Electricity Generating Authority of Thailand
FY	Fiscal Year
GWh	Gigawatt-Hour
H.T.	High tension
HV	High Voltage
HVDC	High Voltage Direct Current
IBRD	International Bank for Reconstruction and Development
JICA	Japan International Cooperation Agency
kVA	Kilovolt-Ampere
kWh	Kilowatt-Hour
L.T.	Low tension
m (MSL)	Meter above Mean Sea Level
MCM	Thousand Circular Mils
MEA	Metropolitan Electricity Authority
MMCFD	Million Cubic Feet per Day
MVA	Megavolt-Ampere
MW	Megawatt
NEA	National Energy Administration
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
PEA	Provincial Electricity Authority
PTT	Petroleum Authority of Thailand
UNDP	United Nation Development Program

Summary

The power generation and transmission projects in Thailand are planned and implemented by three state enterproses, i.e. the Electricity Generating Authority of Thailand (EGAT), the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA).

For EGAT, who owns, maintains and operates power generation plants throughout the country, their existing power plants comprise 48 thydroelectric Plant, 21 Thermal Power Plant, 2 Combined Cycle Power Plant, 45 Gas Turbine and 25 Diesel Engine Power Plant. Their electric system is divided geographically into four regions covering the whole area of Thailnad Projects under construction by EGAT comprises power plants using oil/gas and lignite as fuel. For future projects they are power plants ulilizing oil/gas, hydro, lignite and coal.

Regarding transmission, EGAT has planned to construct 500 KV EHV system in Mae Moh, So Pai and Bang Pakong areas in addition to their conventional 230 and 115 KV system. Apart from the above mention projects, EGAT also has project of upgrading its system Control Centre.

For PEA, whose respondily is providing electricity to consumers in the provincial areas and in the areas where electricity service is not covered by MEA, they are presently able to provide electricity to 41,460 villages which is equivalent to 76% of the total villages under their service areas. It is scheduled that at the end of 1991, about 51,900 villages or 95% of the total villages in PEA service area will be provided with electricity. The projects to be implemented by PEA under the Sixth Economic and Social Plan are the Power Distribution Reinforcement Project 4th stage (PSR IV), the Transmission System Dispatching Centre Project (TSD), the Distribution System Dispatching Centre Project (DDC), the Village Electrification Project Phase III (VEP III), the Normal Rural Electrification Project Phase II (NRE II), the Village Electrification in Tungkularonghai Project, the Mini Hydro Project (MPH) and the Wind Energy Project (WEP).

For MEA, whose responsibility is to provide electricity to customers in Metropolitan area and nearby provinces, they have already launched 5 services of the Power Distribution System Improvement and Expansion Program, each with a 5 year implementation period and was formulated in line with the National Economic and Social Development Plan. The Sixth Plan which will be effective from fiscal year 1987 to 1991 is the continuation of the fifth plan. They are grouped into 5 categories, i.e., substation, subtransmission line, distribution, vehicle and equipment and research and development.

Regarding competition, for most of EGAT's project, suppliers from Japan, Germany, France, U.K and USA have been dominating the market with the Japanese controlling more than 60% of the market. Potential competitors at PEA and MEA are relatively smaller in size with the Japanese capturing less than 50 percent market share and the remaining share was captured by the Korean, Taiwanese, French, Italian, new commers from Eastern Bloc countries and a number of experienced local manufacturers.

The basic rule of success in doing business in Thailand are to plan one's marketing strategy on a long term basis and to be presented in the country as frequently as possible. The Canadian companies can choose to set up representative office, branch office, local agent and joint venture.

Opportunities for Canadian products and technologies exist in the areas where local manufacturers lack knowledge and experiences. They are power plant simulator, dispatching centre, high voltage direct current transmission, extra/ultra high voltage (EHV/UHV) transmission, turnkey thermal power plant, EHV substation and switchyard, control and measuring instrument, communication and telecommunication equipment etc. EGAT is the largest potential client of Canadian suppliers in the power generation and transmission system, whereas opportunities for Canadian suppliers at the PEA and MEA are limited.

RESEARCH METHODOLOGY

THE STUDY ON

POWER GENERATION AND TRANSMISSION IN THAILAND

1. OBJECTIVE

This study aims to identify opportunities that exist or will exist for the Canadian Investors in the power generation and transmission in Thailand.

2. SCOPE OF STUDY

The study on Power Generation and Transmission in Thailand has been organized into 7 main sections:

1. Government Policy under the Sixth Five Year NESDP
2. EGAT's Project to be under taken
3. PEA's Project to be under taken
4. MEA's Project to be under taken
5. Competition in the power generation and transmission in Thailand
6. Procurement
7. Recommendation

    7.1 Doing Bussiness in Thailand
    7.2 Forms of Business Structure
    7.3 Opportunities for Canadian Companies

3. METHODOLOGY

The primary data is obtained from structured interviews with the manufacturers, distributors and importers, including secondary data collection from a number of government and private agencies.

Enterprises and Associations

A: Public Enterprises :

1. Thailand Development Research Institute (TDRI)
2. Office of the National Economic and Social Development Board (NESDB)
3. Electricity Generating Authority of Thailand
4. Metropolitan Eletricity Authority
5. Provincial Electricity Authority
etc.

B: Private Enterprises :

1. Manufacturers
2. Importers
3. Distributors

4. TIMING

After planning the research design at the beginning of July 1987, then we obtained some secondary data from various sources of information. And at the end of August, we started to interview with some officers, manufacturers, distributors and importers of the power generation and transmission industry.

After that we compiled the data and prepared for the report, Finally, we finished the report at the first week of December, 1987.

POWER GENERATION AND TRANSMISSION IN THAILAND

1. Introduction

1.1 General Background

The power generation and transmission projects in Thailand are planned and implemented by three state enterprises who carry out their projects development individually under the national economic and social development policy. The largest of them is the Electricity Generating Authority of Thailand (EGAT) who owns, maintains and operates power generation plants throughout the country. The energy produced by EGAT's power plants is either sold to its direct customers or to the Metropolitan Electricity Authority (MEA) and the Provincial Electricity Authority (PEA) who are the other two state enterprises dealing with power generation and transmission in Thailand. MEA does not own any power plants, therefore the energy distributed to its customers is totally purchased from EGAT. The customers served by MEA are in the Metropolitan area and the nearby provinces. PEA, at present, owns some small diesel plants and plans to develop some small hydro plants and some non-conventional power generating projects in the future. The self-generated energy plus the energy purchased from EGAT is transmitted and distributed by PEA to electricity consumers in the provincial areas and in the areas where electricity service is not covered by MEA. The combined operation of these three state enterprises constitues the overall network for power generation and transmission system of Thailand.

1.2 Electricity Generating Authority of Thailand

The future projects planned by EGAT include the following:

A. Thermal Power Plant Projects

- o Nam Phong Combined Cycle # 1-2
- o Bāng Pakong Combined Cycle
- o Krabi Lignite # 4
- o Mae Moh Lignite # 10-13
- o New Gas Turbine
- o Bang Pakong Thermal # 3-4
- o Region 3 Lignite
- o Ao Phai # 1-2
- o North Bangkok Plant Renovation

B. Hydroelectric Projects

- o Srinagarind # 5
- o Pak Mun # 1-4
- o Kaeng Krung # 1-2
- o Upper Quae Yai # 1-4
- o Bhumibol Plant Renovation

Listed chronologically, EGAT's future projects as appeared in the power expansion plan are as follows:

Power Plant	Fuel Type	Unit Number	Unit Rating (MW)	Proposed Commissioning Date
Project under construction				
Khanom 2nd Power Plant Barge	Oil/gas	2	75	July 1988
Mae Moh	Lignite	8	300	July 1989
Mae Moh	Lignite	9	300	December 1990
2nd Central-Southern Tie Line	-	-	270	February 1990
Future projects				
Nam Phong Combined Cycle	Oil/gas	1-2	105	Nov 89 - Nov 90
Bhumibol Renovation	Hydro	1-2	70	January 1991
Bang Pakong Combined Cycle	Oil/gas	3	300	October 1991
230 kV Tha Tako-Khon Kaen 3	-	-	300	October 1992
Krabi Lignite	Lignite	4	75	November 1992
Srinagarind Reversible Pump	Hydro	5	180	January 1993
New Gas Turbine	Oil/gas	1	100	February 1993
North Bangkok Renovation	Oil	1-3	2x75+87.5	August 1993
Mae Moh	Lignite	10	300	October 1993
Pak Mun	Hydro	1-4	34	November 1993
Kaeng Krung	Hydro	1-2	40	December 1993
Mae Moh	Lignite	11	300	October 1994
Mae Moh	Lignite	12	300	October 1995
Upper Quae Yai	Hydro	1-4	145	Nov 96 - May 97
Bang Pakong Thermal	Gas/oil/coal	3	600	October 1997
Bang Pakong Thermal	Gas/oil/coal	4	600	October 1998
Ao Phai Thermal	Coal	1	600	October 1999
New R3 Lignite	Lignite	1	75	November 1999
Ao Phai Thermal	Coal	1	600	October 1999
Ao Phai Thermal	Coal	2	600	October 2000

1.3 Provincial Electricity Authority

The future projects planned by PEA include the following:

A. The Power Distribution Reinforcement Project, 4th Stage (PSR IV).

B. The Transmission System and Substation Development Project (TSD).

C. The Distribution System Dispatching Centre Project (DDC).

D. The Village Electrification Project, Phase III (VEP 3).

E. The Normal Rural Electrification Project, Phase II (NRE 2).

F. The Village Electrification in Tungkularonghai Project.

G. The Mini Hydro Project (MHP).

H. The Wind Energy Project (WEP).

1.4 Metropolitan Electricity Authority

The scope of MEA's sixth plan can be divided into 5 programmes as follows:

A. Transmission and distribution substation system program

- o Construction of new 230-69 kV transmission substation
- o Addition of existing transmission substation
- o Construction of new 115 and 69 kV distribution substations
- o Addition of existing distribution substations
- o Aquisition of lands

B. Subtransmission line system program

- o Construction of 115 and 69 kV overhead lines
- o Construction of 115 and 69 kV underground cables

C. Distribution system program

- o Construction of 12 and 24 kV primary lines
- o Construction of 416/240 V secondary lines
- o Installation of 12 and 24 kV distribution transformers of various sizes
- o Installation of new and replacement of old revenue meters
- o Installation of capacitors at various voltage levels

D. Procurement of construction equipment, vehicles, tools and testing equipment program

- o Procurement of construction equipment for construction and installation of power distribution facilities.
- o Procurement of vehicles for power distribution services.
- o Procurement of tools and testing equipment.

E. Research and development program

- o Digital mapping system
- o Transformer load management

2. Government Energy Policy under the Sixth Five Year NESDP

2.1 Direction for Energy Development

2.1.1 Reduce dependency on imported energy and diversify the types and sources of energy by accelerating the survey and development of domestic energy resources such as natural gas, crude oil, lignite, hydro potentials and other non-conventional energy sources.

2.1.2 Adjust the price structure of petroleum products and electricity tariff in order to promote an efficient energy use which conforms with the available energy source. The price of natural gas, lignite, imported coal and heavy oil will be determined accordingly.

2.1.3 Encourage the efficient use of energy especially in the energy saving in transportation and industrial sectors as well as in comercial business and in household use of firewood and charcoal for cooking purpose.

2.1.4 Encourage private enterprises to invest more in the energy business to lessen the financial burden of the government.

2.1.5 Encourage the development of suitable energy supply for rural areas which will be considered bilaterally with the poverty relief program.

2.1.6 Manage the use of energy properly with careful consideration on environmental impact.

2.2 Target

2.2.1 Maintain the growth rate of energy consumption of the whole country to be within 3.7 % annually during the period of the sixth NESDP.

2.2.2 Reduce the dependency on imported energy which is about 58 % of the total commercial energy consumption in 1985 to 49 % in 1991 by means of

a) Increasing the natural gas production which was 354 million cubic feet per day (MMCFD) in 1985 to 720 MMCFD in 1991.

b) Increasing the production of LPG from the gulf of Thailand which was 14,250 barrels per day in 1985 to 18,500 barrels in 1991.

c) Increasing the on-shore crude oil production which was 20,800 barrels per day in 1985 to 28,600 barrels per day in 1991.

d) Increasing the natural gas based electricity generation which was 250 MMCFD in 1985 to 500 MMCFD in 1991.

e) Increasing the use of lignite for electricity generation which amounted to 5 million tons in 1985 to 9 million tons in 1991.

f) Increasing the use of lignite in the industrial sector which was 500,000 tons in 1985 to one million tons in 1991.

2.2.3 Maintain the reserve margin of the electric power supply in 1991 at a level of 15 - 20 % of the peak generation requirement.

2.2.4 Expand the electrification project to cover 10,700 more villages within the period of the sixth NESDP. At the same time, the budget of the Provincial Electricity Authority must also be taken into consideration.

2.2.5 Increase the level of coal imported for industrial use which was 200,000 tons in 1985 to 500,000 tons in 1991.

2.2.6 Try to achieve the energy saving in transportation, industrial and household sectors by 390 million liters per year of crude oil equivalent within the period of the sixth NESDP.

2.3 Actions to be Taken

2.3.1 Petroleum exploration and development

a) Update the petroleum law in accordance with the policy to accelerate the exploration and development of petroleum in Thailand.

b) Encourage the natural gas market expansion to be in line with the increase in future production as well as to initiate more exploration and development in this area.

c) Accelerate the agreement on coordination to develop petroleum in the joint development area in the gulf of Thailand with Malaysian Government and the companies which have been granted concession. The implementation of the joint development is aimed to be accomplished in the period of the sixth NESDP.

2.3.2 Lessen dependency on limited oil producers

a) The imported crude oil and refined oil should be acquired from diversified producers and not to rely on any particular group of producers.

b) Adjust the content and effective duration of the purchase contracts such that the risks caused by the fluctuation of prices and uncertainties of supply sources are reduced.

2.3.3 Exploration and development of lignite

a) Encourage the Department of Mineral Resources to carry out the exploration of lignite resources in Thailand for the purpose of industrial and electricity generation utilization.

b) Encourage the Electricity Generating Authority of Thailand to carry on the detailed exploration of lignite reserves at Mae Moh, Krabi and other areas to search for more commercial quantity of lignite which can be used as fuel for electricity generation.

c) Promote research and development to introduce more use of lignite for industrial purpose and in household in the rural areas.

d) Encourage the Electricity Generating Authority of Thailand and other related authorities to take preventive and alleviative measures against environmental effect resulting from lignite development.

2.3.4 Exploration and development of water resource for electricity generation

a) Encourgae the Electricity Generating Authority of Thailand to spend more effort on exploration and development of water resources for electricity generation purpose which are economically feasible and without adverse effect on environment.

b) Establish a reasonable basis for construction cost allocation of the multi-purpose hydroelectric project in order to effectively utilize the water resource.

c) Accelerate the master plan for mini-hydro development to be prepared by the National Energy Administration. Priority must be given to projects according to their economic return so that the right projects will be further implemented by the responsible agencies.

2.3.5 Energy pricing

a) Energy must be priced such that the energy is consumed effectively and that the production cost in various industries is reduced. Energy which is reasonably priced is expected to increase the export opportunity and strengthen the financial situation of the country as a whole.

b) To meet the objective stated in a) above, it is suggested that the fuels which can be used interchangeably such as natural gas, lignite and imported coal or benzene, diesel and LPG be taxed by similar rates. Additionally, the government will not encourage the use of any particular type of fuel and will

i) adjust the price structure of petroleum products by establishing similar rates of taxes on these products.

ii) abolish the control of retail prices and price at refinery of petroleum products during the beginning of the sixth NESDP and allow the prices to be under influences of the world market. A careful study will be conducted before the prices are permanently allowed to float with the market price.

iii) establish a standard for natural gas pricing and specify the structure and rate of conveying the natural gas through pipe lines.

iv) allow import of coal and the government should fix the ceiling for import tax at 25 % throughout the period of the sixth NESDP.

2.3.6 Energy saving policy

Set up an organization to be responsible for energy saving in the transportation, industrial and commercial sectors in order to facilitate the process to its best result.

2.3.7 Increasing the capability of refinery and oil import

It is aimed to improve and upgrade the local refineries to international standard. Fuel oil will be imported only with strict consideration. Private investors will be encouraged to invest in refinery business so as to increase efficiency and flexibility of the business and also to free the government from financial hardship.

2.3.8 Promotion of the research, development, manufacturing and utilization of the non-conventional energy

Government agencies, educational institutes and private organizations will be encouraged to conduct researches on non-conventional energy. Taxes and fees on the equipments used for this purpose will be specifically adjusted so as to initiate both the manufacturers and the users to take part in the investment and utilization of non-conventional energy.

2.3.9 Promotion of the production and utilization of suitable energy forms in rural areas

Promote the home-grown trees to be used as firewood and encourage the private sector to develop and maintain forests for commercial purpose. Make the technology in energy saving more widely known; support the development of bio-energy and the use of LPG and electricity in rural areas based on market prices without price subsidy.

2.3.10 Energy management and roles of government and private sector in energy development

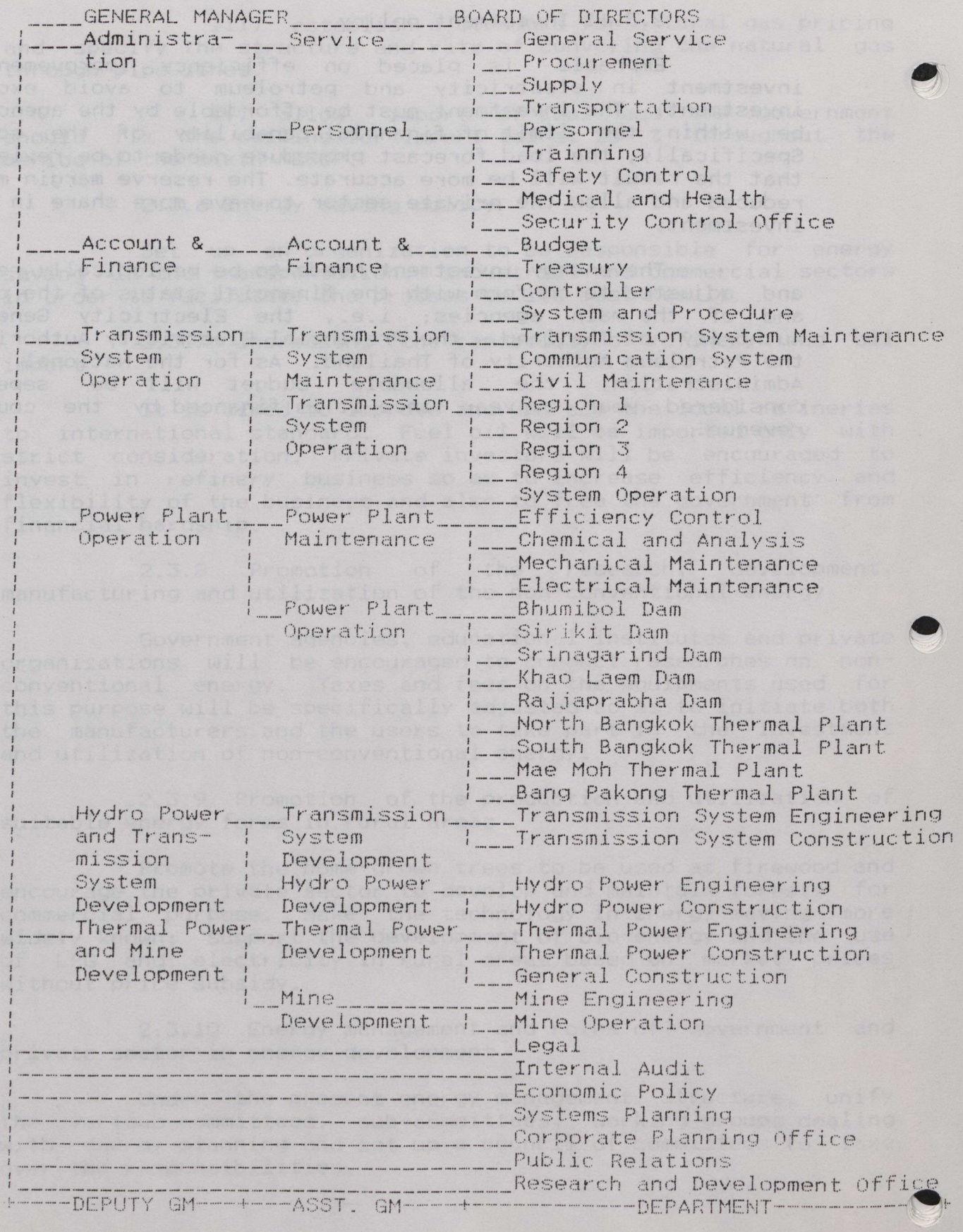
Under the present energy management structure, unify the various committees, sub-committees, working groups dealing with energy planning and set up a council of committees to take over the responsibilities.

2.3.11 Investment policy

Emphasis is placed on efficiency improvement of investment in electricity and petroleum to avoid excessive investment. The investment must be affordable by the agency and be within the limit of financial capability of the country. Specifically, the load forecast procedure needs to be reviewed so that the result will be more accurate. The reserve margin must be reduced and allow the private sector to have more share in energy investment.

The energy investment needs to be periodically reviewed and adjusted to conform with the financial status of the country and of the main agencies; i.e., the Electricity Generating Authority of Thailand, the Provincial Electricity Authority and the Petroleum Authority of Thailand. As for the National Energy Administration, the allowable budget will be seperately considered year by year since it is financed by the country's revenue.

FIGURE 3-1 EGAT'S ORGANIZATION CHART



3. EGAT's Power Generation and Transmission

3.1 Background

The Electricity Generating Authority of Thailand (EGAT) was established in May 1969 as a result of the merger of three state enterprises which had independently generated electricity in Thailand by then. The three enterprises were the Yanhee Electricity Authority, the Lignite Authority and the Northeast Electricity Authority respectively. The EGAT's administrative structure is as shown by the organization chart in Figure 3-1. (Also see Appendix 1 for name of person holding each title)

The responsibilities with which EGAT has been entrusted by the Government are:

-To generate and transmit or distribute electricity to the Metropolitan Electricity Authority (MEA) which distributes electricity to customers in the Bangkok and nearby areas, the Provincial Electricity Authority (PEA) which is responsible for supplying electricity to users in the remanining areas which are not served by MEA, the EGAT's direct customers and the neighbouring countries.

-To undertake the activities related to the production of electricity including the energy resource development and other activities which benefit EGAT.

-To carry out the production and sale of lignite and its by-product.

EGAT's electric system is divided geographically into four regions which are:

-Region 1 covering the central area of the country in which the electricity consumption is the highest.

-Region 2 covering the northeastern area of the country.

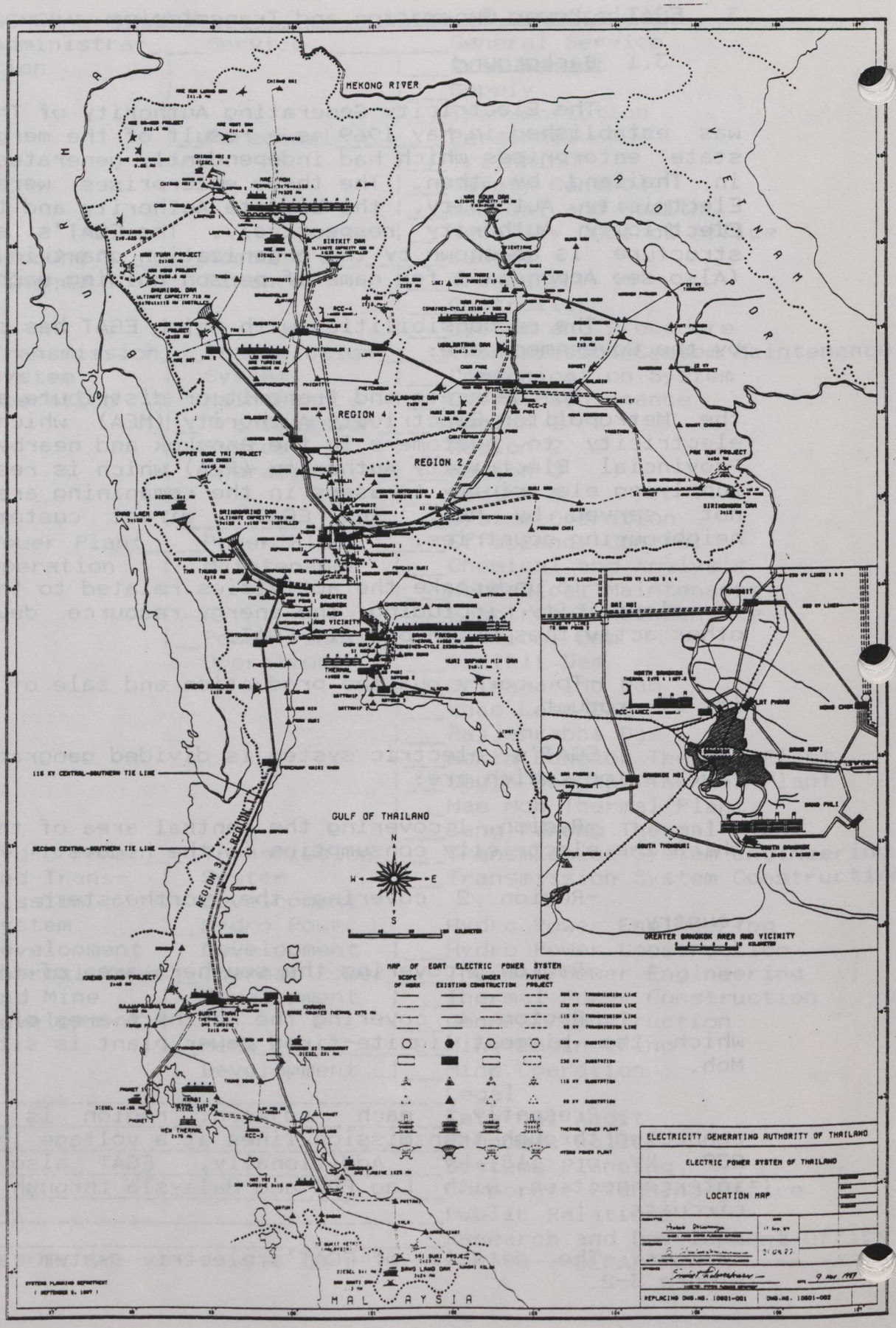
-Region 3 covering the southern area of the country.

-Region 4 covering the northern area of Thailand in which the biggest lignite-fired power plant is situated at Mae Moh.

Presently, each adjacent region is electrically connected through transmission lines at a voltage level of either 230 kV or 115 kV. Additionally, EGAT also has system interconnection with Lao PDR and Malaysia through the 115 kV circuits.

The details of EGAT's electric system can be seen in Figure 3-2.

FIGURE 3-2 EGAT'S ELECTRICITY NETWORK



At present (as of September 1987) EGAT has an installed capacity of 6,874.2 MW of which 2,250.1 MW is hydroelectricity, 3,607.5 MW is from conventional thermal power plants, 720 MW is from combined cycle power plants, 265 MW is from gas turbines and 31.6 MW is from small diesel units. The transmission system expands the length of 16,309 circuit-kilometers. The length of the respective 500 kV, 230 kV, 115 kV and 69 kV systems are 326; 6,122; 9,212 and 649 circuit-kilometers. EGAT's existing generating units and transmission lines and substations are shown in Table 3-1 and Table 3-2 respectively.

A long-term power development plan will be prepared and reviewed twice or three times yearly depending on the economic and energy situations of the country. The plan must be able to serve the load demand which is forecasted by the official Load Forecast Working Group, whose members are representives form energy related agencies. The latest forecast shows that the demand during the next 15 years will grow at a rate of 5.19 % for power and 5.62 % for energy respectively. Usually, the plan covers a period of 15 years and generally includes:

-The optimum power expansion plan that can serve the electric load demand under a certain standard of reliability.

-The transmission system expansion plan which consists of the transmission system associated with the generation project and the transmission system under the Transmission System Expansion Project (TS Project) which is a package of several transmission lines and substations studied together. Currently, the TS No. 6 and No. 7 are under construction or implementation.

The latest (as of September 1987) EGAT's power expansion plan consists of those projects as shown in Table 3-3.

Futhermore, a joint study between EGAT and the National Electric Board of Malaysia is being carried out to consider a second stage interconnection of the electric systems between Thailand and Malaysia. However, it will take a lot more time before and agreement on this interconnection can be made.

3.2 Power Generation Projects

The future generation projects in the proposed plan are composed of 8 thermal power plants, 4 hydroelectric power plants and 2 additional projects to rehabilitate the performance of the existing power plants which have been in operation almost through their expected service lives.

TABLE 3-1 EGAT'S EXISTING POWER PLANTS (AS OF SEPTEMBER 1987)

Plant Type	Number of Units	Capacity (MW) Installed	Capacity (MW) Ultimate	Average Energy Capability (GWh/yr)
A. Hydroelectric Plant				
Bhumibol	7	535	710	1,200.0
Sirikit	3	375	500	1,000.0
Ubolratana	3	25	25	56.0
Sirindhorn	3	36	36	86.0
Chulabhorn	2	40	40	95.0
Kang Krachan	1	19	19	78.0
Nam Pung	2	6	6	15.0
Srinagarind	4	540	720	1,140.0
Bang Lang	3	72	72	200.0
Tha Thung Na	2	38	38	165.0
Khao Laem	3	300	300	760.0
Huai Kum	1	1.3	1.3	0.2
Ban Yang	3	0.125	0.125	0.3
Ban Santi	1	1.3	1.3	6.0
Ban Chong Klum	1	0.02	0.02	0.2
Ban Khun Klang	2	0.18	0.18	0.7
Mae Ngat	2	9	9	29.0
Huai Sapan Hin	2	12.2	12.2	27.0
Rajjaprabha	3	240	240	550.0
Total	48	2,250.13	2,730.13	5,410.2
B. Thermal Power Plant				
North Bangkok	3	237.5		1,250.0
South Bangkok	5	1,300		9,110.0
Mae Moh	7	825		5,420.0
Krabi	2	40		200.0
Surat Thani	1	30		210.0
Khanom PPB	1	75		525.0
Bang Pakong Thermal	2	1,100		7,710.0
Total	21	3,607.5		24,425.0
C. Combined Cycle Power Plant				
Bang Pakong	2	720		3,780.0
Total	2	720		3,780.0
D. Gas Turbine				
Nakhon Ratchsima	1	15		33.0
Udon Thani	1	15		33.0
Hat Yai	3	45		99.0
Surat Thani	3	45		99.0
Songkhla	1	25		55.0
Lan Krabu	6	120		735.0
Total	15	265		1,054.0
E. Diesel Power Plant				
Chiang Mai	1	1		2.2
Mae Moh	8	8		17.6
Phuket	4	10.6		23.2
Bang Lang	5	5		11.0
Khao Laem	5	5		11.0
Krabi	2	2		4.4
Total	25	31.6		69.4
Grand total	111	6,874.23		34,738.6

* Previously known as Chiew Larn

TABLE 3-2 INSTALLED TRANSMISSION LINES AND SUBSTATIONS AS OF SEPTEMBER 1987

Region and System Voltage	Substations		Transmission Lines (Circuit - Kilometers)		
	Number	Transformer Capacity (MVA)	Double Circuit	Single Circuit	Total
Region_1					
230 kV	19	5,920	2,750	18	2,768
115 kV	40	2,125	632	1,355	1,987
69 kV	1	27	-	128	128
Total	60	8,072	3,382	1,501	4,883
Region_2					
230 kV	1	400	290	-	290
115 kV	27	1,023	1,711	1,576	3,287
69 kV	4	35	-	327	327
Total	32	1,458	2,001	1,903	3,904
Region_3					
230 kV	3	400	806	-	806
115 kV	21	796	1,149	1,137	2,286
Total	24	1,196	1,955	1,137	3,092
Region_4					
500 kV	-	-	-	326	326
230 kV	6	650	2,040	218	2,258
115 kV	20	855	633	1,019	1,652
69 kV	6	123	7	187	194
Total	32	1,628	2,680	1,750	4,430
All_Regions					
500 kV	-	-	-	326	326
230 kV	29	7,370	5,886	236	6,122
115 kV	108	4,799	4,125	5,087	9,212
69 kV	11	185	7	642	649
Total	148	12,354	10,018	6,291	16,309

TABLE 3-3 LIST OF PROJECTS IN EGAT'S POWER DEVELOPMENT PLAN

Power plant	Fuel Type	Unit Number	Unit Rating (MW)	Proposed Commissioning Date
Project under construction				
Khanom 2nd Power Plant Barge	Oil/gas	2	75	July 1988
Mae Moh	Lignite	8	300	July 1989
Mae Moh	Lignite	9	300	December 1990
2nd Central-Southern tie line	-	-	270	February 1990
Future projects				
Nam Phong Combined Cycle	Oil/gas	1-2	105	Nov 89 - Nov 90
Bhumibol Renovation	Hydro	1-2	70	January 1991
Bang Pakong Combined Cycle	Oil/gas	3	300	October 1991
230 kV Tha Tako-Khon Kaen 3	-	-	300	October 1992
Krabi Lignite	Lignite	4	75	November 1992
Srinagarind Reversible Pump	Hydro	5	180	January 1993
New Gas Turbine	Oil/gas	1	100	February 1993
North Bangkok Renovation	Oil	1-3	2x75+87.5	August 1993
Mae Moh	Lignite	10	300	October 1993
Pak Mun	Hydro	1-4	34	November 1993
Kaeng Krung	Hydro	1-2	40	December 1993
Mae Moh	Lignite	11	300	October 1994
Mae Moh	Lignite	12	300	October 1995
Upper Quae Yai	Hydro	1-4	145	Nov 96 - May 97
Bang Pakong Thermal	Gas/oil/coal	3	600	October 1997
Bang Pakong Thermal	Gas/oil/coal	4	600	October 1998
Ao Phai Thermal	Coal	1	600	October 1999
New R3 Lignite	Lignite	1	75	November 1999
Ao Phai Thermal	Coal	1	600	October 1999
Ao Phai Thermal	Coal	2	600	October 2000

Existing capacity as of September 1986 = 6,634 MW
Total capacity as of September 2001 = 11,619 MW

3.2.1 Thermal Power Plant Projects

The future plan with respect to the thermal power plants will be aimed toward the development of projects which will utilize the domestic fuels for power generation as the first priority. The domestic fuels which are used to produce electricity are natural gas and lignite. Most of natural gas is from the gulf of Thailand which is presently conveyed through pipe lines to the Bang Pakong and South Bangkok power plants. This off-shore natural gas reserve is estimated to be enough for another combined cycle rated 300 MW provided that the South Bangkok power plant may have to partially or totally operate on heavy oil. The natural gas has also been discovered on-shore at Lan Krabu in Region 2 but the amount is only enough for the operation of gas turbines with total capacity of 120 MW. Additional natural gas resource at Nam Phong, also in Region 2, is expected to be commercially available for electricity generation by the end of 1990.

The lignite reserves have been discovered in the North and South of the country. The reserve in the North is estimated at 614 millon tons which is sufficient for power production of at least 2,625 MW for the whole life time of the power plant. At present, 825 MW of lignite-fired power plants is in operation and 600 MW is under construction totalling 1,425 MW. Therefore, 1,200 MW more is planned for the future which consists of four units of power plant rated 300 MW each. In the South, there are two locations where small commercial amount of lignite has been found. One is the existing mine which is the source of fuel for the existing Krabi power plant which is going to be retired in the near future. However, the remaining lignite in this reserve is still enough for power production of another 75 MW power plant. The other reserve of lignite in the South has been found at Sin Pun. Consequently, it is planned that a new Krabi power plant will be constructed with two possibilities for the selection of the power plant site. It may be either at the original site or at Sin Pun. The siting of this new Krabi plant, therefore, has to be determined later.

The imported fuel will not be incorporated into the power expansion plan until the power demand has grown so high that the power generated from the domestic fuels cannot meet the load requirement. Accordingly, the first unit of coal-fired power plant is expected to be in operation by October 1999 or just 2 years before the end of the 15 year period.

The thermal power plant projects consist of:

-Nam Phong Combined Cycle # 1-2	(Region 2)
-Bang Pakong Combined Cycle	(Region 1)
-Krabi Lignite # 4	(Region 3)
-Mae Moh Lignite # 10-13	(Region 4)
-New Gas Turbine	(Siting under study)
-Bang Pakong Thermal # 3-4	(Region 1)
-Region 3 Lignite	(Region 3)
-Ao Phai # 1-2	(Region 1)
-North Bangkok Plant Renovation	(Region 1)

Details on each thermal power plant project will be given on subsequent pages.

EGAT's Thermal Power Plant Project

1. Project name : Nam Phong Combined Cycle Block # 1&2
2. Type of generation : Combined operation of gas turbines and steam turbines
3. Description and scope of project

   a) Location : Nam Phong District, Khon Kaen Province, close to ESSO gas field.

   b) Rated capacity : 2x105 MW

   c) Annual energy generation : 2x1,100 GWh

   d) Fuel : Natural gas

   e) Fuel consumption : 2x29.2 million cubicfeet per day

4. Project cost (Million Baht) of each block of 105 MW

	FC	LC	Total
a) Power plant equipment			
-Gas turbine	864.00	86.40	950.40
-Boiler	378.00	54.00	432.00
-Turbine & generator	432.00	64.80	496.80
-Electrical	351.00	67.50	418.50
-Miscellaneous	395.55	73.71	469.26
b) Site preparation & civil work	-	121.50	121.50
c) Contingency	125.01	43.20	168.21
d) Engineering & administration	81.00	40.50	121.50
e) Import duty & taxes	-	364.50	364.50
Total	2,626.56	916.11	3,542.67

5. Tentative schedule

   a) Feasibility study and approval : Mid 1987

   b) Engineering : April 1988

   c) Preliminary, manufacturing, construction and installation works : October 1988

   d) Commissioning : November 1989 - November 1990

EGAT's Thermal Power Plant Project

1. Project name : Bang Pakong Combined Cycle #

2. Type of generation : Combined operation of gas turbines and steam turbines

3. Description and scope of project

   a) Location : Bang Pakong District, Cha Choeng Sao Province

   b) Rated capacity : 300 MW

   c) Annual energy generation : 1,576.8 GWh

   d) Fuel : natural gas

   e) Fuel consumption : 40.0 million cubicfeet per day

4. Project cost (Million Baht)

	FC	LC	Total
-Gas turbine	166.33	90.45	1056.78
-Boiler & accessory	490.59	65.88	556.47
-Turbine generator & accessory	505.98	81.27	587.25
-Electrical system	288.36	51.03	339.39
-Water treatment plant	42.14	11.07	53.19
-Gas receiving & distribution	35.91	5.67	41.58
-Distillate storage & distri.	29.70	5.67	35.37
-Workshop & stores machinery	66.15	11.07	77.22
-River pump house plant	4.59	0.81	5.40
-Cooling towers & pumping plant	83.97	11.07	95.04
-Plant miscellaneous equipment	210.06	62.37	272.43
-Land & land right	-	7.56	7.56
-Civil works	148.23	354.51	502.74
-Local transport	-	28.62	28.62
Total	2,871.99	787.05	3,659.04

5. Tentative schedule

   a) Feasibility study and approval : Mid 1987

   b) Engineering : April 1988

   c) Preliminary, manufacturing, construction and installation works : October 1988

   d) Commissioning : October 1991

EGAT's Thermal Power Plant Project

1. Project name : Krabi Lignite # 4

2. Type of generation : lignite-fired steam plant

3. Description and scope of project

   a) Location : Krabi Province

   b) Rated capacity : 75 MW

   c) Annual energy generation : 490.0 GWh

   d) Fuel : lignite

   e) Fuel consumption : 0.515 million ton per year

4. Project cost (Million Baht)

	FC	LC	Total
-Turbine generator & auxiliary	370.98	41.58	412.56
-Steam generator & auxiliary	671.76	64.53	736.29
-Plant miscellaneous equipment	47.52	0.54	48.06
-Electrical equipment	187.10	1.89	188.99
-Civil works	84.51	180.90	256.41
-Local transport	-	14.04	14.04
-Construction equipment	55.08	0.54	55.62
Total	1,916.95	304.02	1,720.97

5. Tentative schedule

   a) Feasibility study and approval : Mid 1987

   b) Engineering : April 1988

   c) Preliminary, manufacturing, construction and installation works : October 1988

   d) Commissioning : Nobermber 1992

EGAT's Thermal Power Plant Project

1. Project name : Mae Moh lignite # 10-13

2. Type of generation : lignite-fired steam plant

3. Description and scope of project

   a) Location : Mae Moh Province

   b) Rated capacity : 4x300 MW

   c) Annual energy generation : 4x1970 GWh

   d) Fuel : lignite

   e) Fuel consumption : 4x1.859 million ton per year

4. Project cost (Million Baht) of each unit of 300 MW

	FC	LC	Total
-Turbine generator & auxiliary	528.95	-	528.95
-Steam generator & auxiliary	1,315.44	-	1,315.44
-Lignite & ash handling system	77.22	-	77.22
-Structural steel	37.26	-	37.26
-Cooling tower & C.W. pumps	138.54	-	138.54
-Water treatment	127.98	-	197.98
-Electrical equipment	295.14	-	295.14
-Instrument & control	236.52	-	236.52
-Plant miscell. equipment	156.24	50.76	216.00
-Civil works	20.52	797.88	818.40
-Erection & site service	-	570.51	570.51
Total	2,942.81	1,941.15	4,361.96

5. Tentative schedule

   a) Feasibility study and approval : Mid 1987 (Mae Moh # 10&11)
   October 1989 (Mae Moh # 12)
   October 1990 (Mae Moh # 13)

   b) Engineering : January 1989 (Mae Moh # 10)
   October 1989 (Mae Moh # 11)
   October 1990 (Mae Moh # 12)
   October 1991 (Mae Moh # 13)

   c) Preliminary, manufacturing, construction and installation works : October 1989 (Mae Moh # 10)
   October 1990 (Mae Moh # 11)
   October 1991 (Mae Moh # 12)
   October 1992 (Mae Moh # 13)

   d) Commissioning : October 1993 - October 1996

EGAT's Thermal Power Plant Project

1. Project name : New Gas Turbine

2. Type of generation : gas-fired gas turbine

3. Description and scope of project

   a) Location : not determined

   b) Rated capacity : 100 MW

   c) Annual energy generation : 525.0 GWh

   d) Fuel : natural gas

   e) Fuel consumption : 20 million cubic feet per day

4. Project cost (Million Baht)

	FC	LC	Total
-Gas turbine	483.30	45.36	528.66
-Gas receiving & distribution	38.10	6.21	44.31
-Distilate storage & distribution	31.62	6.21	37.83
-Electrical equipment	96.12	17.01	113.13
-Land & land rights	-	9.99	9.99
-Civil works	17.28	33.48	50.76
-Local transport	-	6.78	6.78
Total	666.41	125.04	791.45

5. Tentative schedule

   a) Feasibility study and approval : October 1987

   b) Engineering : July 1989

   c) Preliminary, manufacturing, construction and installation works : Mid 1990

   d) Commissioning : February 1993

EGAT's Thermal Power Plant Project

1. Project name : Bang Pakong Thermal # 3

2. Type of generation : oil/gas/coal-fired steam plant

3. Description and scope of project

   a) Location : Bang Pakong District, Cha Cheong Sao Province

   b) Rated capacity : 600 MW

   c) Annual energy generation : 3950 GWh

   d) Fuel : oil/gas/coal

   e) Fuel consumption : 100 million cubic feet of gas per day
   : 1.546 million tons of coal per year

4. Project cost (Million Baht)

	FC	LC	Total
-Turbine generator & auxiliary	1698.06	-	1698.06
-Steam generator & auxiliary	1912.98	-	1912.98
-Structural steel	285.42	-	285.42
-Intake and C.W. pipe	45.90	-	45.90
-Electrical equipment	649.92	-	649.92
-Instrumentation & control	178.50	-	178.50
-Water treatment	164.16	-	164.16
-Building super structure	210.90	-	210.90
-Plant miscellaneous	47.82	-	47.82
-Air conditioning	20.52	-	20.52
-Construction equipment	49.14	-	49.14
-General construction	-	1489.56	1489.56
-Mechanical construction	-	1371.06	1371.06
-Electrical & control construction	-	661.74	661.74
-Inspection service	14.04	-	14.04
-Local transport	-	52.65	52.65
Total	5,227.34	3,575.02	8,852.36

5. Tentative schedule

   a) Feasibility study and approval : October 1990

   b) Engineering : October 1991

   c) Preliminary, manufacturing, construction and installation works : October 1992

   d) Commissioning : October 1997

EGAT's Thermal Power Plant Project

1. Project name : Bang Pakong Thermal # 4

2. Type of generation : oil/gas/coal-fired steam plant

3. Description and scope of project

   a) Location : Bang Pakong District, Cha Cheong Sao Province

   b) Rated capacity : 600 MW

   c) Annual energy generation : 3950 GWh

   d) Fuel : oil/gas/coal

   e) Fuel consumption : 100 million cubic feet of gas per day
   : 1.546 million tons of coal per year

4. Project cost (Million Baht)

	FC	LC	Total
-Turbine generator & auxiliary	1692.09	-	1692.09
-Steam generator & auxiliary	1823.01	-	1823.01
-Structural steel	241.38	-	241.38
-Intake and C.W. pipe	42.39	-	42.39
-Electrical equipment	518.94	-	518.94
-Instrumentation & control	154.71	-	154.71
-Water treatment	46.17	-	46.17
-Building super structure	191.43	-	191.43
-Plant miscellaneous	26.73	-	26.73
-Air conditioning	6.75	-	6.75
-General construction	-	1148.80	1148.80
-Mechanical construction	-	1293.30	1293.30
-Electrical & control construction	-	626.40	626.40
-Inspection service	9.72	-	9.72
-Local transport	-	47.52	47.52
Total	4,753.35	3,112.02	7,865.37

5. Tentative schedule

   a) Feasibility study and approval : October 1990

   b) Engineering : October 1992

   c) Preliminary, manufacturing, construction and installation works : October 1993

   d) Commissioning : October 1998

EGAT's Thermal Power Plant Project

1. Project name : Region 3 Lignite

2. Type of generation : lignite-fired steam plant

3. Description and scope of project

   a) Location : Sin Pun, Krabi Province

   b) Rated capacity : 75 MW

   c) Annual energy generation : 490.0 GWh

   d) Fuel : lignite

   e) Fuel consumption : 0.515 million ton per year

4. Project cost (Million Baht)

	FC	LC	Total
-Turbine generator & auxiliary	370.98	41.58	412.56
-Steam generator & auxiliary	671.76	64.53	736.29
-Plant miscellaneous equipment	47.52	0.54	48.06
-Electrical equipment	187.10	1.89	188.99
-Civil works	84.51	180.90	256.41
-Local transport	-	14.04	14.04
-Construction equipment	55.08	0.54	55.62
Total	1,916.95	304.02	1,720.97

5. Tentative schedule

   a) Feasibility study and approval : Mid 1994

   b) Engineering : Mid 1995

   c) Preliminary, manufacturing, construction and installation works : Mid 1996

   d) Commissioning : November 1999

EGAT's Thermal Power Plant Project

1. Project name : Ao Phai 1-2

2. Type of generation : coal-fired steam plant

3. Description and scope of project

   a) Location : Ao Phai District, Chon Buri Province

   b) Rated capacity : 2x600 MW

   c) Annual energy generation : 2x3950 GWh

   d) Fuel : imported coal

   e) Fuel consumption : 2x1.546 million tons per year

4. Project cost (Million Baht) of each unit of 600 MW

	FC	LC	Total
-Turbine generator & auxiliary	1698.03	-	1698.03
-Steam generator & auxiliary	2764.26	-	2764.26
-Coal handling	353.70	-	353.70
-Ash handling	288.90	-	288.90
-Structural steel	285.39	-	285.39
-Intake and C.W. pipe	45.90	-	45.90
-Electrical equipment	833.49	-	833.49
-Instrumentation & control	216.54	-	216.54
-Water treatment	166.86	-	166.86
-Building super structure	210.87	-	210.87
-Plant miscellaneous	54.81	-	54.81
-Air conditioning	30.24	-	30.24
-Construction equipment	49.14	-	49.14
-Civil works	73.71	2082.24	2155.95
-Mechanical construction	-	1699.11	1699.11
-Electrical & control construction	-	787.05	787.05
-Inspection service	14.04	-	14.04
-Local transport	-	70.74	70.74
Total	7,085.88	4,639.14	11,725.02

5. Tentative schedule

   a) Feasibility study and approval : October 1992

   b) Engineering : October 1993 (Ao Phai # 1)
      October 1994 (Ao Phai # 2)

   c) Preliminary, manufacturing, construction and installation works : October 1994 (Ao Phai # 1)
      October 1995 (Ao Phai # 2)

   d) Commissioning : October 1999 - October 2000

EGAT's Thermal Power Plant Project

1. Project name : North Bangkok Plant Renovation

2. Description and scope of project

The existing three units of North Bangkok Power Plant have been in operation since 1961, 1963 and 1968 respectively. This power plant has been in service for 26 years and generally the condition of the generating units is such that it is possible for renovation to be taken. Study is now being performed to determine the method and cost of renovating the three generating units by considering the utilization of either natural gas or heavy oil as fuel. The schedule for renovation will be determined after the study is completed. However, it is estimated that the commissioning of this plant after the renovation will be no later than August 1993.

3. Project cost (Million Baht)

The total cost for the renovation is estimated to be 1,297.5 million Baht. The foreign currency requirement is 736.7 million and the local currency is 560.8 million.

4. Tentative schedule

a) Feasibility study and approval : April 1987
b) Engineering : October 1990
c) Preliminary, manufacturing, construction and installation works : October 1991
d) Commissioning : August 1993

3.2.2 Hydroelectric Power Plant Project

The development of future hydroelectric projects will be of small scale because nearly all large hydro potentials have already been exploited. Upper Quae Yai (Nam Chon) is the only sizable project but the possibility of construction is controversial due to its location which is in the national reserved forest. Archaeologists are also against the project on the ground that the reservoir will inundate the trace of accient civilization which has been abundantly discovered in that area.

The future hydroelectric projects in EGAT's power expansion plan consist of

-Srinagarind # 5	(Region 1)
-Pak Mun # 1-4	(Region 2)
-Kaeng Krung # 1-2	(Region 3)
-Upper Quae Yai # 1-4	(Region 1)
-Bhumibol Plant Renovation	(Region 4)

Details on each hydroelectric power plant are given on the next pages.

EGAT's Hydroelectric Power Plant Project

1. Project name : Srinagarind # 5

2. Type of generation : Pumped storage

3. Description and scope of project

a) Location

Srinagarind # 5 will be installed at the existing dam which was constructed across the Quae Yai River in Kanchanaburi Province. The site of the dam is 68 km upstream from the confluence of Quae Yai and Quae Noi Rivers.

b) Power plant

Srinagarind # 5 is a reversible pump-turbine rated 180 MW , capable of generating 113.2 GWh annually. The pumping energy is 165.8 GWh yearly.

4. Project cost (Million Baht)

	FC	LC	Total
a) Preliminary works	-	-	-
b) Compensation, resettlement and environmental impact mitigation plan	-	-	-
c) Civil works	11.23	17.54	28.77
d) Hydraulic equipment	-	-	-
e) Electro-mechanical equipment			
-Turbine	265.89	21.34	287.23
-Generator	175.61	14.10	189.71
-Others	53.78	4.22	58.00
f) EGAT administration	0.00	28.54	28.54
g) Engineering consulting service	25.27	8.33	33.60
h) Import duties, taxes and IDC	0.00	176.95	176.95
Total	531.78	271.02	802.80

5. Tentative schedule

a) Government approval : January 1988
b) Bidding : April 1989
c) Construction : October 1989
d) Commissioning : January 1993

EGAT's Hydroelectric Power Plant Project

1. Project name : Pak Mun # 1-4

2. Type of generation : Run-off-river

3. Description and scope of project

a) Location

This project will be situated in Ubolratchathani Province. The dam will be constructed across the Mun River at Khong Jiam District which is about 6 km. away from the mouth of Mun River.

b) Dam and reservoir

The dam is a 17 m. high and 255 m. long rockfill type. The crest elevation is 111 m. The reservoir has the surface area of 60 square km. at the normal water level of 108 m. MSL.

c) Power plant

The power plant will be on the right bank of the Mun River. It will accommodate four horizontal bulb type generating units rated 34 MW each totalling 136 MW. The average annual energy generation is 317 GWh.

4. Project cost (Million Baht)

	FC	LC	Total
a) Preliminary works	0.00	17.11	17.11
b) Compensation, resettlement and environmental impact mitigation plan	0.00	53.15	53.15
c) Civil works	396.89	324.73	721.62
d) Hydraulic equipment	216.83	68.19	285.02
e) Electro-mechanical equipment			
-Turbine	394.69	92.84	487.53
-Generator	342.06	80.64	422.52
-Others	272.04	63.99	336.03
f) EGAT administration	0.00	81.61	81.61
g) Engineering consulting service	87.83	48.95	136.78
h) Import duties, taxes and IDC	0.00	839.43	839.43
Total	1,710.34	1,670.46	3,380.80

5. Tentative schedule

a) Government approval	: September 1988
b) Bidding	: January 1989
c) Construction	: April 1989
c) Commissioning	: November 1993

EGAT's Hydroelectric Power Plant Project

1. Project name : Kaeng Krung # 1-2

2. Type of generation : Pondage

3. Description and scope of project

a) Location

This project will be located in Khiriratnikhom District, Surat Thani Province. The dam will be constructed across the Yan Canal at a site 40 km. away from the Yan Canal and Pum Duang River confluence.

b) Dam and reservoir

The dam is a concrete faced rockfill type with a crest elevation of 158.76 m. MSL and a crest length of 520 m. The normal level of storage is 154.50 m. MSL at which the surface area is 37.8 square km.

c) Power plant

The power plant will be on the right bank of Yan Canal. It will house two units of generator and vertical Francis turbine. The total capacity will be 80 MW and the average annual energy generation will be 178 GWh.

4. Project cost (Million Baht)

	FC	LC	Total
a) Preliminary works	0.00	187.31	187.31
b) Compensation, resettlement and environmental impact mitigation plan	0.00	65.18	65.18
c) Civil works	672.90	465.94	1,138.84
d) Hydraulic equipment	93.94	30.14	124.08
e) Electro-mechanical equipment			
-Turbine	77.58	7.55	85.13
-Generator	72.04	7.01	79.05
-Others	59.30	5.90	65.20
f) EGAT administration	0.00	48.03	48.03
g) Engineering consulting service	65.89	30.04	95.93
h) Import duties, taxes and IDC	0.00	391.63	391.63
Total	1,041.65	1,238.73	2,280.38

5. Tentative schedule

a) Government approval : April 1988
b) Bidding : June 1988
c) Construction : October 1988
d) Commissioning : December 1993

EGAT's Hydroelectric Power Plant Project

1. Project name : Upper Quae Yai # 1-4

2. Type of generation : Pondage

3. Description and scope of project

a) Location

This project will be located 135 km. upstream from the Srinagarind dam. The dam will be constructed across the Quae Yai River in Thong Pa Pum District, Kanchanaburi Province.

b) Dam and reservoir

The dam will be a rockfill, impervious clay core type; 187 m. high; 430 m. long. The crest elevation is 377.0 m. MSL. The reservoir has a storage level at 379 m. MSL at which the surface area is 137 square km.

c) Power plant

The power plant will be constructed on the right bank of the river to house 4 units of generator and vertical Francis turbine. The total capacity of the power plant is 580 MW and the annual energy generation is 1,168 GWh.

4. Project cost (Million Baht)

	FC	LC	Total
a) Preliminary works	0.00	275.39	275.39
b) Compensation, resettlement and environmental impact mitigation plan	0.00	528.92	528.92
c) Civil works	2,128.00	1,773.22	3,901.22
d) Hydraulic equipment	286.06	96.48	382.54
e) Electro-mechanical equipment			
-Turbine	377.58	46.16	423.74
-Generator	350.61	42.87	393.48
-Others	335.04	40.48	375.52
f) EGAT administration	0.00	187.68	187.68
g) Engineering consulting service	216.54	40.41	256.95
h) Import duties and taxes	0.00	511.17	511.17
Total	3,693.83	5,432.78	9,126.61

5. Tentative schedule

a) Government approval	: April 1988
b) Bidding	: January 1989
c) Construction	: September 1989
d) Commissioning	: November 1996 (# 1-2)
	: May 1997 (# 3-4)

EGAT's Hydroelectric Power Plant Project

1. Project name : Bhumibol Plant Renovation

2. Type of generation : Pondage

3. Description and scope of project

Bhumibol Hydro Power Plant has been in operation for more than 20 years. The last inspection reveals that some mechanical equipments such as runner, protection liner, grease bearing, etc. and most of the electrical equipments such as generator, excitation system and the unit control system are deteriorated. Therefore, unit 1 and unit 2 are proposed to be renovated to increase their efficiencies, reliability and generation capacities.

4. Project cost

Cost estimate of the project is 609.7 million Baht. The foreign currency portion is equivalent to 338.3 million Baht (12.5 US.$ million) and the local currency is 271.4 million Baht.

5. Tentative schedule

The project is expected to be completed in November 1990.

3.3 Transmission Project

EGAT's transmission system development in the future will cover the expansion of 500, 230 and 115 kV transmission lines and substations to all provinces of Thailand. The 500 kV EHV transmission system is being developed to transmit bulk power through long distance and to superimpose the 230 kV system. The future development will be concentrated in 5 areas - the eastern area (Bang Pakong/Ao Phai), the western area (Quae Yai and Quae Noi Rivers), the northern area (Mae Moh), the northeastern area (Nam Phong) and the southern area (Chiew Larn, Khanom and Krabi).

The large scale generation development of lignite-fired power plants at Mae Moh minemouth for additional capacity of 1,200 MW in the period up to year 2001 will require long distance EHV transmission lines to transmit bulk power to load center at the greater Bangkok area. Presently, it is envisaged that 500 kV AC lines will be required from the new Mae Moh power plant (3rd power plant site) to Tha Tako intermediate substation, and from Tha Tako to Nong Chok Substation. Integration of power generation between Mae Moh 2 and Mae Moh 3 power plant sites are also required.

For the southern transmission system, interconnection between Thailand and Malaysia has been in operation since 1981. The power exchanges between the two power utilities are to prevent power shortage during scheduled and unscheduled outages. In the context of ASEAN cooperation, Power System Interconnection Stage II has been initiated and is under preliminary study. The study covers the Stage II power exchange in the range of 100, 200, and 300 MW. The HVDC back-to-back system may be one of the most promising alternatives to overcome the power swing and stability problems.

This report will emphasize more on the 500 kV EHV system because it is the system that will likely offer better opportunities for Canadian suppliers in competition with suppliers from other countries.

3.3.1 500 kV EHV Transmission System

The EHV transmission system will be developed for Mae Moh 10-13, Bang Pakong Thermal # 3-4 and Ao Phai # 1&2.

EGAT's 500 kV EHV System

1. Project name : Transmission System for Mae Moh # 10

2. Project description

The project requires the construction of the 2nd circuit of 500 kV transmission line to link Mae Moh 4 and Tha Tako Substations for a distance of 326 km. Another 500 kV transmission line from Mae Moh 3 Substation to Mae Moh 4 Substation which is 5 km away is also part of the project. The transmission lines are made of 4x795 MCM ACSR conductors. The project also requires the expansion of the 500 kV Mae Moh 3 and the construction of Mae Moh 4 Switchyards, the 500 kV Tha Tako Substation and the 500 kV Nong Chok Substation at which a transformer rated 500/230 kv, 600 MVA will be installed.

3. Project cost (Million Baht)

	FC	LC	Total
a) Mae Moh 4 - Tha Tako (4x795 MCM ACSR, SC/ST, 326 km)	625.9	410.8	1,036.7
b) Mae Moh 3 - Mae Moh 4 (4x795 MCM ACSR, SC/ST, 5 km)	9.6	5.2	14.8
c) 500 kV Mae Moh 3 Switchyard expansion	25.1	5.6	30.7
d) 500 kV Mae Moh 4 Switchyard	113.9	26.2	140.1
e) 500 kV Tha Tako Substation expansion	53.8	8.6	62.4
f) 500 kV Nong Chok Substation expansion and addition of 500/230 kV 600 MVA transformer	125.9	17.1	143.0
g) Communication system addition	5.8	1.0	6.8
h) Engineering and contingencies	64.5	133.5	198.0
i) Escalation	26.0	52.5	78.5
j) Import duties, taxes and IDC	0.0	452.5	452.5
Total	1,050.0	1,113.0	2,163.5

4. Tentative schedule
   a) Government approval : Mid 1987
   b) Bidding : May 1990
   c) Construction : February 1981
   d) Commissioning : Jul 1993

EGAT's 500 kV EHV System

1. Project name : Transmission System for Mae Moh # 11

2. Project description

The construction of the 2nd circuit of the 500 kV Tha Tako - Nong Chok is being proposed. This line will be made of 4x795 MCM ACSR conductors for a distance of 215 km. In addition, 500 kV Mae Moh 4 Switchyard, 500 kV Tha Tako Substation the 500 kV Nong Chok Substation will also be expanded.

3. Project cost (Million Baht)

	FC	LC	Total
a) 500 kv Tha Tako - Nong Chok (4x795 MCM ACSR, SC/ST, 215 km)	413.0	326.0	379.0
b) 500 kV Mae Moh 4 Switchyard expansion	26.0	6.6	32.6
c) 500 kV Tha Tako Substation expansion	43.0	5.6	48.6
d) 500 kV Nong Chok Substation expansion	45.4	6.0	51.4
e) Communication system addition	1.6	0.3	1.9
f) Engineering and contingencies	53.0	101.5	154.5
g) Escalation	28.0	51.5	79.5
h) Import duties, taxes and IDC	0.0	254.5	254.5
Total	610.0	752.0	1,362.0

4. Tentative schedule

a) Government approval : Mid 1987
b) Bidding : August 1991
c) Construction : May 1992
d) Commissioning : July 1994

EGAT's 500 kV EHV System

1. Project name : Transmission System for Mae Moh # 12

2. Project description

There is no construction of transmission lines for Mae Moh # 12. Only the expansion of the 500 kV Mae Moh 4 Switchyard and the 500 kV Nong Chok Substation including the addition of a transformer rated 500/230 kV, 600 MVA at this substation will be required.

3. Project cost (Million Baht)

	FC	LC	Total
a) 500 kV Mae Moh 4 Switchyard expansion	26.0	6.5	32.5
b) 500/230 kV Nong Chok Substation expansion	118.0	15.0	133.0
c) Engineering and contingencies	14.5	15.0	29.5
d) Escalation	19.5	7.0	26.5
e) Import duties, taxes and IDC	0.0	54.0	54.0
Total	178.0	97.5	275.5

4. Tentative schedule

a) Government approval : October 1989
b) Bidding : April 1993
c) Construction : November 1993
d) Commissioning : July 1995

EGAT's 500 kV EHV System

1. Project name : Transmission System for Mae Moh # 13

2. Project description

The project consists of the expansion of 500 kV Mae Moh 4 Switchyard.

3. Project cost (Million Baht)

	FC	LC	Total
a) 500 kV Mae Moh 4 Switchyard expansion	26.0	6.5	32.5
b) Engineering and contingencies	2.5	3.5	6.0
c) Escalation	7.0	3.0	10.0
d) Import duties, taxes and IDC	0.0	13.0	13.0
Total	35.5	26.0	61.5

4. Tentative schedule
   a) Government approval : October 1990
   b) Bidding : July 1994
   c) Construction : February 1995
   d) Commissioning : July 1996

EGAT's 500 kV EHV System

1. Project name : Transmission System for Bang Pakong Thermal # 3,4

2. Project description

The project includes a) construction of 500 kV Bang Pakong - Nong Chok (4x795 MCM ACSR, DC/ST) transmission lines for a distanc of 44 km., b) 500/230 kV Bang Pakong Substation, and c) expansion of the 500 kV Nong Chok Substation.

3. Project cost (Million Baht)

	FC	LC	Total
a) 500 kV Bang Pakong - Nong Chok (4x795 MCM ACSR, DC/ST, 44 km)	148.0	85.5	233.5
b) 500/230 kV Bang Pakong Substation	335.6	53.6	389.2
c) 500 kV Nong Chok Substation expansion	52.5	11.8	64.0
d) Communication system addition	3.2	0.6	3.8
e) Engineering & contingencies	54.0	68.5	122.5
f) Escalation	120.5	58.5	179.0
g) Import duties, taxes and IDC	0.0	242.0	242.0
Total	713.5	520.5	1234.0

4. Tentative schedule

a) Government approval :
b) Bidding : January 1995
c) Construction : October 1995
d) Commissioning : July 1997

EGAT's 500 kV EHV System

1. Project name : Transmission System for Ao Phai Thermal # 1

2. Project description

The project includes the construction of a 230 kV transmision line section between Ao Phai 1 and Ao Phai 2 Substations. In addition, 230 kV Ao Phai 1 Substation will be expanded and a new switchyard will also be constructed at Ao Phai 2.

3. Project cost (Million Baht)

	FC	LC	Total
a) 230 kV Ao Phai 1 - Ao Phai 2 (2x1272 MCM ACSR, DC/ST, 6 km)	12.5	6.5	19.0
b) 230 kV Ao Phai 1 Substation expansion	16.0	4.9	20.9
c) 500/230 kV Ao Phai 2 Switchyard	290.3	72.1	362.4
d) Communication system addition	2.7	0.5	3.2
e) Engineering and contingencies	32.5	40.0	72.5
f) Escalation	102.0	45.0	147.0
g) Import duties, taxes and IDC	0.0	148.0	148.0
Total	456.0	317.0	773.0

4. Tentative schedule

a) Government approval :
b) Bidding : November 1996
c) Construction : August 1997
d) Commissioning : July 1999

EGAT's 500 kV EHV System

1. Project name : Transmission System for Ao Phai # 2

2. Project description

The project includes a) construction of the transmission line section to link the 500 kV Ao Phai 2 and Nong Chok substions b) 500 kV switchyard expansion at Ao Phai 2 Substation, and c) 500 kV Nong Chok Substation expansion.

3. Project cost (Million Baht)

	FC	LC	Total
a) 500 kV Ao Phai 2 - Nong Chok (4x795 MCM ACSR, DC/ST, 97 km)	326.0	203.5	529.5
b) 500 kV Ao Phai 2 Switchyard expansion	85.6	19.7	105.3
c) 500 kV Nong Chok Substation expansion	52.2	11.7	63.9
d) Communication system addition	3.2	0.6	3.8
e) Engineering and contingencies	47.0	78.0	125.0
f) Escalation	171.5	122.5	294.0
g) Import duties, taxes and IDC	0.0	263.5	263.5
Total	685.5	699.5	1385.0

4. Tentative schedule

a) Government approval :
b) Bidding : November 1997
c) Construction : August 1998
d) Commissioning : July 2000

3.3.2 230 kV and 115 kV Transmission System Projects

There are quite a few transmission projects rated below 500 kV which are scheduled to be constructed during the next 15 years. These projects are listed below.

A. 230 kV Projects

Name of Transmission Lines and Substations	Length in km	Number of Circuit	Conductor Size (MCM)	In Service Date (Fiscal Year)
1) Srinagarind Switchyard addition				1993
2) Sai Noi Substation				1993
3) Nam Chon-Srinagarind 2	110	2	2x1272	1996
4) Ban Pong 2-Sai Noi	54	2	1272	1996
5) Ao Phai 1-Ao Phai 2	3	2	2x1272	1999
6) Saraburi 2-Nakhon Ratchasima 2	120	2	1272	1990
7) Mae Moh 3-Chiang Mai 3	118	2	1272	1992
8) Khon Kaen 3-Roi Et	115	2	1272	1991
9) Tha Tako-Khon Kaen 3	300	2	1272	1992
10) Prachuap Khiri Khan-Surat Thani	350	2	1272	1990

B. 115 kV Projects

Name of Transmission Lines and Substations	Length in km	Number of Circuit	Conductor Size (MCM)	In Service Date (Fiscal Year)
1) Ubol Ratchathani 1-Ubol Ratchathani 2	25	1	477	1993
2) Pak Mun-Ubon Ratchathani 2	70	2	477	1993
3) Ubon Ratchathani 2-Si Kaket	65	1	477	1993
4) Kaeng Krung-Chiew Larn	42	2	477	1993
5) Khao Laem-Nam Chon	70	1	477	1990
6) Nam Phong-Khon Kaen 1	30	1	95 sq.mm	1989
7) Nam Phong-Udon Thani 1	95	1	477	1990
8) Krabi Switchyard reconstruction				1992
9) Krabi 2-Thung Song	44	2	477	1999
10) Bang Pakong-Chachoeng Sao	19	1	477	1990
11) Ang Thong 2-Ayutthaya 1	38	1	477	1990
12) Ayutthaya 1-Bang Pa In	21	2	477	1990
13) Ao Phai-Sri Racha	5	1	477	1990
14) Tha Tako-Takhli 2	44	2	477	1990
15) Mae Moh 3-Phayao	114	1	477	1990
16) Tak 1-Mae Sot	79	1	477	1990
17) Sawankhalok Substation and line termination	11	2	477	1990

Name of Transmission Lines and Substations	Length in km	Number of Circuit	Conductor Size (MCM)	In Service Date (Fiscal Year)
18) Ang Thong 2-Doembang Nangbuat	34	1	477	1990
19) Nakhon Sawan-Salokbat	49	1	477	1990
20) Thalan 1-Phra Phutthabat	19	1	477	1990
21) Saraburi 4-Nakhon Nayok	30	1	477	1990
22) Surat Thani-Bandon	17	1	477	1990
23) Ayutthaya 2 Substation				1990
24) Kalasin-Sakon Nakon	113	1	477	1992
25) Nakhon Ratchasima 2-Buri Ram	120	2	477	1992
26) Phichit-Bang Mun Nak	49	1	477	1992
27) Bang Pakong-Bang Wua	12	1	477	1992
28) Narathiwat-Sungai Kolok	48	1	477	1992
29) Hat yai 2-Pattani	120	1	477	1992
30) Ban Na San Substation				1992
31) Bang Pakong-Phanom Sarakham	52	1	477	1992
32) Kabin Buri Substation				1992
33) Ao Phai-Bang Lamung(No.2)	22	1	477	1992
34) Phatthalung-Ranot	48	1	477	1992
35) Chiang Rai-Thoeng	61	1	477	1992
36) Amnat Charoen Substation				1992
37) Buri Ram-Prakhon Chai	46	1	477	1992
38) Yasothon-Si Sa Ket	89	1	477	1992
39) Hua Hin Substation				1992

3.4 Upgrading of EGAT's System Control Center

3.4.1 Objective

The existing central dispatching center was commissioned in 1971 and has been in service for more than 10 years. Therefore, both the hardware and the software become technologically obsolete and will soon inadequate to cope with the system expansion. Due to this, the present EGAT's system control center needs to be upgraded to a more satisfactory operating condition.

3.4.2 Project Scope and Description

Project Scope

The upgrading of the system control center consists of the following works :

a) National Control Center (NCC) and Region 1 Control Center (RCC-1)

Initially, there will be 80 remote stations under control of NCC and RCC-1 which will share the same computer system. The installation of hardware includes :

-Duel computer systems: one will be served as an on-line, real-time function and the other will be served as hot standby. Each consists of a CPU 16 megabytes main memory, two units of 300 magawords mass storage subsystem and one programming development sybsystem.

-A man-machine interface subsystem, a telecontrol subsystem and remote termianl units (RTU).

The software system for NCC and RCC-1 consists of an operating system, a supervisory control and data acquistition (SCADA) software system and an application software system.

b) Region 4 Control Center (RCC-4)

There will be 26 remote stations under supervision and control of RCC-4. The installation of hardwares and softwares includes :

-Duel computers with 2 megabytes main memory, two units of 80 megawords mass storage and one programming development equipment subsystem.

-A man-machine interface subsystem, a telecontrol subsystem and remote terminal units (RTU)

-An operating system software, a SCADA software system and an application software system.

c) Communication Equipment

-Approximately 100 data modems will be required for NCC and RCC-1 plus 44 for RCC-4, totalling 144 modems.

-Approcimately 100 PLC terminals will be required for NCC and RCC-1 plus 50 terminals for RCC-4, totalling 150 terminals.

-Approximately 70 multiplexer or TDMA channel units will be required for NCC and RCC-1 plus 20 for RCC-4, totalling 90 units.

Project Description

Presently, there are three dispatching centers each located at North Bangkok, Khon Kaen and Lam Poo Ra Substations. Region 1 and Region 4 are under control of North Bangkok dispatching center while Region 2 and Region 3 are under control of Khon Kaen and Lam Poo Ra dispatching centers respectively. However, the scope of the upgrading of system control center project will only cover the NCC and the RCC for Region 1 and Region 4 only.

The NCC, located at North Bangkok Power Plant, will control all generating units not less than 100 MW, the 500 kV and 230 kV transmission systems as well as all capacitor banks and reactors rated above 60 MVAr. The functions of the NCC are :

a) Real time control of load, generation, power and energy transfer between regions and utilities, reserve of generation and transmission network including production control.

b) Follow up efficiency, recording historical data for use in scheduling and compilation of ststistics, reporting, monitoring, recording of disturbance for subsequent analysis.

c) Operational planning including load prediction and generation schedules, power balance, co-ordination of overhauls and operation reserves.

d) Co-ordinate functions of all RCCs including interchange management for establishing and monitoring power transfers between regions and utilities.

e) Optimization of reactive power transfer.

f) System security assessment including state estimator, contingency analysis, static and dynamic security monitor and on-line dispatching of load flow analysis.

g) Performing the economic load dispatch program.

h) Providing for system simulation and operator training.

The RCC-1 and RCC-4 will be located in the vicinity of the existing dispatching centers of North Bangkok Power Plant and Phitsanulok 2 Substation respectively. The RCC-1 and RCC-4 will control all small generating units under 100 MW, supervisory control all 115 kV and 69 kV transmission systems as well as all capacitor banks and reactors rated under 60 MVAr in Region 1 and Region 4. Also they will accept operational control form NCC. The functions of the RCC-1 and RCC-4 are :

a) Issuing switching orders for sub-transmission systems and distribution feeders.

b) Collection of information from substations.

c) Automatic control for on-load tap changer of transformers.

d) Receiving instruction from the NCC and execute accordingly and co-ordinating any functions between the nieghbouring regions.

e) Following up efficiency, recording historical data for use in scheduling and compilation of statistics, reporting, monitoring, recording disturbance for subsequent analyses.

f) Providing for system security assessment.

3.4.3 Cost Estimate

The estimated cost for this project is 770.0 million Baht, 410.0 of which is the foreign currency and 360.0 of which is the local currency. The detailed breakdowns of cost estimate can be found in Table 3-4, 3-5 and 3-6.

TABLE 3-4 COST ESTIMATES FOR NATIONAL AND REGION 1 CONTROL CENTERS

	EC	LC	Total
a) Hardware system	154.6	-	154.6
b) Operating system	17.7	-	17.7
c) Application software	19.0	-	19.0
d) Installation & testing	7.6	2.6	10.2
e) Training course	2.8	1.8	4.6
f) Miscellaneous Facilities	3.8	32.6	36.4
Total	205.5	37.0	242.5

TABLE 3-5 COST ESTIMATES FOR REGION 4 CONTROL CENTERS

	RC	LC	Total
a) Hardware system	63.9	-	63.9
b) Operating system	10.1	-	10.1
c) Application software	11.3	-	11.3
d) Installation & testing	7.6	1.1	8.7
e) Training course	2.8	1.8	4.6
f) Miscellaneous Facilities	3.8	20.6	24.4
Total	99.5	23.5	123.0

TABLE 3-6 COST ESTIMATES FOR COMMUNICATION SYSTEM

	FC	LC	Total
a) Communication system	42.4	-	42.4
b) Installation & testing	3.8	5.9	9.7
c) Training course	0.8	0.7	1.5
d) Miscellaneous Facilities	-	1.4	1.4
Total	47.0	8.0	55.0

4. PEA's Power Generation and Transmission

4.1 Background

The Provincial Electricity Authority (PEA) was established in 1960 to be responsible for generation, acquisition and distribution of electric energy to customers in the provincial areas of the country. Presently, 70 provinces comprising 54,500 villages, covering 514,000 square kilometers which is about 99 % of the country area, with the total number of customers amounts to 45 millions are served by PEA. Since the beginning of the establishment, PEA has adhered to three operational objectives :

1. To improve the service and acquisition of electricity with respect to efficiency, safety, reliability and promptness which should be in line with the ever-increasing demand and the changing situations.

2. To improve the performance of various business activities to increase the profit, reduce the cost so that PEA can rely financially on its own with substantial benfit and thus be able to afford the future investments.

3. To improve the organization structure, manpower management and resources management to the highest efficiency and effectiveness.

In order to achieve the objectives especially those related to the acquisition, transmission, distribution of electricity and provision of service to customers, business entities and industrial plants, PEA has formulated the following strategic goals :

1. Modernize the existing systems to the higher efficiency and reliability and also incorporate more facilities to the systems to serve the future demand.

2. Reduce the operating cost and losses to the lowest possible level.

3. Extend the electricity service to cover as much unelectrified areas as possible within a reasonable time period.

4. To develop and utilize the renewable energy which is locally available for electricity generation.

PEA has adopted the systematic planning which is not only in harmony with PEA's policy but also in conformity with the National Economic and Social Development Plan, Master Plans of the Ministry of Interior as well as operational plans of other agencies such as EGAT, MEA, BOI, etc.. PEA projects can be classified into 4 categories in accordance with the 4 strategic goals. They are

a) Power Distribution System Reinforcement Project (PSR),
b) Electric Distribution System Extension to Small Diesel Power Plants Project (EDE),
c) Tambon Electrification Project (TEP),
d) Village Electrification Project (VEP) and the Renewable Energy Project.

During the past 10 years, PEA has expanded the distribution system considerably and has been able to provide services to more customers with acceptable efficiency. The PEA's highlights in this period are :

-The increase of high tension distribution lines from 18,736 circuit-km to 89,369 curcuit-km, representing a growth rate of 19 % annually.

-The increase of peak demand from 640.1 MW to 1,953.4 MW, representing a growth rate of 13 % annually.

-The increase of energy demand from 2,875.5 GWh to 9,440.7 GWh, representing a growth rate of 14 % annually.

-The increase of the number of customers from 927,298 to 4,054,200, representing a growth rate of 18 % annually.

At the end of 1985, PEA was able to provide electricity supply to 37,094 villages which was equivalent to 68 % of the total villages in PEA service areas. Up to the present, the electrified villages are approximately 76 %.

The 5th NESDP (1982 - 1986) emphasised on the industrial reorganization, decentralization of industrial plants to provincial areas in parallel with promoting specific development programmes such as principle towns development, eastern seaboard development, etc..

Similarly, the 6th NESDP (1987 - 1991) concentrates on the rural development, specific area development programmes and decentralizaion of industrial plants. The plan has also set a target in upgrading quality of life which is largely related to provision of basic services having energy especially electric energy as the key factor.

In accordance with the 6th NESDP, it is anticipated that the energy requirement in PEA service areas will substantially increase. It is estimated that the peak demand will be 3,240 MW, the energy demand will be 16,630 GWh and the total number of customers will be 6 millions by the end of the 6th NESDP (1991). These represent the growth rates of 9 %, 10 % and 7 % respectively.

To provide sufficient supply to costomers, PEA has proposed 8 projects to be implemented under the 6th NESDP. These projects are :

1. The Power Distribution Reinforcement Project, 4th Stage (PSR IV).

2. The Transmission System and Substation Development Project (TSD).

3. The Distribution System Dispatching Centre Project (DDC).

4. The Village Electrification Project, Phase III (VEP 3).

5. The Normal Rural Electrification Project, Phase II (NRE 2).

6. The Village Electrification in Tungkularonghai Project.

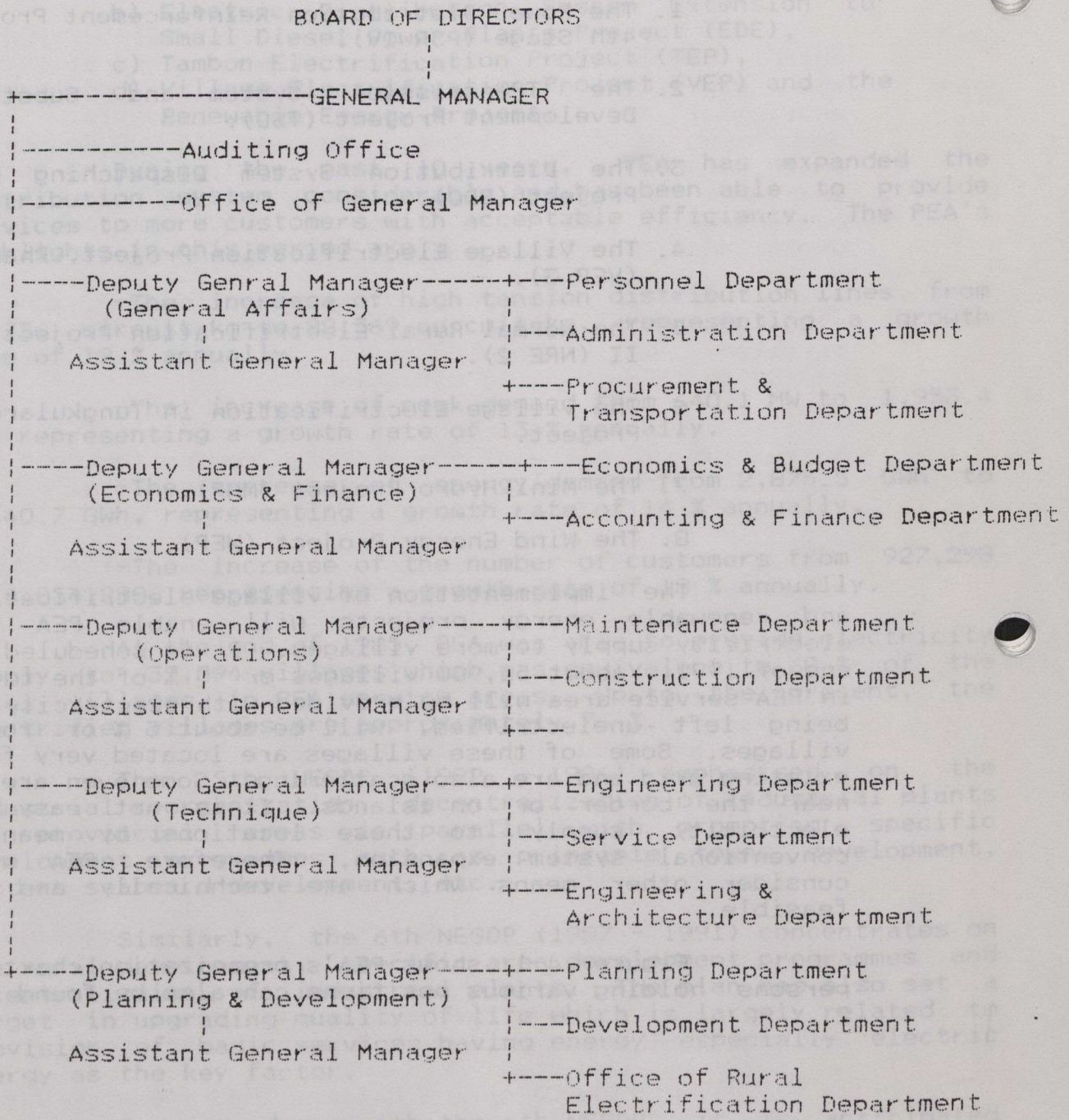
7. The Mini Hydro Project (MHP).

8. The Wind Energy Project (WEP).

The implementation of village electrification projects and renewable energy projects will enable PEA to provide electricity supply to more villages. It is scheduled that at the end of 1991, about 51,900 villages or 95 % of the total villages in PEA service area will be provided with electricity. The rest, being left unelectrified, will be about 5 % or roughly 2,600 villages. Some of these villages are located very far from the existing grid and are also scattering. Some even are in valleys, near the border or on islands. It is not easy to provide electricity supply to these locations by means of the conventional system expansion. Therefore, PEA will try to consider other means which are technically and financially feasible.

Figure 4-1 shows PEA's organization chart. Names of persons holding various positions can also be found in Appendix 2.

FIGURE 4-1 PEA'S ORGANIZATION CHART



4.2 Details on PEA's Future Projects

Details of the 8 projects mentioned earlier will be given in this section. They could be grouped into 3 categories; i.e., Power Transmission, Power Distribution and Power Generation Projects.

4.2.1 Power Transmission Projects

There is only one project of this kind under the present PEA's development plan.

PEA's Power Transmission Project

1. Project name : Transmission System and Substation Development Project

2. Project description

This project is designed to serve the demand in the central region covering 18 provinces with 33,00 square kilometers and a population of 6 million. These 18 provinces are known as the U-Shape area and they surround MEA's service area. Electricity consumption in the U-Shape area is quite high and is steadily increasing due to the government's policies on promoting the establishment of new businesses and industries together with some specific development programs such as the development of principal towns, the Eastern Seaboard Project, etc. Demand in this area is currently served by a 22 kV system which will be no longer suitable for supplying higher future demand. Therefore, PEA will consider upgrading the system voltage from 22 kV to 115 kV, constructing transmission lines and substations, as well as improving commuication systems in order to be abreast with the load requirement.

3. Status of project

Construction of 115 kV system and substations needs well qualified personnel having high experiences in system analysis and planning. At this stage, PEA has sought assistance from the United States of America in sending experts to PEA to undertake the feasibility study of the project before committing further actions.

4. Project cost

The project cost will be estimated after the completion of the feasibility study.

5. Tentative schedule
   a) Feasibility study : 1987 to 1988 (14 months)
   b) Construction : 1990
   c) Commissioning : 1992

4.2.2 Power Distribution Project

Up to present, there are altogether 101,062 circuit-kilometers of high voltage distribution lines in the PEA's service areas. The figure shows an increase of 11,693 circuit-kilometers or 13.1 % which was in line with the target PEA had projected to serve the public more sufficiently.

Aerial cables are also used in part of the outgoing lines of substations where many feeders are installed side by side. At the moment, there is no use of underground cables in the country. In 1987, Submarine Cable Project is under construction in order to substitute electric supply condition in Ko Samui, an island in the southern part of Thailand where diesel power plants are operated.

Five projects are included in the distribution system expansion. They are listed below:

a) Power Distribution Reinforcement Project, 4th Stage

b) Distribution Systems Dispatching Center Project

c) Village Electrification Project, Phase III

d) Normal Rural Electrification Project, Phase II

e) Village Electrification in Tungkularonghai Project

Details of these five projects are as follows:

PEA's Power Distribution Project

1. Project name : Power Distribution Reinforcement Project, 4th Stage

2. Project description

This project is the continuation of the similar 1st, 2nd and 3rd stages which were implemented during the period of the 3rd, 4th and 5th NESDP. PEA has to implement the construction and reinforcement of distribution sytems in stages due to the widespread service area and high investment requirement if the work would be done in one stage. The project is divided into 2 parts. Part A includes the distribution systems construction and reinforcement connected to 60 substations, and Part B includes 26 more substations totalling 86 substations altogether for the whole project.

Part A consists of the construction of 12 substations in the northern provinces, 17 substations in the northeastern provinces, 20 substations in the central region and 11 substations in the southern region. Construction of these substations is ranked at high priority because the problems of excessive voltage drop, losses, rapidly increasing demand and service reliability are severe. The 26 substations planned for construction in Part B will be in the areas where they are likely to become new industrial zones and also in the specific development areas under the government promotion.

The construction work of Part A and Part B consists of

	Part A	Part B	
Transmission lines	29	-	cct-km
Substations	60	26	substation
H.T. distribution line	3,900	1,200	cct-km
L.T. distribution line	1,100	190	cct-km
Distribution transformers	545,000	200,000	kVA

3. Project status

The feasibility study report has been completed and proposed to the cabinet for approval.

4. Project cost (Million Baht)

	Part A	Part B	Total
Foreign currency	2,135	600	2,735
Local currency	1,290	380	1,670
PEA's revenues	75	20	95
Total	3,500	1,000	4,500

5. Tentative schedule

The project will be implemented during 1987 - 1992. The first year will be for survey and design, producing technical details for bid invitation to purchase materials and equipment. Project construciton works will be carried out in the next 5 years after bidding.

PEA's Power Distribution Project

1. Project name : Distribution System Dispatching Center Project

2. Project description

At present, there are 12 distribution system dispatching centers each at PEA's 12 regional offices. The communication equipments used to propagate information among the head office and regional offices are radios operating at different frequencies such as VHF, UHF and SSB. PEA's distribution systems have been expanding and become more and more complicated. It is apparent that the current control system will not be sufficient for the future situation. Therefore, PEA has considered installing 13 additional distribution system dispatching centers throughout the country, one at the head office and one at each of the 12 regional offices. However, only 2 centers will be initially installed as a pilot project, one at the Central Electric Administration Area 1 (Ayutthaya) and the other at the Central Electric Administration Area 3 (Nakhon Pathom). The installation of equipment for distribution system dispatching control will be on a turnkey basis. The contractor will also provide PEA's staff with recommendations and training regarding installation and preventive maintenance of the equipment. The construction, expansion and modernization of the control buildings as well as the additional installation of protective equipment in the distribution systems will be carried out by PEA.

3. Project cost (Million Baht)

Investment cost of the pilot project totals 110 million Baht. Foreign loan will amount to 70 million while local currency is 40 million. The local investment will be co-financed by the Ministry of Finance and PEA.

4. Tentative schedule

The period during 1985 - 1987 is for assistance seeking, data acquisition, interim activities and feasibility study. Period during 1988 - 1990 will be for pilot project implementation. The rest will be undertaken after the completion of post evaluation of the pilot project.

PEA's Power Distribution Project

1. Project name : Village Electrification Project Phase III

2. Project description

This stage is the 3rd one of the similar work done earlier. It is aimed to provide electricity supply to another 3,000 villages not included in other PEA undergoing projects. These villages are located in 37 provinces througout the country. The first priority has been given to villages in the northeastern region where the number of unelectrified villages is the highest. There are 14 provinces in the northern region, 17 provinces in the northeastern region and 6 provinces in the central region in this 3rd stage development. The construction work consists of:

H.T. distribution line	6,000 circuit-km
L.T. distribution line	7,200 circuit-km
Transformers	110,000 kVA
Meters	180,000 sets

3. Project status

The feasibility study has been completed and submitted to the concerned agencies since 17th November, 1986. The project was approved by PEA's Board of Directors on 27th January, 1986.

4. Project cost (Million Baht)

Foreign currency	1,249
Local currency	345
PEA revenues	520
Total	2,114

5. Tentative schedule

Project is scheduled to be implemented during 1988 - 1991. The first year will be spent for preliminary activities on survey, design, map drafting, procurement of materials, equipment and vehicles, resource preparation and construction planning. Construciton works will be carried out in the remaining 3 years of the period.

PEA's Power Distribution Project

1. Project name : Normal Rural Electrification Project, Phase II

2. Project description

PEA has already executed the Normal Rural Electrification Project, Phase I during the 5th NESDP. The 2nd phase project is the continuation of Phase I and will be implemented under the 6th NESDP. The project is aimed to provide electricity supply upon requests to 2,000 unelectrified villages and another 2000 partly electrified villages. In priciple, villagers under this project have to contribute electric poles, cross-arms and half of the labour which is aproximately 30 % of the total investment altogether. PEA provides conductors, insulators, transformers and accessories which is approximately 70 % of the total investment. This project requires the following components:

H.T. distribution line	4,400 circuit-km
L.T. distribution line	7,000 circuit-km
Transformers	84,000 kVA
Meters	170,000 sets

3. Project status

Post evaluation of the first stage has already been carried out. Its result will be used as a guideline for the feasibility study of this project which will be accomplished by 1987.

4. Project cost (Million Baht)

Foreign currency	877
Local currency	160
Local contribution	503
Total	1,540

5. Tentative schedule

The project is scheduled to be implemented during 1987 - 1991. The first year will be spent for the preparation of materials, equipment, instrument and vehicles as well as resources and construction planning. Construction work will be performed in the next remaining 4 years of the period.

PEA's Power Distribution Project

1. Project name : Village Electrification in Tungkularonghai Project

2. Project description

Tungkularonghai is an extremely arid region in the northeast of the country. There is not enough rainfall to support vegetation. The villagers are lacking in the fundamental necessities of life, resulting in lower income and lower standard of living than the other regions of Thailand. Tungkularonghai is composed of 10 districts connecting together the provinces of Roi Et, Yasothon, Surin, Si Sa Ket and Maha Sarakham. This project is, therefore, expected to upgrade the standard of living and increase the earning of the villagers in Tungkularonghai area in accordance with the national rural development plan. The total number of villages covered by the project is 300. The major components of equipment and materials are:

H.T. distribution line	800 circuit-km
L.T. distribution line	600 circuit-km
Transformers	10,000 kVA
Meters	23,000 sets

3. Project status

Forty-four villages in Tungkularonghai were electrified in 1987 with financial support from the government.

4. Project cost (Million Baht)

The project will be financed with the government budget approximately 36 million Baht yearly, totalling 180 million for the whole project.

5. Tentative schedule

The project is scheduled to be implemented during 1987 - 1991. In 1987, 44 villages are already provided with electricity. In the remaining period, 64 villages will be served each year.

4.2.3 Power Generation Project

At present, PEA can not produce an immense electricity supply by itself. Only 0.2 % of the total distribution was generated by PEA's own diesel power plants in 1986. The main source is EGAT from which PEA purchased electricity approximately 99.6 % of the total distribution in the fiscal year 1986, while the remaining 0.2 % was bought from the NEA.

Although PEA takes most of the electricity from EGAT, the Authority still has to depend also on its own diesel power plants by using EGAT's facilities whenever the new connections or expanded facilities are made available. However, it is the PEA's policy to renounce these plants. During 1986 PEA could reduce its diesel power plants throughout Thailand to 28, a reduction of 9 plants or 24.3 % from 1985. These existing small plants are capable of supplying a total of 29.1 MW and their 1986 production amounted to 24.8 million kWh or 0.2 % of total energy generated and purchased.

In 1986, PEA purchased from EGAT 10,190.3 million kWh of electricity with a demand of 2,078.0 MW, an energy increase of 799.3 million kWh or 8.5 % and its demand on the EGAT system increased by 160.4 MW or 8.4 % over 1985.

At present time, PEA puts much effort on setting up some pilot projects on generating electric power by using renewable energy sources. The projects on constructing the Mini Hydro Electric Generating Plants at Mae Tien in Sun Pa Tong District and at Mae Chai in Phang District, Chiang Mai Province were entering into the construction period.

In 1986, three stations of the Solar Power Plant Project were set up in Tak, Nakhon Sawan and Nakhon Ratchasima Provinces. The Wind Power Plant Project and the Submarine Cable Project were under the feasibility study stage during 1986. the latter is under construciton since mid 1987.

There are two power generation projects contained in the power development program of PEA during the 6th NESDP. One of them is a mini hydro project which consists of 10 individual mini hydro power plants to be located in the northern regions of the country. The other project is the wind power plant rated 100 MW to be installed at Pha-ngan Island, on the southern province of Surat Thani. Details of these two projects are as follows:

PEA's Power Generation Project

1. Project name : Mini Hydro Project

2. Project description

This project consists of 10 individual mini hydropower plants with a total capacity of 8,275 kW. The project is financially sponsored by four sources of fund as follows:

a) 3 plants by the assistance of the Government of the United Kingdom.

-Mae Ya Project located at Chomthong District, Chanig Mai Province. Capacity 1,000 kW.

-Mae Pai Project located at Mae Pai District, Mae Hong Son Province. Capacity 2,000 kW.

-Mae Toey Project located at Om Koi District, Chiang Mai Province. Capacity 2,000 kW.

b) 5 Plants by the Royal Project under His Majesty the King's Patronage

-Ban Pang Ung Project located at Mae Cham District, Chiang Mai Province. Capacity 75 kW.

-Ban Hak Mai Tai Project located at Mae La Noi District, Mae Hong Son Province. Capacity 50 kW.

-Ban Dong Project located at Mae La Noi District, Mae Hong Son Province. Capacity 10 kW.

-Ban Koon Pae Project located at Chomthong District, Chiang Mai Province. Capacity 100 kW.

-Ban Kae Noi Project located at Chiangdao District, Chiang Mai Province. Capacity 40 kW.

c) 1 plant by the assistance of the Government of Belgium

-Nam Mae Cham Project located at Mae Cham District, Chiang Mai Province.

d) 1 plant by the assistance of the Government of Norway

-Mae Tien Hydropower Plant Unit 2 located at Sanpatong District, Chiang Mai Province.

The distribution system expansion associated with the mini hydro project consists of:

-H.T. distribution line	500 circuit-km
-L.T. distribution line	300 circuit-km
-Transformers	4,000 kVA

3. Project status

Construction of the 3 plants under the sponsorship of the Government of the United Kingdom was approved by the cabinet on July 22, 1986. The design of the plants is now being performed.

Construction of the 5 plants by the assistance of the Royal Project under H.M. the King's patronage was approved in principle by the Office of the Coordinating Committee of Royal Development Project (OCRD) in 1985 and it is expected to receive the budget from OCRD in 1987.

The construction of the plant under the sponsorship of the Government of Belgium is under the consideration of the Government of Belgium and is expected to be approved by 1987.

The construction of the plant by the assistance of the Government of Norway is under consideration and the work is expected to get started in 1987.

4. Project cost (Million Baht)

Foreign currency	200
United Kingdom	100
Norway and Belgium	100
Local currency	272
Ministry of Finance	260
OCRD	12
Total	472

5. Tentative schedule

The project is scheduled to be implemented during 1987 - 1991.

PEA's Power Generation Project

1. Project name : Wind Energy Project

2. Project description

The project is a wind power plant rated 100 kW to be located on Pha-ngan Island in Surat Thani Province to provide electricity in parallel with the PEA's existing diesel power plants to customers on the island as a pilot project to transform renewable energy locally available to electric energy for the villages not suitable to be connected to the main grid. The project consists of the construction of one wind power plant and H.T. distribution line of 10 circuit-km.

3. Project status

The project is currently under consideration of the Government of the Federal Republic of Germany to provide assistance to PEA.

4. Project cost (Million Baht)

Foreign currency	5
Local currency	5
Total	10

5. Tentative schedule

The project is scheduled to be implemented during 1987 - 1988. The survey, design, specification preparation and bidding commitment will be caried out in the first year. The construction work will be in the second year.

5. MEA's Power Transmission and Distribution

5.1 Background

The Metropolitan Electricity Authority (MEA) was established on August 1, 1958 as a state enterprise following the promulgation of the Metropolitan Electricity Authority Act B.E. 2501. According to this Act, the agency is responsible for distributing electricity within its service area covering Bangkok Metropolis, Nonthaburi and Samut Prakarn Provinces. The electricity so distributed is transmitted to MEA by EGAT.

MEA has already launched 5 series of the Power Distribution System Improvement and Expansion Program, each with a 5-year implementation period, which were formulated in line with the National Economic and Social Development Plan. The sixth plan which will be effective from fiscal years 1987 to 1991 is, therefore, the continuation of the fifth plan which is aimed firstly to satisfy the increasing demand, secondly to justify the financial capability of MEA and finally to suit the prevailing economic and social conditions. The objectives, policy, scope and implementation of the sixth plan are as the followings:

5.1.1 Objectives

1. To improve and expand MEA's power distribution system to be able to cope with the power demand which is forecasted to have an average growth rate of 5.52 % per annum during fiscal years 1987 - 1991. To render effective, punctual and good quality services to the public, business, industry and services alike.

2. To expand the power utility services to people of all walks of life both in the urban and suburban service areas of MEA.

3. To limit the investment cost to that which is actually required.

5.1.2 Policy

To meet the above-mentioned objectives, MEA has set a series of policy as follows:

1. To construct good quality, reliable and safe power distribution system to serve both existing and new customers.

2. To promote investment atmostphere for industrial investors by the construction of power facilities to ensure its availability. At the same time, with adequate and reliable power supply, investors may get interested in investing more in their businesses.

3. To improve power system reliability and at the same time to utilize the system to its maximum capacity.

4. To cooperate with other public agencies in order that action, investment and manpower planning be coordinately made and systematically related to the national economic and social policies.

5. To rehabilitate the power distribution systems in certain areas that need higher reliability of supply and more aesthetic environment by replacing the overhead lines with underground cables.

6. To extend distribution service to MEA's suburban service area in order to persuade those people to use electricity for their living as well as to boost the production of agricultural sector, aqua-cultural sector and livestock.

7. To utilize planning and management technologies in order that the sixth plan is effectively laid down, economically planned and technically sound. The management technique will monitor the project management to attain the goal.

5.1.3 Scope

The scope of the sixth Power Distribution System Improvement and Expansion Plan is, firstly, to construct and install distribution facilities to improve and expand the power distribution system as required during the fiscal years 1987 - 1991 at every utilization voltage level and , secondly, to study the existing researched and developed technical innovations in order to further employ them in MEA distribution system where applicable.

The scope of the sixth plan can be divided into 5 programmes as follows:

1) Transmission and distribution substation system program which consists of the following works:

- o Construction of new 230-69 kV transmission substation
- o Addition of existing transmission substation
- o Construction of new 115 and 69 kV distribution substations
- o Addition of existing distribution substations
- o Aquisition of lands

2) Subtransmission line system program which consists of the following works:

- o Construction of 115 and 69 kV overhead lines
- o Construction of 115 and 69 kV underground cables

3) Distribution system program which consists of the following works:

- o Construction of 12 and 24 kV primary lines
- o Construction of 416/240 V secondary lines
- o Installation of 12 and 24 kV distribution transformers at various sizes
- o Installation of new and replacement of old revenue meters
- o Installation of capacitors at various voltage levels

4) Procurement of construction equipment, vehicles, tools and testing equipment program which consists of the following items:

- o Procurement of construction equipment for construction and installation of power distribution facilities.
- o Procurement of vehicles for power distribution services.
- o Procurement of tools and testing equipment.

5) Research and development program which constists of the following:

- o Digital mapping system
- o Transformer load management

5.1.4 Implementation

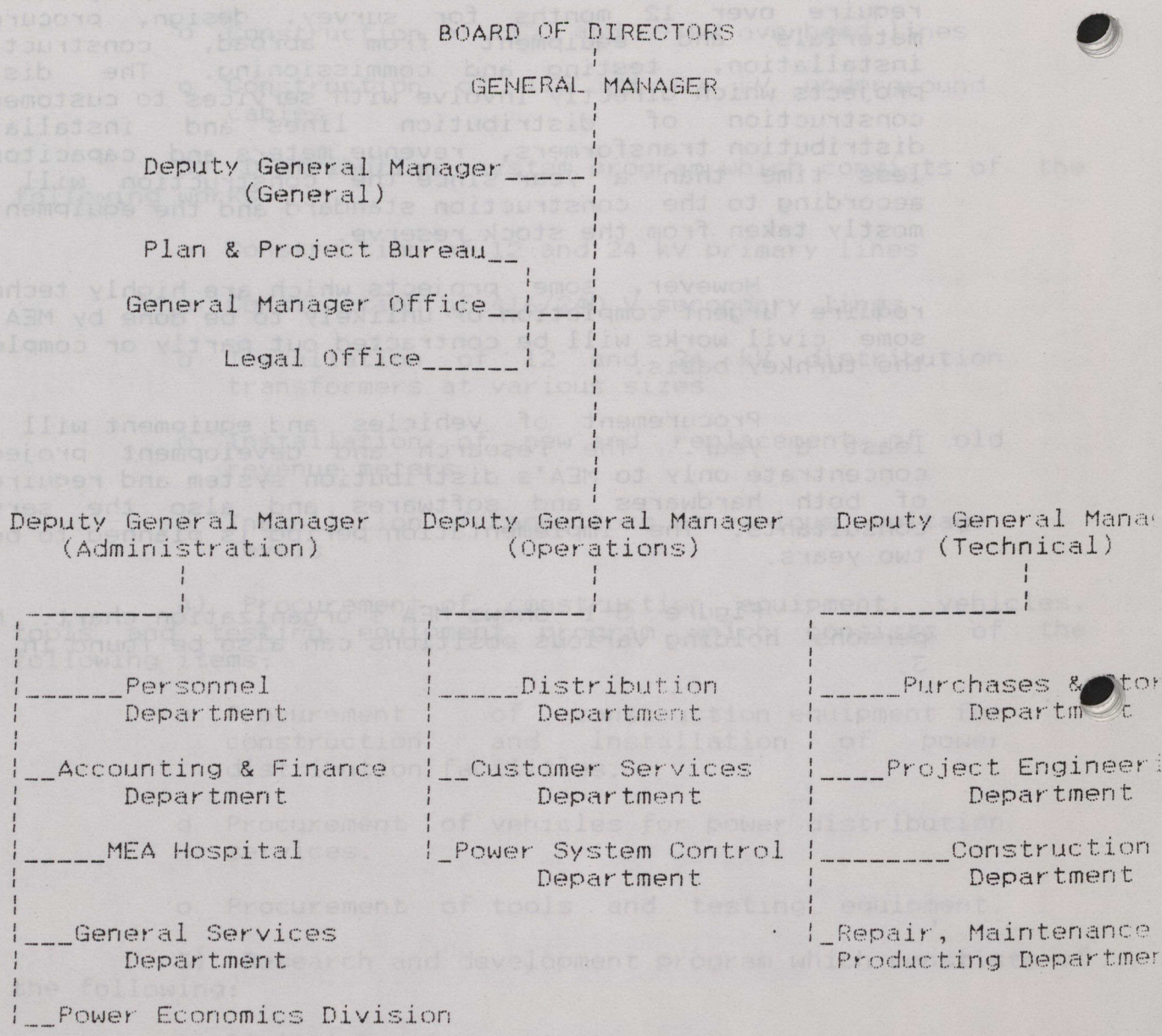
Substation and subtransmission line projects normally require over 12 months for survey, design, procurement of materials and equipment from abroad, construction and installation, testing and commissioning. The distribution projects which directly involve with services to customers; i.e., construction of distribution lines and installation of distribution transformers, revenue meters and capacitors, take less time than a year since the construction will be done according to the construction standard and the equipment will be mostly taken from the stock reserve.

However, some projects which are highly technical or require urgent completion or unlikely to be done by MEA such as some civil works will be contracted out partly or completely on the turnkey basis.

Procurement of vehicles and equipment will take at least a year. The research and development projects will concentrate only to MEA's distribution system and require the use of both hardwares and softwares and also the service of consultants. The implementation period is planned to be within two years.

Figure 5-1 shows MEA's organization chart. Names of persons holding various positions can also be found in Appendix 3.

FIGURE 5-1 MEA'S ORGANIZATION CHART



5.2 Details on MEA'S Future Projects

The future projects under the 6th NESDP can be grouped into 5 categories as follows:

Category 1 - Substation
Category 2 - Subtransmission Line
Category 3 - Distribution
Category 4 - Vehicle & Equipment
Category 5 - Research & Development

Each category consists of serveral projects. Every project will be given a group of numbers. The first two numbers represent the year of project completion, while the third belongs to the category and the last two numbers are the running number. The investment figures which are enclosed in parentheses are those of the on-going projects from the 5th NESDP.

Details of each project together with the project component, the associated investment cost in both foreign and local currency for each year are tabulated in the following pages (See Appendix 4 for more details) :

MEA's Future Project

Project No.	Project Name	Project Cost Required		
		FC	LC	Total
	CATEGORY I-SUBSTATION (Details of substation equipments are shown in Appendix 5)			
			(28.08)	(112.8)
87.1	Substation 1987	(87.75)	119.29	119.29
			(13.47)	(57.91)
88.1	Substation 1988	(44.44)	15.30	15.30
89.1	Substation 1989	219.16	131.99	351.15
90.1	Substation 1990	96.04	61.06	157.10
91.1	Substation 1991	187.71	141.29	329.00
		(129.2)	(41.55)	(170.7)
	Subtotal I-Substation	502.92	468.92	971.84
	Contingency	15.09	14.07	29.15
	Price Escalation	166.71	83.31	250.02
		(129.2)	(41.55)	(170.7)
	Total I-Substation	684.71	566.30	1251.01
	CATEGORY II-SUBTRANSMISSION LINE			
			(1.9)	(6.1)
87.2	Subtransmission Line 1987	(4.2)	6.65	6.65
			(2.1)	(9.7)
88.2	Subtransmission Line 1988	(7.6)	19.18	19.18
89.2	Subtransmission Line 1989	24.60	64.18	88.78
90.2	Subtransmission Line 1990	44.72	115.98	160.70
91.2	Subtransmission Line 1991	57.72	143.54	201.26
		(11.8)	(4.0)	(15.8)
	Subtotal II-Subtransmission	127.05	349.52	476.57
	Contingency	3.81	10.48	14.29
	Price Escalation	46.19	59.25	105.44
		(11.8)	(4.0)	(15.8)
	Total II-Subtransmission	177.05	419.26	596.31

MEA's Future Project

Project No.	Project Name	Project Cost Required		
		FC	LC	Total
	CATEGORY III-DISTRIBUTION		(93.7)	(350.4)
87.3	Distribution 1987	(256.7)	344.12	344.12
			(84.8)	(321.3)
88.3	Distribution 1988	(236.5)	362.59	362.59
89.3	Distribution 1989	266.92	421.16	648.08
90.3	Distribution 1990	211.93	383.52	595.45
91.3	Distribution 1991	221.22	406.24	627.46
		(493.2)	(178.6)	(671.8)
	Subtotal III-Distribution	660.07	1917.6	2577.7
	Contingency	19.80	57.53	77.33
	Price Escalation	280.89	209.12	570.01
		(493.2)	(178.6)	(671.8)
	Total III-Distribution	960.76	2264.3	3225.1
	CATEGORY IV-VEHICLE TOOL AND TESTING EQUIPMENT			
89.4	Vehicle and Equipment 1989	45.14	39.80	84.94
90.4	Vehicle and Equipment 1990	11.69	9.84	21.53
91.4	Vehicle and Equipment 1991	19.65	14.22	33.87
	Subtotal IV-Vehicle& Equipment	76.47	63.87	140.34
	Contingency	2.29	1.92	4.21
	Price Escalation	23.69	13.49	37.18
	Total IV-Vehicle & Equipment	102.46	79.27	181.73
	CATEGORY V-RESEARCH&DEVELOPMENT			
88.5	Research & Development 1988	-	10.00	10.00
91.5	Research & Development 1991	33.98	31.76	65.74

MEA's Future Project

Project No.	Project Name	Project Cost Required		
		FC	LC	Total
	Subtotal V-Reaesrch&Development	33.98	41.76	75.74
	Contingency	1.02	1.25	2.27
	Price Escalation	10.77	8.13	18.90
	Total V-Research & Development	45.77	51.14	96.91
	TOTAL COST REQUIRED FOR THE SIXTH FICE-YEAR PLAN	(634.3)	(224.2)	(858.5)
A.	Subtotal 1987-1991	1400.5	2841.7	4242.2
B.	Contingency	42.02	85.25	127.27
C.	Price Escalation	528.25	453.29	981.54
D.	Grand Total	1970.7	3380.3	5351.0

6. Competition

For most of EGAT's projects, suppliers from Japan, Germany, France, U.K. and USA have been dominating the market, with the Japanese controlling more than 60 per cent of the market share. A list of Canada's potential competitors is being displayed below. They are suppliers who were awarded contracts in EGAT's previous thermal and hydro electric projects.

Manufacturers of Major Component Parts
EGAT's Power Plants

	Boiler	Generator	Turbine
Thermal Plant			
1. North Bangkok	Babcock-Wilcox	Westinghouse	Westinghouse
2. South Bangkok	Mitsubishi	Mitsubishi	Mitsubishi
3. Mae Moh # 1-3	Babcock-Wilcox	ELIN	FRANCO TOSI
4. Mae Moh # 4-7	CEMAR	Fuji	Fuji
5. Mae Moh # 8-9	C-E Canada Power Systems	Fuji	Fuji
6. Krabi	Waag Ner Biro	ELIN	ELIN
7. Bang Pakong Thermal	Mitsubishi	Fuji	Mitsubishi
8. Bang Pakong Combined Cycle	KWU	KWU	KWU
9. Khanom Barge # 1	Mitsui	Toshiba	Toshiba
10. Khanom Barge # 2	C-E Canada Power Systems	ALSTHOM	ALSTHOM
11. Surat Thani	Waag Ner Biro	ELIN	AEG-KANIS
Hydro Plant			
1. Bhumibol # 1-6		AEG	Hitachi
2. Bhumibol # 7		BHEL	Hitachi
3. Sirikit		Mitsubishi	Mitsubishi
4. Mae Ngat		Fuji	Fuji
5. Bang Lang		Dolmel Wroclaw	BHEL
6. Rajjaprabha		Toshiba	Fuji
7. Kaeng Krachan		Fuji	Fuji
8. Khao Laem		Hitachi	Hitachi
9. Srinagarind # 1-3		Hitachi	Mitsubishi
10. Sirnagarind # 4		Mitsubishi	Mitsubishi
11. Ubolratana		AEG	Ehcher Wyss
12. Sirindhorn		Meidensha	Toshiba
13. Chulabhorn		Toshiba	Fuji
14. Nam Pung		Meidensha	EBARA
15. Huai Kum		EBARA	EBARA
16. Ban Khun Klang	Fujian Nan Ping Electric Machinery Work		
17. Ban Santi		EBARA	EBARA
18. Tha Thung Na		Hitachi	Hitachi

Potential competitors at PEA and MEA are relatively smaller in size. The Japanese are only able to capture less than 50 per cent market share in these two organizations. The Korean, Taiwanese, French, Italian, and new comers from the Eastern Bloc countries share the other half of the cake with a number of experienced local manufacturers.

7. Procurement

Procurement in all Thai government agencies are generally done through bidding. There are several forms of procurement methods or biddings, mainly determined by the size or total value of the procurement package and the source of financing. Procurement methods could be classified in to

1. Local procurement
2. Foreign procurement

7.1 Local procurement

It is normally stipulated in the terms and conditions for local procurement that only local companies are eligible to participate in the bidding. Local companies is defined as company which is registered with the Ministry of Commerce under the Thai Business Act and has its domicile in the Kingdom of Thailand. Goods and services procured under this method can either be available locally or imported. However, fund for the procurement will be from local sources only, such as from the government's budget, or from the agency's own revenue. Therefore, all price quoted must be in local currency, the Thai Baht. All correspondence and documents are written in Thai Language. Local procurement is again divided into "price enquiry" and "bidding", depending on the size or value of the total package.

7.1.1 Price enquiry is normally for goods and services that do not exceeds a budget of Baht 800,000. It is normally carried out in the form of closed bidding. At least three companies will be contacted by the agency for price enquiry. There is no fixed date and time for submission of quotation nor official announcement of the result. Purchase order will go to the company which offers the lowest price. No bid bond or performance bond is required in this kind of procurement.

7.1.2 Bidding normally involves procurement which exceeds Baht 800,000. Bid invitation will be announced at least 15 days prior to the closing date. Bidding results would be made known to the bidders one to two hours after the closing time. For the results to be valid, there must be at least three bidders participating in the bid. In this kind of procurement, a bid bond has to be submitted with the bid and a performance bond submitted upon being awarded the contract.

7.2 Foreign procurement

There are many large turnkey projects which require sophisticated technical know how and/or high investment. As Thailand is a developing country, it is impossible for the government to shoulder all the financing required in these investment project. These executing agencies then turn to overseas sources of financing, i.e., ADB, IBRD, export credits from the suppliers country, etc. These financial institutions would normally set forth conditions that procurement should be in the form of international competitive bidding (ICB). Therefore, in projects which are financed by foreign loans, foreign companies as well as local companies are eligible to participate in the bidding. Invitations to ICB are announced in local Thai and English newspapers at least three months before the closing date. Bidder is allowed to quote either in Thai Baht, bidder's own currency or currencies of the countries supplying the goods. Bid offer must be accompanied by a bid bond equivalent to at least five or ten per cent of the bid, which ever stipulated in the bid conditions. Bid results would normally be announced one hour after the closing time. However, it may take the agency three to four months to complete bid evaluation and officially announce the name of successful bidder.

Recommendation for bid preparation.

It is recommended that bidder should adhere to both the commercial terms and technical specifications given in the bidding document. If the bidder has any offers that deviate from the main specification, be it more beneficial to the executing agency technicalwise or costwise, they should only be proposed as alternative offers. The main offer should always be in accordance with requirements stipulated in the bidding document. Bidder should also be precise in answering the various commercial and technical questions, irrelevant or supporting information could be included in the appendix part of the document.

Normally, local agent would play a vital role in assisting and advising the bidder in document preparation, by liaising with the executing agency or with its long accumulated experience. In case of any doubt, clarification should be seek from the executing agency. A deficiency free bidding proposal will always place the bidder in a more favorable position if his offer price is in par with the others.

8. Recommendation

8.1 Doing Business in Thailand

The basic rules of success in doing business in Thailand are to plan one's marketing strategy on a long term basis and to be present in the country as frequently as possible. This can very well be demonstrated by the success in this market of most Japanese companies and some European companies.

It is not uncommon in Thailand for a process of project feasibility study, specification drafting or tender document preparation and tender issuance to take 4 to 5 years to complete. Getting in touch with the executing agency in the early stage provides a company the advantages of

a) Being able to obtain first hand information of the project for the company's planning purpose and

b) Being able to influence the tender specification so that it places the company in a more favourable position or the competitors in less favourable position. Visiting the clients frequently gives an impression that the company is really enthusiatic to do business with them.

Frequent visit of a company also implies that it will provide strong marketing support to the local agent and good aftersales service to the client.

8.2 Forms of Business Structure

As Canada is half the world away from Thailand, it is almost impossible for a Canadian company to efficiently and economically monitor the market development from its home-base. In this regard, the company may consider adopting one of the following approaches

A) Setting up its own representative office

B) Establishing its own branch office

C) Appointing a local company as agent or representative

D) Forming joint-venture with a local company

A) Representative Office. Under Thai Business Act, this form of business is not allowed to perform any direct business transaction in Thailand. Its role would be mainly to support its headquarters' activities in Thailand by acting as a liaison between its headquarters and clients.

B) Branch Office. The company would be able to carry out in Thailand full business activities of its headquarters. This form of business is desirable only when headquarters wishes to retain its identity and have full control of the company's policy. However, under Thai Business Act, headquarters has to be fully responsible for any liability that occurs as a result of its branch office's operation in Thailand. And as a branch office is normally 100 per cent foreign owned, it is not being considered as a Thai business entity and, therefore, its business access may be restricted in some sectors of the economy under the Alien Business Act.

C) Local Agent. Canadian company should go through careful study of several potential agents before selecting one, taking into consideration its market knowledge and experience, technical capability and financial strength. A Canadian company will have the least involvement and risk in this form of representation. However, it is recommended that a representative from the company should visit the agent and its clients at least once or twice a year.

D) Joint-Venture. This form of business should be considered when there is already a large market for the company's products. A joint-venture may also be set up in anticipation of a coming project; i.e.,to vie for a power plant construction project. A Canadian company has to be more careful in selecting its joint-venture partner than in selecting a local agent as in joint-venture, equity participation is involved. A good local partner will bring along to the joint-venture its market knowledge, valuable contacts in both the private and public sectors and poiltical infulences, if there are any.

8.3 Opportunities for Canadian Companies

Opportunities for Canadian products and technologies exist in the areas where local manufacturers lack knowledge and experiences. Manufacturers in Thailand are able to supply various kinds of basic electrical equipment required in the low to high voltage installations; i.e., insulators, hardwares, transformers up to 20 MVA, aluminum conductors, transmission line towers etc. There are also approximately 10 local civil, mechanical, and electrical engineering companies that are capable of undertaking large projects either independently or in joint-venture with foreign counterparts.

Opportunities for Canadian companies, therefore, would possibly be in the areas involving hi-tech manufacturing process and sophisticated engineering expertise; i.e.,

power plant simulator,
dispatching center,
high voltage direct current transmission,
extra / ultra high voltage(EHV/UHV) transmission,
turnkey thermal power plant,
EHV substation and switchyard,
control and measuring instrument,
communication and telecommunication equipment,
etc.

In the service sector, Canadian consultants may find opportunities in the areas of power system efficiency improvement, management informaion system which involve computer software development, power plant waste management, system reliability improvement, personnel training, etc.

In conclusion, the Electricity Generating Authority of Thailand (EGAT) is the largest potential client of Canadian suppliers in the power generation and transmission sectors. EGAT has to carry on its mandate to develop new power generation projects to meet the rapidly growing power demand which is a result of the country's flourishing economy. Projects on the development plans of Provincial Electricity Authority's (PEA) and Metropolitan Electricity Authority's (MEA) mainly concentrate on improvement and maintenance of the existing systems. Therefore, opportunities for Canadian suppliers at both PEA and MEA are rather limited.

APPENDIX I

EGAT'S EXECUTIVES

- General Manager
  Paopat Javanalikikorn

- Deputy General Manager (Administration)
  Prayura Chanleudfa

- Deputy General Manager (Account & Finance)
  Jujit Kambhu

- Deputy General Manager (Transmission System Operation)
  Somboon Maneenava

- Deputy General Manager (Power Plant Operation)
  Bhallobh Krairiksh

- Deputy General Manager (Hydro Power & Transmission System
  Srid Aphaiphuminart Development)

- Deputy General Manager (Thermal Power & Mine Development)
  Charmon Suthipongchai

- Assistant General Manager (Service)
  Swarng Champa

- Assistant General Manager (Personnel)
  Yongyuth Boonyapraphatsara

- Assistant General Manager (Account & Finance)
  Nongkran Chandhanayingyong

- Assistant General Manager (Transmission System Maintenance)
  Vilas Utaichai

- Assistant General Manager (Transmission System Operation)
  Somvonk Poshyananda

- Assistant General Manager (Power Plant Maintenance)
  Charnchai Tipayachant

- Assistant General Manager (Power Plant Operation)
  Amporn Pongpricha

- Assistant General Manager (Transmission System Development)
  Bhisit Anantasanta

- Assistant General Manager (Hydro Power Development)
  Sommart Boonpirugsa

- Assistant General Manager (Thermal Power Development)
  Preecha Chungwatana

- Assistant General Manager (Mine Development)
  Prasert Chumroum

- Director, General Service Department
  Visuitt Janlekha

- Director, Procurement Department
  Prasit Srivichit

- Director, Supply Department
  Pisuitt Suppetpisal

- Director, Transportation Department
  Charung Osothsongkroh

- Director, Personnel Department
  Somkuan Wattakeekul

- Director, Trainning Department
  Supasee Kamolyabutra

- Director, Safety Control Department
  Payong Ekarat

- Director, Medical and Health Department
  Manus Prabhas-sornkul

- Director, Security Control Office Department

- Director, Budget Department
  Boonraum Arevongse

- Director, Treasury Department
  Pimolsri Siripaiboon

- Director, Controller Department
  Boonchoo Direksathapon

- Director, System and Procedure Department
  Vitoon Skonthawat

- Director, Transmission System Maintenance Department
  Prasart Prayachkapan

- Director, Communication System Department
  Tavorn Oongramol

- Director, Civil Maintenance Department
  Kittivatana Sutcharitphong

- Superintendant, Region 1
  Waravat Navarat

- Superintendant, Region 2
  Supol Aue-a-nanta

- Superintendant, Region 3
  Uthit Sunthornpradit

- Superintendant, Region 4
  Pratuan Soonprasert

- Director, System Operation Department
  Siriwadh Sribhibhadh

- Director, Efficiency Control Department
  Archamphon Khampanonda

- Director, Chemical and Analysis Department
  Manod Punthayangkool

- Director, Mechanical Maintenance Department
  Yeen Vajaragupta

- Director, Electrical Maintenance Department
  Swasdi Phadungchan

- Superintendant, Bhumibol Dam
  Sarerng Makarasara

- Superintendant, Sirikit Dam
  Anukul Mingvimol

- Superintendant, Srinagarind Dam
  Viravatna Chlayon

- Superintendant, Khao Laem Dam
  Kamnuan Hiranmas

- Superintendant, Rajjaprabha Dam
  Khangkan Viriyasiri

- Superintendant, North Bangkok Thermal Plant
  Vichien Viraphanish

- Superintendant, South Bangkok Thermal Plant
  Boonsong Pokhatong

- Superintendant, Mae Moh Thermal Plant
  Sujin Wangpaiboon

- Superintendant, Bang Pakong Thermal Plant
  Narong Wongpaiboon

- Director, Transmission System Engineering Department
  Kraidej Ansusinka
- Director, Transmission System Construction Department
  Chalee Mallikamas
- Director, Hydro Power Engineering Department
  Taweesak Mahasandana
- Director, Hydro Power Construction Department
  Obhas Chanpayom
- Director, Thermal Power Engineering Department
  Khien Vongsuriya
- Director, Thermal Power Construction Department
  Piroj Pochanart
- Director, General Construction Department
  Chulawat Shenakul
- Director, Mine Engineering Department
  Thongjati Sopondisya
- Director, Mine Operation Department
  Boonchai Jiwalai
- Director, Legal Department
  Pancha Piemphongsarn
- Director, Internal Audit Department
  Pilai Piemphongsarn
- Director, Economic Policy Department
  Viroj Nopakun
- Director, Systems Planning Department
  Somkiet Phaloprakarn
- Director, Coporate Planning Office
- Director, Public Relations Department
  Subhin Panyamag
- Director, Research and Development Office
  Archamphon Khampanonda

APPENDIX II

PEA'S EXECUTIVES

- General Manager
  Dr. Vira Pitrachat

- Deputy General Manager (General Affairs)
  Mr. Sawasd Puipunthavong

- Assistant General Manager (General Affairs)
  Mr. Sombat Wiengkaew

- Deputy General Manager (Economics & Finance)
  Mr. Pravit Vetcho

- Assistant General Manager
  Mr. Damrong Damrianant

- Deputy General Manager (Operations)
  Lt. Col. Aroon Kaewsonthi

- Assistant General Manager
  Dr. Chulapongs Chullakesa

- Deputy General Manager (Technique)
  Mr. Surasukdi Senavongse

- Assistant General Manager
  Sub. Lt. Sunandh Chaowanapreecha

- Deputy General Manager (Planning & Development)
  Mr. Sakol Wongbuddha

- Assistant General Manager
  Mr. Sunthorn Tanthavorn

- Manager Auditing Office
  Mr. Virul Puvakul

- Manager Office of General Manager
  Mr. shaibol punya

- Manager Personnel Department
  Mr. Vinai Jamikorn

- Manager Administration Department
  Mr. Vibul Charupas

- Manager procurement & Transportation Department
  Miss Orawan Kochananda

- Manager Economics and Budget Department
  Sub. Lt. Arun Wangsuke

- Manager Accounting and Finance Department
  Mr. Kriengsakdi Kantarugsa

- Manager Maintenance Department
  Mr. Pracha Thitathan

- Manager Construction Department
  Sub. Lt. Archin Jotisalikorn RTN

- Manager Engineering Department
  Mr. Chutharat Leerabhandh

- Manager Service Department
  Mr. Chalor Adhibai

- Manager Civil Engineering & Architecture Department
  Mr. Manop Chaiyakam

- Manager Planning Department
  Mr. Thanu Chinkrua

- Manager Development Department
  Mr. Phlavut Javanayothin

- Manager Office of Rural Electrification
  Mr. Vibulya Kuhirun

APPENDIX III

MEA'S EXECUTIVES

- General Manager
  Dr. Anan Atialksana

- Deputy General Manager (Technical and Planning)
  Mr. Bongsnid Snidvongs

- Deputy General Manager (Administration)
  Mr. Boontip Krisnaphakdi

- Deputy General Manager (Operations)
  Mr. Kasem Kularbkeo

- Deputy General Manager (Service)
  Sub.Lt. Bhodhi Imchitt

- Director of Property and Internal Service Dept.
  Mr. Saeri Limpiti

- Director of Plan and Project Dept.
  Mr. Precha Pramkhich

- Director of Engineering Dept.
  Dr. Thongtaj Hongladarom

- Director of Purchases and Stores Dept.
  Mr. Wanawit Thammawanich

- Director of Power Economics Dept.
  Mr. Namchoak Rangsiyawat

- Director of Power System Control Dept.
  Mr. Thongchai Chaiyanil

- Director of Power System Maintenance Dept.
  Mr. Sombun Khaowsam-ang

- Director of Construction Dept.
  Mr. Phayap Thong U-thai

- Director of Map and Distribution Equipment Dept.
  Mr. Sudhi Sudhiprakarn

- Director of Commercial Dept.
  Mr. Snid Ratananakhintr

- Director of Wat Liab District Office
  Mr. Vichit Poopradit

- Director of Bang Kapi District Office
  Mr. Manochya Chiraphso

- Director of Khlong Toei District office
  Mr. Supan Sa-nguanpan

- Director of Yan Nawa District office
  Mr. Vinai Piaptanakul

- Director of Samut Prakarn District office
  Mr. Sombhorn Bamrungruk

- Director of Samsen District office
  Mr. Somyoh Chantaraskul

- Director of Thon Buri District office
  Mr. Thawaj Dumrongsiri

- Director of Rat Burana District office
  Mr. Amphol Wongcharoen

- Director of Nonta Buri District office
  Mr. Thawil Klangsin

- Director of Bang Yai District office
  Mr. Dumrong Tiranarat

- Director of Min Buri District office
  Mr. Vicharn Narupiti

APPENDIX IV

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht)		
		FC	LC	Total
87.1.01	Construction of Bang Ping distribution substation 115-24 kV	(45.660)	(14.147)	(59.807)
	New substation, 2x40 MVA	-	16.407	16.407
87.1.02	Addition of Lumpini distribution substation, 69-12 kV	(34.345)	(12.931)	(47.276)
	Increase capacity from 2x40 to 4x40 MVA	-	11.190	11.190
87.1.03	Addition of Petchkasem distribution substation, 69-12 kV	(4.750)	(1.003)	(5.753)
	Increase capacity from 3x20 to 2x20+40 MVA	-	0.824	0.824
87.1.04	Acquistition of 8 pieces of land for substation construction	-	99.156	99.156
87.2.01	Bang Ping distribution substation 115 kV cable connection	(2.920)	(1.536)	(4.456)
	Line length 0.6 cct.km., 1x800 sq.mm., 2 ccts.	-	4.875	4.875
87.2.02	Lumpini distribution substation 69 kV cable connection	(1.264)	(0.438)	(1.702)
	Line length 0.2 cct.km., 1x800 sq.mm.	-	2.240	2.240
87.3.01	Construction and modification of primary line, 12 & 24 kV	(42.838)	(16.941)	(59.779)
	Line length 205 and 60 cct.km.	-	179.001	179.001
87.3.02	Construction and modification of secondary line ,416/240 V	(40.841)	(3.508)	(44.349)
	Line length 500 and 200 cct.km.	-	83.716	83.716
87.3.03	Installation of distribution transformer	(98.348)	(38.376)	(136.724)
	Various sizes, total capacity 179.982 MVA	-	21.769	21.769
87.3.04	Installation and replacement of revenue meter	(60.507)	(27.996)	(88.503)
	Various sizes, total 54,800 sets	-	79.882	79.882

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht)		
		FC	LC	Total
87.3.05	Installation of capacitor	(14.156)	(6.896)	(21.052)
	Various voltage levels, total 97.5 MVAR	-	3.666	3.666
87.4.-	None	-	-	-
87.5._		-	-	-
Total investment cost : fiscal 1987		(345.629)	(123.772)	(469.401)
		-	502.726	502.726
88.1.01	Construction of Klong Sarn distribution substation, 69-12 kV	(44.443)	(13.472)	(57.915)
	New substation, 2x40 MVA capacity	-	16.882	16.882
88.2.01	Klong Sarn distribution substation 69 kV line connection	(4.399)	(1.262)	(5.661)
	Line length 1.0 cct.km., 1x800 sq.mm., 2 circuits	-	12.015	12.015
88.2.02	Lard Prao waterworks 69 kV line connection	(2.888)	(0.709)	(3.597)
	Line length 0.2 cct.km., 1x800 cct.km. underground cable and 4.5 cct.km., 1x400 sq.mm. overhead line	-	12.015	12.015
88.2.03	Samrong waterworks 69 kV line connection	(0.359)	(0.083)	(0.442)
	Line length 0.5 cct.km., 1x400 sq.mm.	-	1.432	1.432
88.3.01	Construction and modification of primary line, 12 & 24 kV	(42.838)	(16.941)	(59.779)
	Line length 205 and 60 cct.km.	-	207.466	207.466
88.3.02	Construction and modification of secondary line, 416/240 V	(40.841)	(3.508)	(44.349)
	Line length 500 and 200 cct.km.	-	86.395	86.395
88.3.03	Installation of distribution transformer	(80.182)	(30.656)	(110.838)
	Various sizes, total	-	20.427	20.427

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht) FC	LC	Total
	capacity 183.552 MVA			
88.3.04	Installation and replacement of revenue meter	(60.846)	(28.015)	(88.861)
	Various sizes, total 54,800 sets	-	82.687	82.687
88.3.05	Installation of capacitor	(11.831)	(5.773)	(17.604)
	Various voltage levels, total 81.3 MVAR	-	3.217	3.217
88.4.-	None	-	-	-
88.5.-	None	-	-	-
Total investment cost : fiscal 1988		(288.627)	(100.419)	(389.046)
		-	438.239	438.239
89.1.01	Addition of Bangkapi transmission substation, 230-69 kV			
	Increase capacity from 2x100+200 to 3x200 MVA	44.060	23.983	68.043
89.1.02	Construction of Teparak distribution substation, 69-12/24 kV			
	New substation, 3x40 MVA	66.977	38.863	105.840
89.1.03	Construction of Ramkamhaeng distribution substation, 69-12 kV			
	New substation, 2x40 MVA	56.340	34.518	90.858
89.1.04	Addition of Pathumwan distribution substtion, 69-12 kV			
	Increase capacity from 2x20 to 2x40 MVA	14.026	17.517	21.543
89.1.05	Addition of Bang Pood distribution substation, 69-12 kV			
	Increase capacity from 2x20 to 2x40 MVA	26.600	13.384	39.984
89.1.06	Addition of Thonburi distribution substation, 69-12 kV			
	Increase capacity from 2x40 to 3x40 MVA	69.823	40.797	110.620

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht)		
		FC	LC	Total
89.2.01	Chidlom transmission sub-station - Pathumwan distrubution substation, 69 kV cable			
	Line length 2.2 cct.km., 1x800 sq.mm.	11.498	28.482	39.980
89.2.02	Teparak distribution sub-station 69 kV cable connection			
	Line length 1.0 cct.km., 1x800 sq.mm., 2 circuits	5.947	10.541	16.488
89.2.03	Ramkamhaeng distribution substation 69 kV line connection			
	Line length 2.0 cct.km., 1x800 sq.mm. underground cable and 3.0 cct.km., 2x400 sq.mm. overhead line	13.745	35.018	48.763
89.3.01	Construction and modification of primary line, 12 & 24 kV			
	Line length 185 and 60 cct.km.	64.126	220.927	285.053
89.3.02	Construction and modification of secondary line, 416/240 V			
	Line length 460 and 185 cct.km.	51.020	86.043	137.063
89.3.03	Installation of distribution transformer			
	Various sizes, total capacity 172.382 MVA	101.223	65.864	167.087
89.3.04	Installation and replacement of revenue meter			
	Various sizes, total 52,000 sets	79.377	117.751	197.128
89.3.05	Installation of capacitor			
	Various voltage levels, total 72.3 MVAR	14.068	9.978	24.046
89.4.01	Procurement of construction equipment, vehicle, tool and testing equipment, 22 items	57.221	47.412	104.633

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht)		
		FC	LC	Total
89.5.-	None			
Total investment cost : fiscal 1989		676.051	781.078	1457.129
90.1.01	Construction of King Petch distribution substation, 69-12 kV			
	New substation, 2x40 MVA capacity	60.678	36.408	97.086
90.1.02	Construction of Tong Lor distribution substation, 69-12 kV			
	New substation, 2x40 MVA capacity	60.678	36.408	97.086
90.1.03	Addition of Rasburana distribution substation, 69-12 kV			
	Increase capacity from 2x40 to 3x40 MVA	9.775	4.495	14.270
90.2.01	Tong Lor distribution substation 69 kV cable connection			
	Line length 4.0 cct.km., 1x800 sq.mm., 2 circuits	21.783	36.227	58.010
90.2.02	King Petch distribution substation 69-kV line connection			
	Line length 2.1 cct.km., 1x800 sq.mm. underground cable, 2 circuits and 0.6 cct.km., 2x400 sq.mm. overhead line	12.710	29.352	42.062
90.2.03	Lumpini mass transit system 69 kV cable connection			
	Line length 1.5 cct.km., 1x800 sq.mm., 2 circuits	8.776	17.491	26.267

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht)		
		FC	LC	Total
90.2.04	Bang Plee transmission substation - Bang Bor distribution substation, 115 kV line			
	Line length 1.5 cct.km., 1x800 sq.mm. underground cable and 18.0 cct.km., 1x400 sq.mm. overhead line	17.790	55.998	73.788
90.3.01	Construction and modification of primary line, 12 & 24 kV			
	Line length 185 and 60 cct.km.	43.336	189.339	232.675
90.3.02	Construction and modification of secondary line, 416/240 V			
	Line length 460 and 185 cct.km.	54.899	89.070	143.969
90.3.03	Installation of distribution transformer			
	Various sizes, total capacity 175.716 MVA	111.810	63.458	175.268
90.3.04	Installation and replacement of revenue meter			
	Various sizes, total 52,000 sets	85.883	123.479	209.362
90.3.05	Installation of capacitor			
	Various voltage levels, total 75.9 MVAR	15.411	10.810	26.221
90.4.01	Procurement of construction equipment, vehicle, tool and testing equipment, 8 items	15.954	12.402	28.356
Total investment cost : fiscal 1990		519.483	704.937	1224.42
91.1.01	Construction of South Thonburi transmission substation, 230-69 kV			
	New substation, 2x200 MVA capacity	78.098	69.214	147.312

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht)		
		FC	LC	Total
91.1.02	Construction of Pak Kred distribution substation, 69-12 kV			
	New substation, 2x40 MVA capacity	65.290	38.401	103.691
91.1.03	Construction of Silom 2 distribution substation, 69-12 kV			
	New substation, 2x40 MVA capacity	65.289	38.401	103.690
91.1.04	Construction of Bang Bor distribution substation, 115-24 kV			
	New substation, 2x40 MVA capacity	67.078	39.447	106.525
91.2.01	Bang Bor distribution substation - Union Textile Co., Ltd. 115 kV line			
	Line length 19.0 cct.km., 1x400 sq.mm.	9.366	40.997	50.363
91.2.02	Pak Kred distribution substation 69 kV line connection			
	Line length 0.6 cct.km., 1x800 cct.km. underground cable, 2 circuits and 5.5 cct.km., 2x400 sq.mm. overhead line, 2 circuits	8.820	19.388	28.208
91.2.03	Silom 2 distribution substation 69 kV line connection			
	Line length 2.5 cct.km., 1x800 sq.mm. underground cable, 2 circuits and 0.5 cct.km., 2x400 sq.mm. overhead line	15.124	28.625	43.749
91.2.04	South Thonburi - Taksin road 69 kV line			
	Line length 6.0 cct.km., 1x800 sq.mm. underground cable, 4 circuits and 21.0 cct.km., 2x400 sq.mm. overhead line, 4 circuits	51.486	88.859	140.345

DETAILS ON MEA'S FUTURE PROJECTS

Project No.	Project Title & Component	Investment Cost (Million Baht) FC	LC	Total
91.3.01	Construction and modification of primary line, 12 & 24 kV			
	Line length 185 and 60 cct.km.	60.068	222.540	282.608
91.3.02	Construction and modification of secondary line, 416/240 V			
	Line length 460 and 185 cct.km.	57.369	92.066	149.435
91.3.03	Installation of distribution transformer			
	Various sizes, total capacity 179.131 MVA	119.220	67.378	186.598
91.3.04	Installation and replacement of revenue meter			
	Various sizes, total 52,000 sets	90.259	128.311	218.570
91.3.05	Installation of capacitor			
	Various voltage levels, 59.7 MVAR	12.691	9.047	21.738
91.4.01	Procurement of construction equipment, vehicle, tool & testing equipment, 13 items	19.687	12.917	32.604
91.4.02	Procurement of construction equipment, vehicle, tool & testing equipment, 10 items	9.595	6.541	16.136
91.5.01	Digital mapping system, 100 %	39.252	36.234	75.486
91.5.02	Transformer load management, 100 %	6.520	14.904	21.424
Total investment cost : fiscal 1991		775.212	953.270	1728.482
Grand total investment cost		(634.256) 1970.746	(224.191) 3380.250	(858.447) 5350.996

APPENDIX V

BREAKDOWN OF EQUIPMENT USED IN MEA'S DISTRIBUTION SUBSTATION

Subproject-No. 88.1.01 : Klongsarn Distribution Substation, 69-12 kV
: New Substation, 2x40 MVA Capacity, Indoor Type

Subproject Cost
Unit : Million Baht

Item	Description	Unit	Qty	FC Mat	FC Tax	LC Mat	LC Labour	LC Equat	LC Other	LC Tot	Total (FC+LC)
	Civil Work										
1)	Indoor Land Elevating, Fence, Road & Guard House	Sub	1	-	-	0.75	0.22	0.03	-	0.99	0.99
2)	Foudation for Power Transformer	Ea	3	-	-	0.81	0.13	0.02	-	0.96	0.96
	Building										
3)	Indoor Substation Building (3 Bay)	Sub	1	-	-	4.37	1.67	0.21	-	7.26	6.26
4)	Steel Tower and UHF Radio System	Sub	1	0.37	0.14	0.37	0.07	0.03	-	0.61	0.98
	SFG Gas Insulated Part of Substation										
5)	69 kV 3 Bay SFG Metal Clad Switchgear	Sub	1	17.77	4.02	-	0.12	0.01	-	4.16	21.92
	Indoor Metalclad Switchgear										
6)	12 kV Incoming (2500A 25kA)	Set	2	0.77	0.39	-	0.01	0.01	-	0.41	1.18
7)	12 kV Bus-Section (2500A 25kA)	Set	3	1.16	0.59	-	0.01	0.01	-	0.61	1.76
8)	12 kV Feeder (800A 25 kA)	Set	12	3.41	1.73	-	0.06	0.03	-	1.81	5.22
9)	12 kV Capacitor-Bank (800A 25kA)	Set	2	0.57	0.29	-	0.01	0.01	-	0.31	0.88
10)	12 kV Station Service Tran.(45 kVA)	Set	2	0.85	0.43	-	0.01	0.01	-	0.45	1.30
	Control Board										
11)	12 kV Control Board	Set	19	3.79	1.92	-	0.06	0.03	-	2.01	5.81
12)	69 kV Control Board	Set	5	1.27	0.65	-	0.05	0.02	-	0.72	1.99
	Control Cable										
13)	Control Cable for Indoor Substation	Board	24	0.25	0.13	-	0.09	0.02	-	0.24	0.49
	Power Transformer										
14)	69-12/24 kV 30/40 MVA LTC.	Ea	2	11.03	2.28	-	0.19	0.05	-	2.52	13.55
	Power Cable and Terminator										
15)	Underground Cable, 25 kV 800 Sq.mm. CU. XLPE	M	360	0.29	0.16	-	0.04	0.01	-	0.21	0.50
16)	Underground Cable, 69 kV 800 Sq.mm. CU. XLPE	M	180	0.23	0.06	-	0.03	0.01	-	0.10	0.33
	Battery										
17)	Battery 125 V. 210 AH.	Set	1	0.66	0.13	-	0.05	-	-	0.18	0.84
18)	Battery Charger	Set	1	0.10	0.03	-	0.01	-	-	0.04	0.14
	Distribution Panel										
19)	AC Distribution Panel	Pnl	1	0.04	0.02	-	-	-	-	0.02	0.06
20)	DC Distribution Panel	Pnl	1	0.03	0.01	-	-	-	-	0.01	0.04

Item	Description	Unit	Qty	FC Mat	LC Tax	LC Mat	LC Labour	LC Equpt	LC Other	LC Tot	Total (FC+LC)
	SCADA Equipment										
21)	Telemetering and Remote Control Equipment	Set	1	0.90	0.18	0.58	0.10	0.02	-	0.88	1.78
	Grounding										
22)	Indoor Substation Grounding System	Set	1	0.09	0.05	-	0.03	-	-	0.08	0.17
	Insurance										
23)	Transformer Transportation Insurance	Ea	2	-	-	0.08	-	-	-	0.08	0.08
24)	Miscellaneous Items	Ls	1	0.87	0.26	0.14	-	-	-	0.40	1.27
(A)	Direct Subproject Cost			44.44	13.47	7.09	2.99	0.49	-	24.04	68.48
	Overhead Charge :										
	For Project Engineering Department			-	-	-	-	-	2.36	2.36	2.36
	For Purchase and Stores Department			-	-	-	-	-	2.36	2.36	2.36
	For Construction Department			-	-	-	-	-	-	-	-
	For Distribution Department			-	-	-	-	-	-	-	-
(B)	Total Overhead Charge			-	-	-	-	-	4.73	4.73	4.73
(C)	Total Subproject Cost (A+B)			44.44	13.47	7.09	2.99	0.49	4.73	28.77	73.21
(D)	FC Material and Tax on Hand			44.44	13.47	-	-	-	-	13.47	57.91
(E)	Total Budget Required (C-D)			-	-	7.09	2.99	0.49	4.73	15.30	15.30
(F)	FC Material and Tax to be Paid in Year 1988			-	-	-	-	-	-	-	-
(G)	Other LC to be Paid in Year 1988			-	-	8.70	3.67	0.60	5.80	18.76	18.76
(H)	Projected Completion in Year 1988										