JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF ENERGY DEVELOPMENT AND PROMOTION
MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT
THE KINGDOM OF THAILAND

THE STUDY (AFTER-CARE)
ON
THE ENERGY CONSERVATION PROJECT
IN
THE KINGDOM OF THAILAND

FINAL REPORT
(I)

MARCH 1995

THE ENERGY CONSERVATION CENTER, JAPAN

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

DEPARTMENT OF ENERGY DEVELOPMENT AND PROMOTION
MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT
THE KINGDOM OF THAILAND

THE STUDY (AFTER-CARE)
ON
THE ENERGY CONSERVATION PROJECT
IN
THE KINGDOM OF THAILAND

FINAL REPORT
(I)

MARCH 1995

THE ENERGY CONSERVATION CENTER, JAPAN

Preface

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a study (Ater-Care) on the Energy Conservation Project in the Kingdom of Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Thailand a study team five times between August 1993 and January 1995. The team was headed by Mr. Teruo Nakagawa (from the first to the third study) and Mr. Hiroshi Ishida (the fourth and the fifth study) of the Energy Conservation Center. They held discussions with the officials concerned of the Government of the Kingdom of Thailand, and conducted field surveys at the study area. After the study team returned to Japan, further studies were made and the present report was prepared.

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

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

February 1995

Kimio Fujita
President
Japan International Cooperation Agency

Report • Part I

Contents

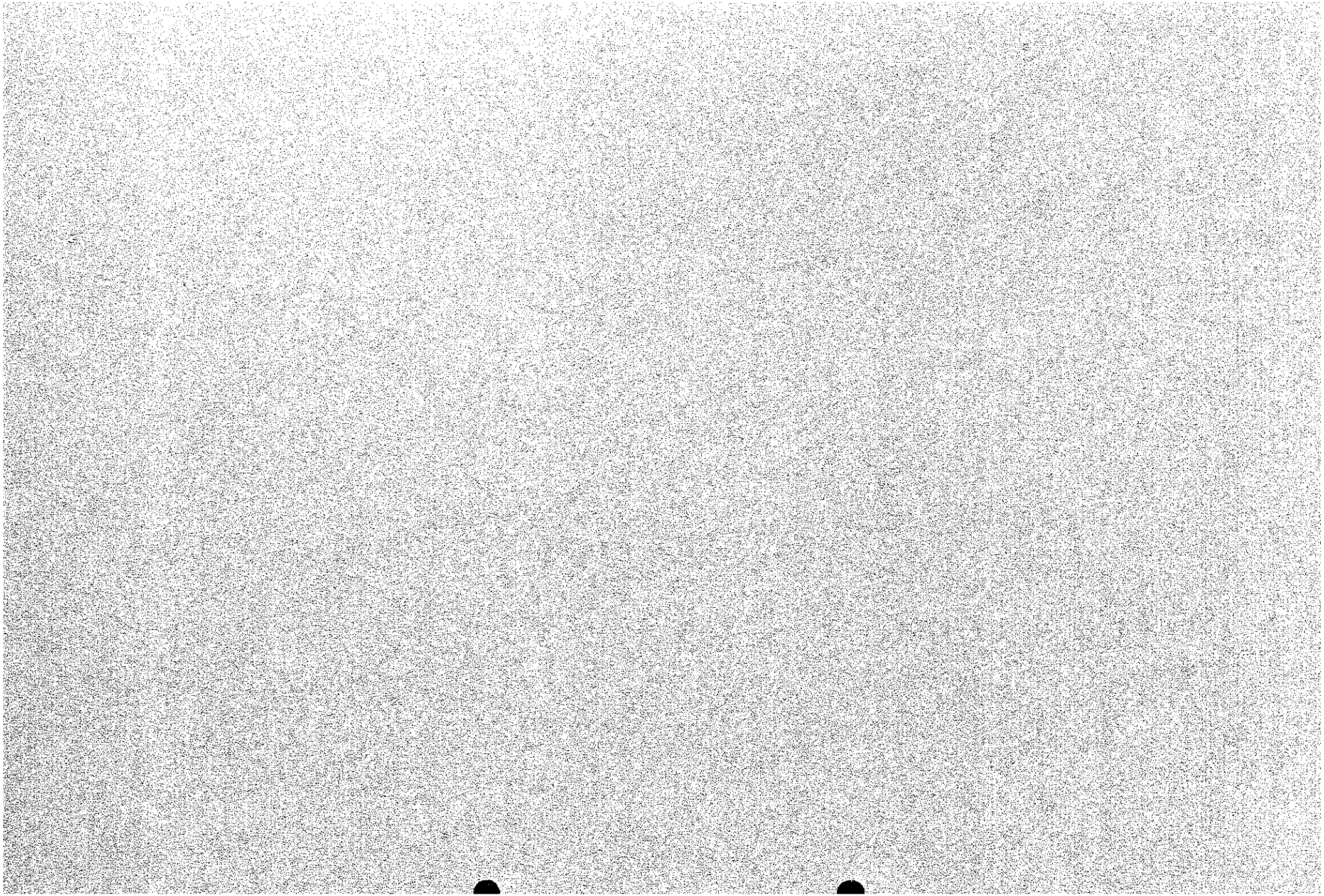
Report • Part I

Contents

List of Tables

List of Figures

1. OVERVIEW OF THE STUDY



1. OVERVIEW OF THE STUDY

1.1 Background of the Study

(1) In 1980, the Government of Thailand requested the Government of Japan to cooperate in the rational use of energy in order to cope with the impact of the steep rise in oil prices on its economy. In response to this request, the Japan International Cooperation Agency (JICA) conducted a study on "Energy Conservation Project in the Kingdom of Thailand" for the period of 1982 to 1984 with the then Ministry of Science, Technology and Energy in Thailand as its counterpart.

The above study and the recommendations covered the following:

1) Recommendation on the enactment of an energy conservation act, and offering of financial support, etc. to clarify policies for the promotion of the rational use of energy.

2) Recommendation on establishment of semigovernmental organizations for energy conservation promotion, and offering of specific technical supports to disseminate the energy conservation concept in the industrial field, etc.

3) An energy conservation study was conducted on 55 factories in 6 industrial sectors as the model factories for energy conservation promotion in the industrial field, and thereafter recommendation was made on working out the technical guideline for energy conservation improvement methods and energy conservation promotion for each industrial sector.

The technology related to the method for energy conservation improvement was transferred to the counterpart personnel in the course of the factory study.

(2) The Government of Thailand set up the Energy Conservation Center (NEA ECC) under the National Energy Administration (NEA) in 1981 to form the framework for the promotion of the rational use of energy, and then in 1985, the Energy Conservation Center of Thailand (ECCT) under the leadership of the Industrial Federation of Thailand, thus preparing for the establishment of the system for the promotion of energy conservation in the private and industrial sectors through these organizations.

(NEA ECC was reorganized into Ministry of Science, Technology and Environment/ Department of Energy Development and Promotion (DEDP) according to the organizational reform in Autumn 1992.)

(3) Thereafter, the Thai Government promulgated the "Energy Conservation Promotion Act" in April 1992 on the basis of the 7th National Economic and Social Development Plan to aim at further promotion of energy conservation activities.

This Energy Conservation Promotion Act has, however, not operated effectively so far since no relevant regulations, enforcement ordinances and standards have been enacted.

(4) Under these circumstances, JICA dispatched a Project Finding Team to Thailand in October 1992 to exchange views with the personnel concerned of the Ministry of Science, Technology and Environment. This led the Thai Government to a better understanding of the necessity for an after-care study of the energy conservation project. Thus, in January 1993, the Thai Government requested the Japanese Government to conduct an after-care study.

(5) Based on the results of the above study, JICA sent a preparatory study team to Thailand in April 1994 in order to have discussions on various matters required for implementation of the study of this project, and to confirm the details of the request of the Thai side. Thereafter, an agreement on Scope of Work (S/W) was concluded between JICA and the Ministry of Science, Technology and Environment, a counterpart agency of this study.

1.2 Purpose of the Study

This study is regarded as an after-care study of the "Study on the Energy Conservation Project in the Kingdom of Thailand" implemented by JICA for the period of 1982 to 1984. Its purpose is to work out an action plan for the promotion of the rational use of energy related to the Energy Conservation Promotion Act promulgated in April 1992 on the basis of the 7th National Economic and Social Development Plan, and to transfer the technology for energy conservation promotion to the counterpart.

1.3 Counterpart Governmental Organization and Objects to be Studied

1.3.1 Counterpart governmental organization

Ministry of Science, Technology and Environment/Department of Energy Development and Promotion (DEDP)

1.3.2 Objects to be studied

(1) Relevant organizations

a. Department of Energy Development and Promotion (DEDP)
b. The Energy Conservation Center of Thailand (ECCT)
c. DEDP Energy Training Center (DEDPETC)

d. Ministry of Industry (MOI)
e. Ministry of Finance (MOF)
f. Ministry of Interior (MOI)
g. Department of Environment Promotion
h. National Energy Policy Office (NEPO)
i. National Economic and Social Development Board (NESDB)
j. The Industrial Finance Corporation of Thailand (IFCT)
k. Thai Industrial Standard Institute (TISI)
l. Electric Generating Authority of Thailand (EGAT)
m. Metropolitan Electricity Authority (MEA)
n. The Federation of Thai Industries (FTI)
o. Technological Promotion Association (Thai-Japan) (TPA)
p. JETRO Bangkok Center
q. Japanese Chamber of Commerce, Bangkok
r. Thai Obayashi Co., Ltd.

(2) Universities and Institutes

a. Chulalongkorn University
b. King Mongkut's Institute of Technology Thonburi

(3) Factories

1) A Factory (Glass)
2) B Factory (Glass)
3) C Factory (Steel)
4) D Factory (Cannery)
5) E Factory (Rice Cleaning)
6) F Factory (Automobile parts)
7) G Factory (Plastic)
8) H Factory (Dyeing)
9) I Factory (Dyeing)
10) J Factory (Chemical)
11) K Factory (Tire)

(4) Buildings

1) a Building (Department Store)
2) b Building (Department Store)
3) c Building (Department Store)
4) d Building (Bank)
5) e Building (Bank)
6) f Building (Hospital)
7) g Building (Hospital)
8) h Building (Hotel)
9) i Building (Office)

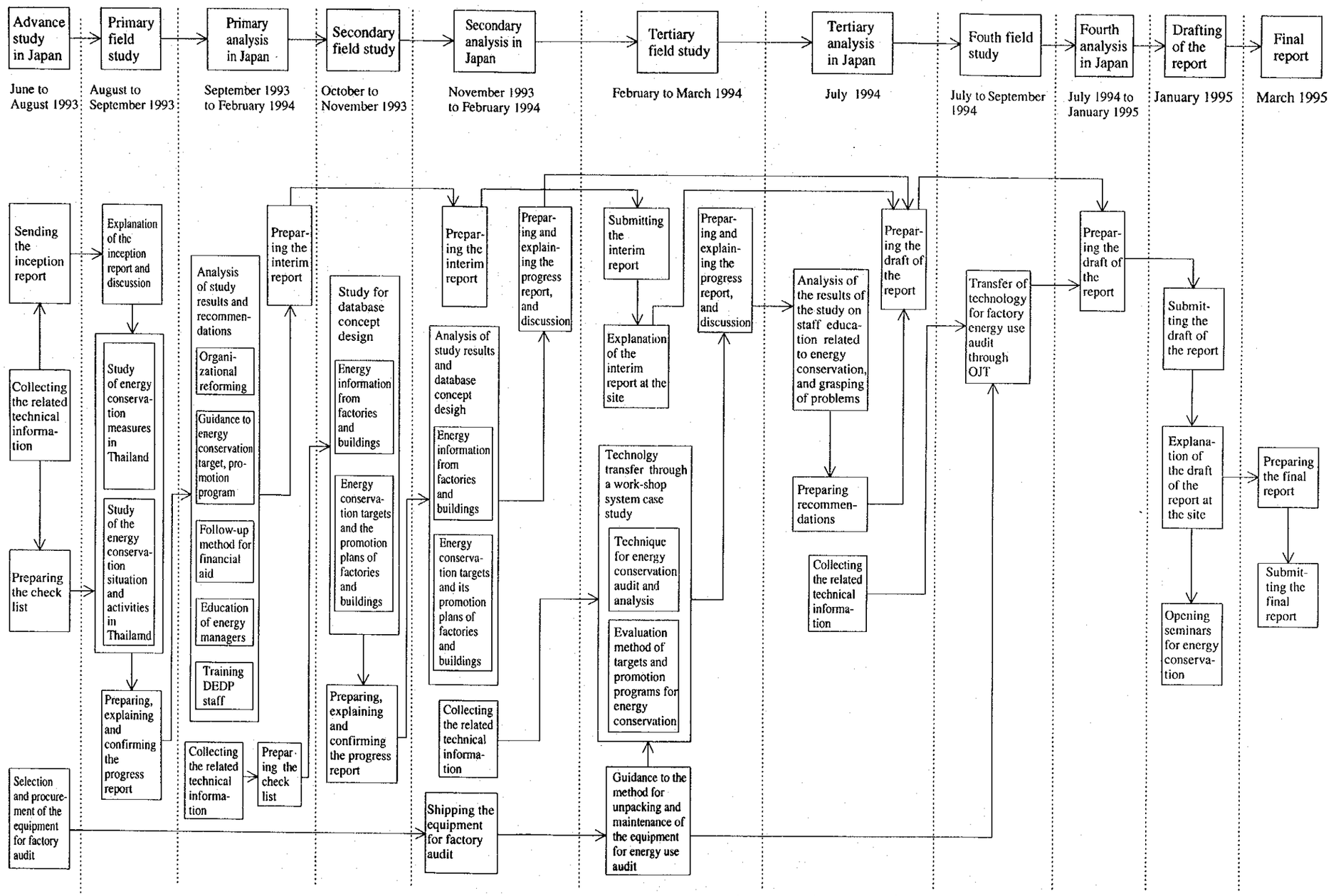
1.3.3 Factories to be studied for energy use audit

Type	Name
Steel	Y Co., Ltd.
Paper & Pulp	Z Co., Ltd.

1.4 Method of Study

The overview of the study is shown in Figure 1.1.

Figure 1.1 Overview of the Study (After-care) on the Energy Conservation Project in the Kingdom of Thailand



1.4.1 Preparatory work in Japan (from July to August 1993)

Based on the results of the "Study on the Energy Conservation Project" implemented by JICA for 1982 to 1984, and of the preparatory study of this study, the related information available in Japan was collected to prepare for the primary field study.

The inception report was prepared for the Thai counterpart to understand the overview of the field study.

1.4.2 Primary field study (from August to September 1993)

In the primary field study, the study method was explained to the counterpart by the use of the inception report, while interviews with the personnel concerned of energy-related organizations and factories to be studied were conducted with regard to energy measures and the current situation and activities for energy conservation promotion.

Upon the completion of the field study, the details of the study were discussed with the Thai side for confirmation, and thereafter a progress report was prepared and submitted to the Ministry of Science, Technology and Environment.

1.4.3 Primary analysis in Japan (from September 1993 to February 1994)

Based on the results of the primary field study, recommendations were made on organizations and activities for energy conservation promotion and education of staff involved in it. Furthermore, preparatory work for the secondary field study was conducted.

1.4.4 Secondary field study (from October to November 1993)

The secondary field study was conducted for database concept design concerning the energy-related information and targets for energy conservation and promotion programs in factories and buildings.

Upon the completion of the field study, the contents of the study were discussed with the Thai side for confirmation, and thereafter a progress report was prepared and submitted to the Ministry of Science, Technology and Environment.

1.4.5 Secondary analysis in Japan (from November 1993 to February 1994)

Following the primary analysis in Japan, on the basis of the results of the primary field study, recommendations were made with regard to organizations and activities for energy conservation promotion and education of staff related thereto. These recommendations were summarized into an interim report to be submitted to the Government of Thailand in January 1994.
In addition, based on the results of the secondary field study, recommendation was prepared for database concept design. Preparatory work for the tertiary field study was also carried out.

1.4.6 Tertiary field study (from February to March 1994)

An explanation of the interim report was given and the contents thereof were discussed with the Ministry of Science, Technology and Environment.
Prior to the tertiary field study, two team members and one person for schedule arrangement were sent in advance to receive, unpack and adjust the measuring instruments for the field study.
On the completion of setting up the equipment, the remaining team members entered the country to start the study.

In the field study, technology transfer to the counterpart was carried out through workshop case study by using the measuring instruments with regard to the evaluation method for energy-related information.

Following the primary and secondary field studies, investigation was carried out with regard to education of staff related to energy conservation activities in Thailand.
At the end of the field study, the contents of the study were confirmed upon discussion with the Thai counterpart. Thereafter a progress report was prepared and submitted to the Ministry of Science, Technology and Environment.

1.4.7 Tertiary analysis in Japan (July 1994)

The results of the tertiary field study were analyzed, and on the basis of this, recommendations were prepared.
In addition, preparatory work for the fourth field study was carried out.

1.4.8 Fourth field study (from July to September 1994)

In the fourth field study, the technology for factory energy use audit was transferred to the counterpart through on-the-job training (OJT) by means of the equipment for the study.
After the completion of the study on factory energy conservation, specialists in staff education, heat management technology and electricity management technology stayed at the site for about 1.5 more months so as to give the counterpart instruction in arrangement and analysis of the results of the study as well as in drafting of the improvement plan, thereby conducting technology transfer.

1.4.9 Fourth analysis in Japan (from July 1994 to January 1995)

The interim report of the primary field study and the results of the secondary tertiary field studies are summarized into the draft final report and sent to Thailand.

1.4.10 Explanation of the draft final report at the site and opening of the seminars for dissemination of energy conservation (January 1995)

The draft final report is explained at the site, while the contents thereof are discussed with the Ministry of Science, Technology and Environment. Meanwhile a seminar is held for the staff related to energy conservation in Thailand, to disseminate the method for energy conservation promotion.

1.5 Progress in Implementation of the Field Study

1.5.1 Study on energy situation, energy conservation promotion situation and database concept design

A study was made with regard to the energy situation, the energy policy of the Government and the current implementation status for energy conservation promotion measures in the Kingdom of Thailand. This was conducted on the basis of interviews with energy-related organs, factories and buildings, data collection and inspections. Before starting the study, the details of the study were explained to the counterpart by the use of a prepared inception report. Moreover, appropriate arrangement by the counterpart and cooperation offered by energy-related organs, factories and buildings allowed a smooth study, thus leading to the successful achievement of the expected results. On the basis of the results of the field study, recommendations were prepared on such measures as would be applicable to the current situation in the Kingdom of Thailand.

1.5.2 Technology transfer by workshop method

Concrete methods related to the technology for energy conservation promotion were transferred to the counterpart through workshop system by the effective use of the equipment and instruments carried by the study team.

1.5.3 Guidance to factory study and drafting of improvement plans for rational use of energy

(1) Prior to the implementation of the factory study, instruction in the study method was provided to the counterpart according to the checklist prepared in advance.

On the basis of this, the counterpart explained the method of the study to the persons in charge of the factories to be studied, and at the same time asked them to prepare the reference data and to work the position to install the measuring instruments.

(2) The outlines of the factories and the energy management situation were studied through interviews based on the check list, data collection, book examination and visual inspections to have a correct understanding of the current situation, problems and the future plan.

Studies on energy consuming equipment and problems in the energy use were conducted through measurement by the factory audit equipment brought from Japan, survery of drawings and diagrams, inspection of past data, and observation of actual operation, to identify and understand the actual situation and problems in the operation method and the performance of the equipment.

These factory studies were implemented led by the counterpart, while the transfer of the technology for energy use audit was the main concern of the Japanese team.

(3) At the end of the factory study, the counterpart and the Japanese side reported the results of the measurement and the comments on factory observation to the factory management to exchange opinions.

(4) After the end of the factory study, the Japanese side instructed the counterpart to sort out and analyze the data for the study and to draft improvement plans.

(5) Regarding problems in the energy management and the improvement measures, the study was focused on the overall energy conservation promotion system including energy management organization, target setup, the record and utilization of actual energy consumption data and employee education, in the light of the particular local circumstances and the measures successfully adopted by the same kinds of Japanese factories. Thus, recommendations were made on improvement measures which would possibly be applicable to the factory.

Regarding the problems involved in energy use and their countermeasures, minor modification of existing equipment without changing the current process or more efficient energy conservation measures by additional installation of equipment were evaluated in terms of economy, and thus appropriate improvement measures for the factory were proposed.

1.5.4 Counterpart

In the factory study, referring to the text and note used at workshop, the counterpart operated the audit equipment to collect the measured data.
Further, its members had a high morale, and were very cooperative in the work.

1.5.5 Equipment for audit

All of the audit equipment operated normally, and the study was successfully carried out without any trouble.

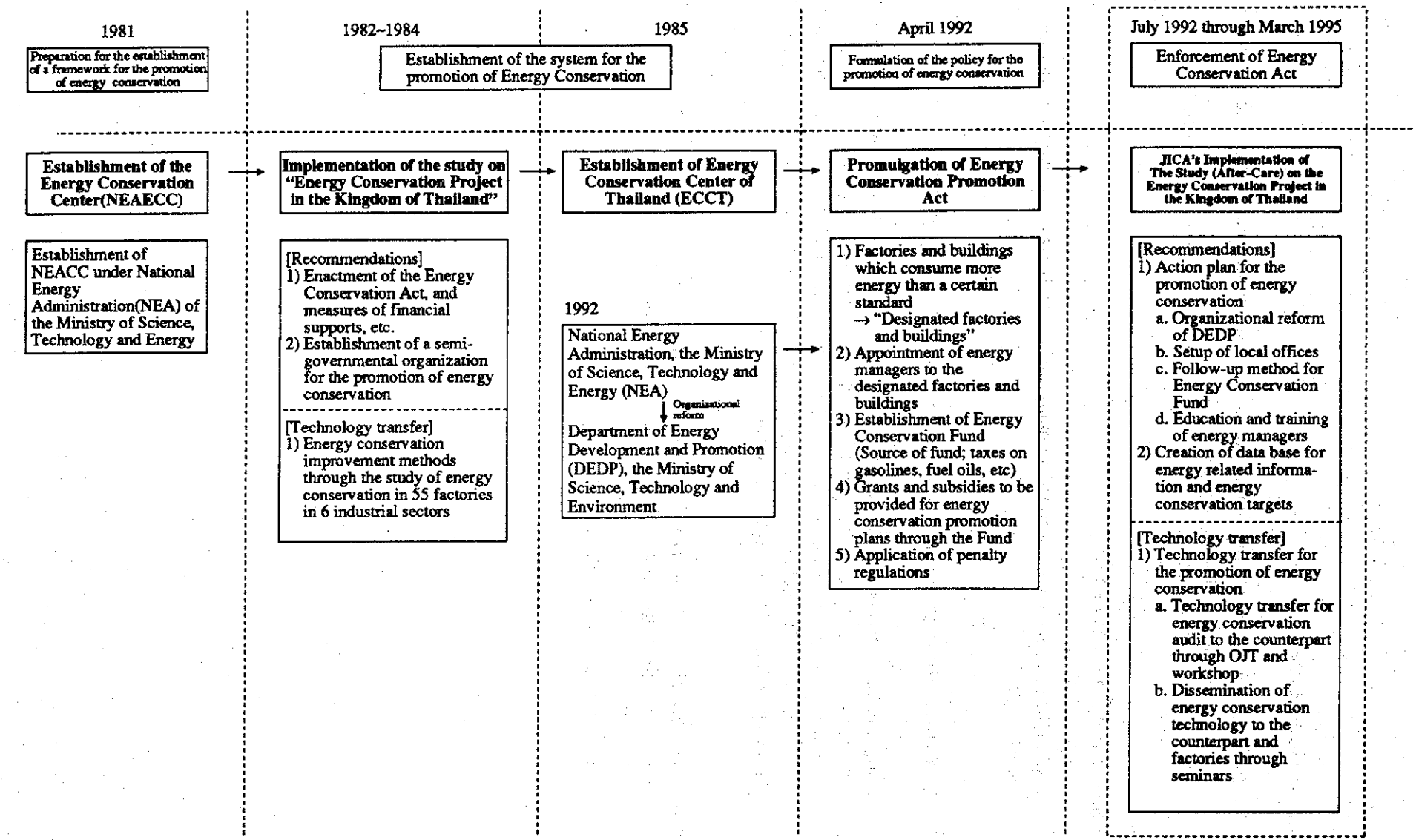
1.5.6 Preparation of reference data for the technical guideline

Major points to be noted on energy management and energy use for each sector of industry to be studied were picked up on the basis of the results of the factory study.
The main energy conservation technology and the actual implementation examples were presented to prepare the reference data on the basis of which the counterpart could prepare its own technical guideline for energy conservation.

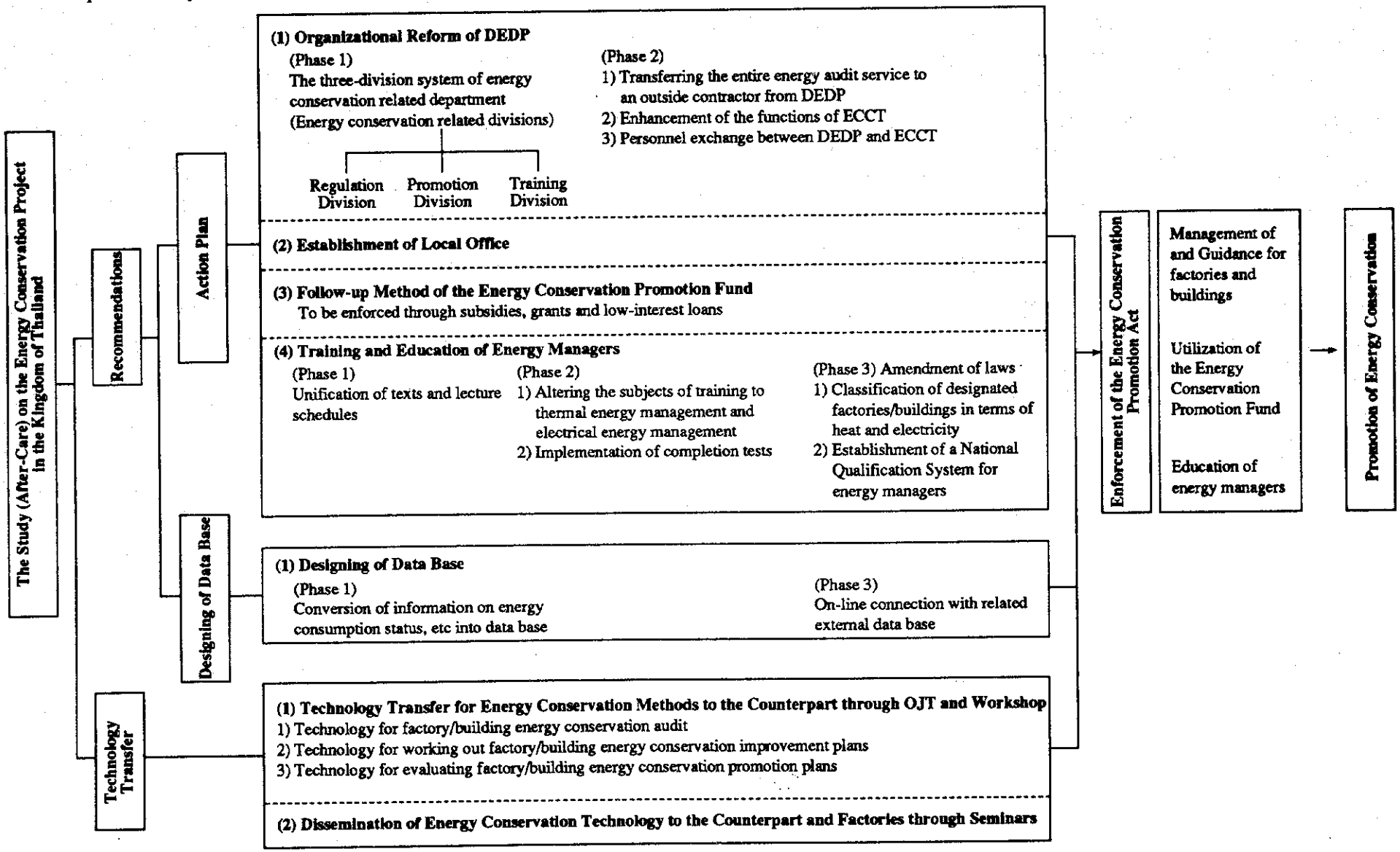
1.6 Composition of the Study Team, and the Counterpart, Schedule of the Field Study and List of Measuring Instruments

See Appended Data (1) through (4).

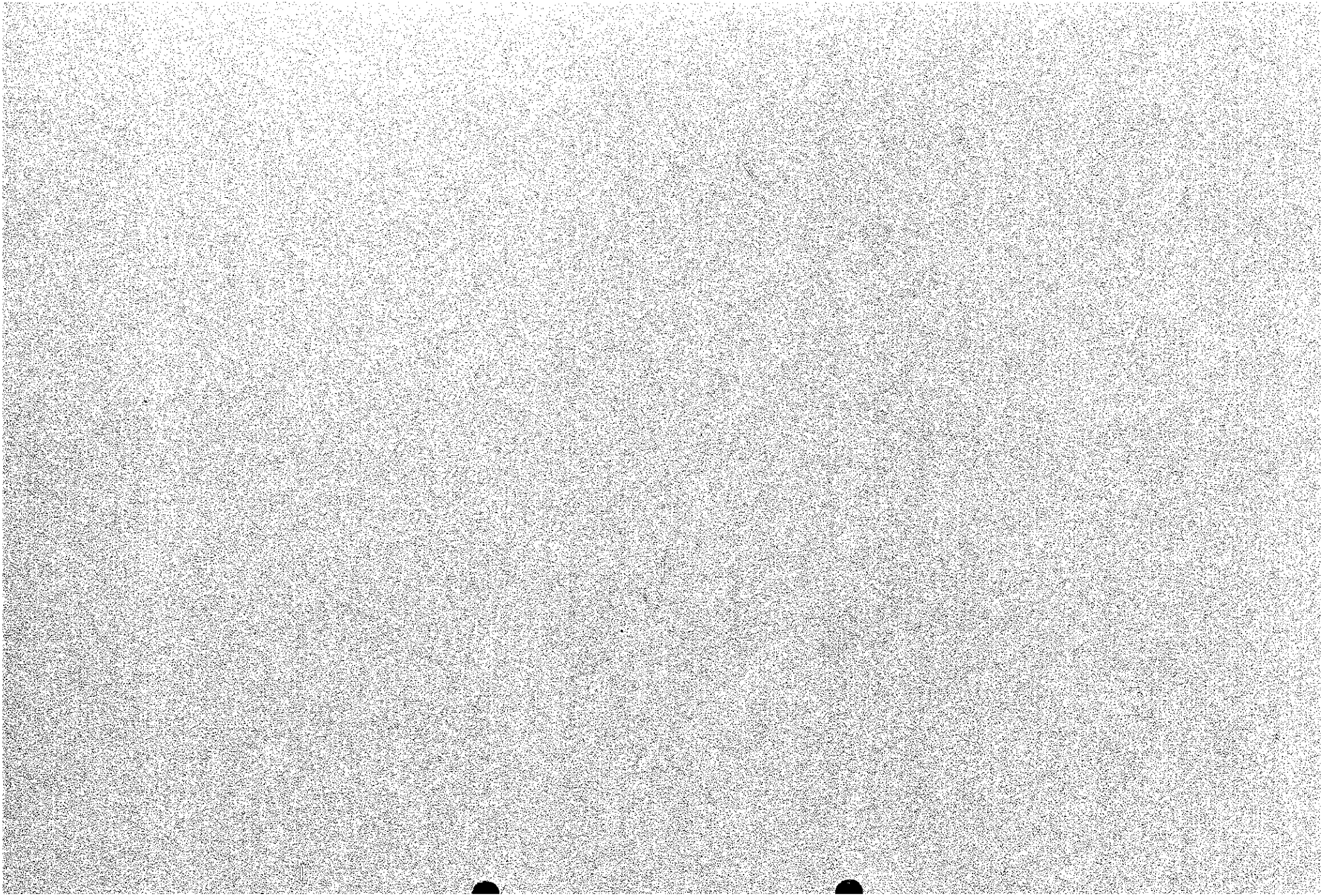
Overview of the study



The Concept of the Study



2. THE BACKGROUND FOR ENERGY CONSERVATION IN THAILAND



2. THE BACKGROUND FOR ENERGY CONSERVATION IN THAILAND

2.1 Economy and Industries in the Kingdom of Thailand

(1) Process of Economic Growth of Thailand

Thailand blessed with abundant and fertile land had been economically based on agriculture.

However, recommendation of "Public Development Program in Thailand" made by the World Bank in 1959 provided an important turning point of the economic growth of Thailand thereafter. This recommendation indicated the following points.

- To work out total development plans as the nation.
- To discontinue industrialization by national corporations and to aim at industrialization led by private sectors.
- The government is to support private sectors and to consolidate infrastructure such as electric power, transportation and communication.
- To positively introduce investment, loan, etc. from outside nations.

The Government of Thailand accepted this recommendation and established the National Economic Development Bureau (renamed to National Economic and Social Development Board, NESDB in 1972), and the structure for creation of programs was established.

The process of the economic growth of Thailand is described below along with National Economic and Social Development Plan. (NESDP).

1.1) The 1st and 2nd NESDP — Attachment of importance to consolidation of infrastructure

The 1st Plan (1961 ~ 1966)

The principal objective was to reorganize infrastructure such as electric power and roads, which are required for growth of industries. Investment by private sectors was activated by establishment of the Industrial Investment Promotion Act, and Thailand entered the age of economic growth.

The 2nd Plan (1967 ~ 1971)

A domestic business setback occurred because of stagnation of the world market and also because of reduction of special procurements due to termination of the war in Vietnam.

1.2) The 3rd and 4th NESDP — Attachment of importance to social development

The 3rd Plan (1972 ~ 1976)

Efforts were made to expand agricultural production that would lead to acquisition of foreign currency, while processing of agricultural products was promoted aiming at upturn of business. In the field of industries, the policy of industrialization to promote export was established instead of industrialization to substitute for import.

The 4th Plan (1977 ~ 1981)

The social development strategy was adopted to aim at alleviation of the differences between urban areas and rural areas, while export promotion policy was adopted in the aspect of trade. The ratio of industrial products exceeded 30% toward the end of the 70's as a result. The international balance of payment worsened due to outbreak of second oil crisis.

1.3) The 5th and 6th NESDP — Strengthening of economic constitution

The 5th Plan (1982 ~ 1986)

Strengthening of the economic constitution that would not be affected by changes in the world situation became an important theme. Efforts were made to conserve energy and to increase savings, while importance was attached to diversification of agricultural production and promotion of export-oriented manufacturing businesses.

Measures for elimination of differences between areas, on the other hand, involved starting of programs to exterminate poverty in rural areas including creation of employment and development of industries in specific areas.

Particularly with start of development of the natural gas field in the Gulf of Siam in 1981, Thailand secured valuable energy resources and this development constituted the foundation for large-scale development projects including the East Coast Development Project.

The 6th Plan (1987 ~ 1991)

Target was placed on restructuring of production and market structure to cope with international competition and revitalization of regional society, while an attempt was made to further enhance processing of agricultural products and promote metal working and parts industries which support export.

1.4) The 6th NESDP (1992 ~ 1996) — To stable growth

The following goals were set with due regard to correction of the strains arising from the rapid economic growth and solution of environmental problems.

1) To upkeep suitable economic growth (to achieve 8% growth).
2) To distribute income and to disperse fruits of development to local areas.
3) To develop human resources.
4) To secure quality of life and environmental conservation

(2) Recent Economy of Thailand

The economy of Thailand has maintained "vigorous two-digit growth" in general since 1987, which is the higher figure in the West Pacific area enjoying the highest growth in the world. The national income level is positively increasing with such growth of economy. The national income per capita was US$500, which was less than 1/3 of the level in NICs, and Thailand had a strong coloring of an agricultural nation in 1978.

About ten years later, however, Thailand emerged as an industrial nation and the national income per capita reached the level of US$1,600, which was far higher than levels of Indonesia and Philippines and was comparable to that of Malaysia that is rich with petroleum income among ASEAN nations, in 1991.

The national income in Thailand slipped out of the level of many developing nations and approached the levels of South Korea and Taiwan, which are called NIES nations.

Today Thailand is about to be called "new NIES nation" or "the fifth tiger" because of industrialization and economic growth of paces higher than those of NIES nations in Asia. However, it is necessary to solve the following subjects, which are bottlenecks involved in vigorous economic growth.

- Shortage of infrastructure (roads –in Bangkok in particular–, electric power, etc.)
- Shortage of man-power, engineers of middle standing in particular
- Elimination of differences between areas
- Upbringing of supporting industries (industries which supply production machinery and parts to export-oriented industries)

(3) Economy of Thailand in the Future

As the move toward reconstruction of Indo-China spreads after termination of the war in Vietnam and the intestine war in Cambodia, the importance of Southeast Asia as the growth center of the world has become higher. Under these circumstances, Thailand is attempting to play the role of a leader of the regional economy with "let us convert Indo-China from the battlefield to a market" as the slogan. It is clearly indicated in the 7th NESDP that Thailand intends to become an international financial center, a trade center of Indo-China and a tourism center of Southeast Asia. Construction of roads and bridges which link Thailand with three Indo-China nations is in progress as supported by the World Bank and outside nations, and it is expected that inter-area economic intercourse will become more active as shown in Table 2.1. Multi-national regional development concepts called "North Square" and "South Triangle" areas have been created. "North Square" starts with Bangkok as the start point, extends to the northern part of Thailand and Myanmar on the west, the southern part of China on the north, and Laos and Vietnam on the east. This square economic circle is expected to grow in future. In fact, Baht economic circle with Baht as the hard currency is about to be formed at the Myanmar and Laos boundary areas. "South Triangle", on the other hand, is the concept to connect the southern part of Thailand, Sumatra Island and Penang together. For the southern part of Thailand, there is such an ambitious plan to switch transport of petroleum from Middle and Near East by the ocean route to that by land and bridges in a development project that follows the East Coast Development Project, and feasibility study is in progress. Thus, Thailand is expected to grow into an entity having a large sweep as a leader of the Indo-China regional economy with a population of 170 million, emerging from the conventional one-nation economy. There was no case in the past where a large nation located close to the equator grew into a modern industrial nation. All the more because of this fact, success of industrialization in Thailand will probably encourage other developing nations and will become a model of new feasible development. How development was made in many nations in the past involved a strong trend of limping growth to leave agriculture behind because of speeding up of industrialization. In Thailand, however, the primary industries including agriculture and fisheries were successfully industrialized, and acquisition of foreign currency with industries such as cultured shrimps, broilers and canned pineapples led to formation of domestic markets, and industrialization supported by agriculture became fixed. Thus, Thailand is particularly featured with well-balanced growth occurring concurrently in both of agriculture and industrialization.

Table 2.1 Regional Economic Intercourse

Nation	Description
Vietnam	1991 ... Investment protection treaty Memorandum related to cooperation in energy 1992 ... New treaty related to trade, economy and technology Memorandum related to rice production and its market development
Cambodia	1991 ... Establishment of Cambodia Commercial Bank (jointly with a bank of Thailand)
Laos	1991 ... Establishment of Thailand-Laos Joint Committee

2.2 Energy Demand and Supply Situation and Its Forecast

(1) Primary energy supply

a. General situation

The primary energy supply in 1993 was 58.6 Mtoe (equivalent to one million ton in oil), increasing by 11.6% over that in 1992. Moreover, energy supply has expanded by approximately 2.4 times for ten years since 1984.

The energy self-sufficiency in 1993 was approximately 58%, with the remaining 42% energy resources imported from other countries. The exported energy is approx. 1%, consisting mainly of condensate.

Figure 2.1 Trend of Energy Supply

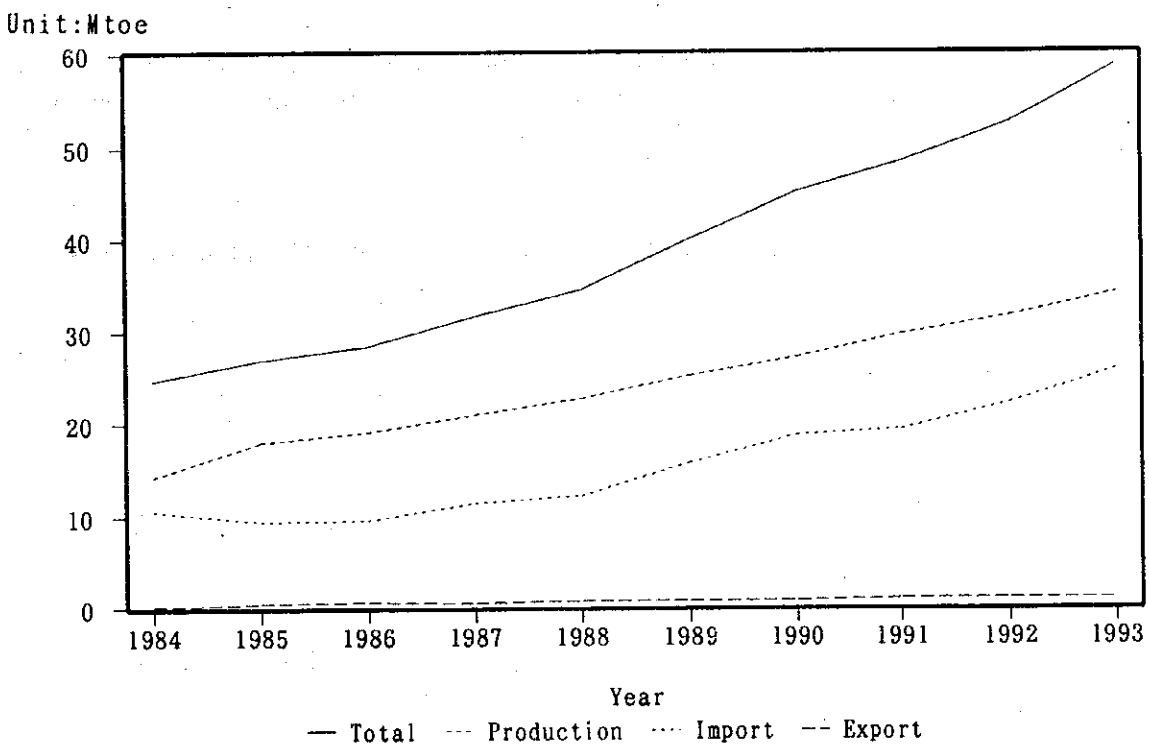


Table 2.2 Trend of Energy Supply

Unit:1000toe

Sources	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Production	14,294	17,951	19,172	21,037	22,698	25,269	27,207	29,716	31,670	34,132
Import	10,600	9,401	9,543	11,368	12,123	15,792	18,810	19,361	22,279	25,893
Export	169	474	596	523	693	799	803	958	1,016	987
Total	24,780	26,899	28,433	31,706	34,592	40,010	45,122	48,361	52,535	58,616

Source:Thailand Energy Situation 1993

In 1984, the traditional energy resources such as charcoal, firewood, paddy husks and bagasse accounted for 60% or more of the total energy resources, while in 1993 the energy resource composition was petroleum (32%), lignite (13%) and traditional energy resources including charcoal, etc. (51%).

In addition, regarding firewood and charcoal, there is an increasing tendency that fall should be restricted from the viewpoint of the forest protection. Also the use of bagasse and paddy husks has reached its peak.

Figure 2.2 Comparison of Primary Energy Production by Sources in 1984 and 1993

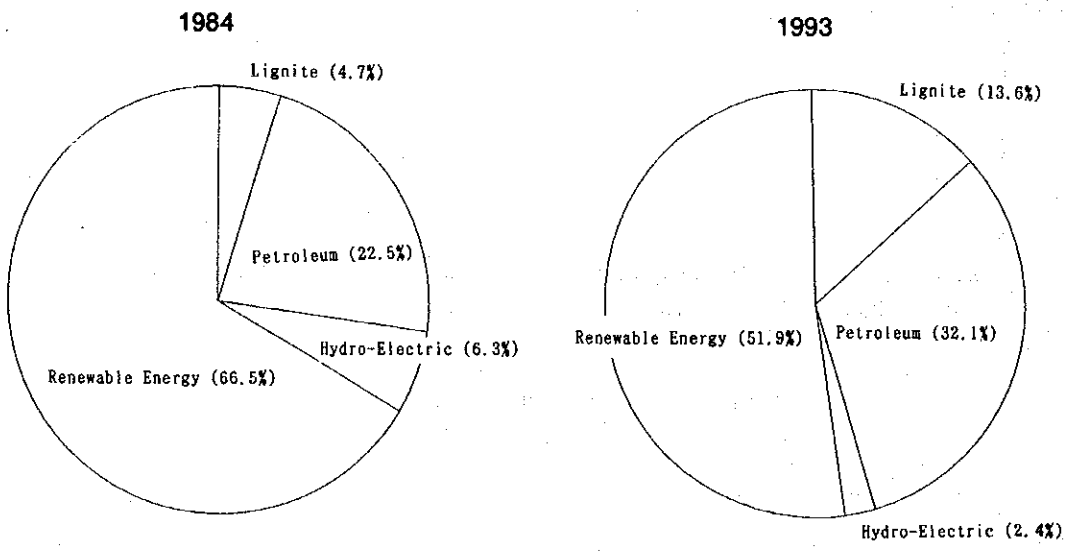


Table 2.3 Trend of Primary Energy Production by Sources

Unit:1000toe

Sources	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Modern Energy										
Anthracite	-	-	-	-	-	-	-	-	16	12
Lignite	667	1,401	1,508	1,932	2,049	2,592	3,570	4,193	4,410	4,619
Crude Oil	737	1,083	1,058	894	1,017	1,066	1,196	1,222	1,317	1,247
Condensate	374	649	648	690	815	838	897	988	1,204	1,307
Natural Gas	2,101	3,250	3,139	4,390	5,200	5,194	5,657	7,011	7,501	8,397
Hydro-Electirc	904	818	1,230	903	837	1,234	1,103	1,016	939	820
Sub total	4,783	7,201	7,583	8,809	9,918	10,924	12,423	14,430	15,387	16,402
%	33.46	40.11	39.55	41.87	43.70	43.23	45.66	48.56	48.59	48.05
Renewable Energy										
Fuel Wood	7,459	8,470	9,440	10,244	10,872	11,725	12,439	12,863	13,816	15,180
Paddy Husk	940	1,061	919	760	624	731	630	455	607	571
Bagasse	1,112	1,219	1,230	1,224	1,284	1,889	1,715	1,968	1,860	1,979
Sub total	9,511	10,750	11,589	12,228	12,780	14,345	14,784	15,286	16,283	17,730
%	66.54	59.89	60.45	58.13	56.30	56.77	54.34	51.44	51.41	51.95
Total	14,294	17,951	19,172	21,037	22,698	25,269	27,207	29,716	31,670	34,132

Source:Thailand Energy Situation 1993

The raw oils to be refined in Thailand include its domestic crude oil, condensate, and imported crude oil.

Due to small production of domestic crude oil, conventionally oil has been mainly imported. Although the country depended for its imported crude oil highly on the Middle East, oil export countries have been getting increasingly diversified since the start of the second oil crisis. The country now imports the crude oil from the Middle East and the ASEAN countries. The primary energy supply keeps on increasing every year, reflecting its high economic growth rate.

In 1983 Thailand succeeded in the development of petroleum in its middle district, etc., producing $1,247 \times 10^3$ toe in 1993.

Figure 2.3 Trend of Oil Supply

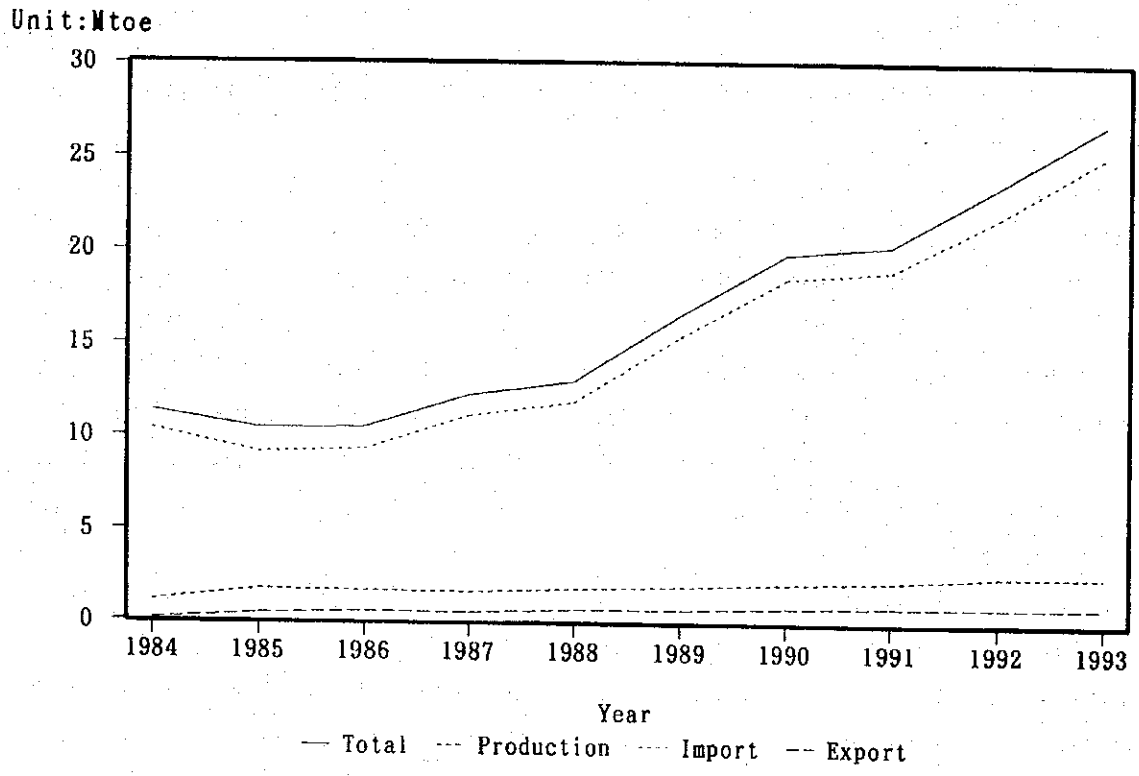


Table 2.4 Trend of Oil Supply

Unit:1000toe

Sources		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Production	Crude Oil	737	1,083	1,058	894	1,017	1,066	1,196	1,222	1,317	1,247
	Condensate	374	649	648	690	815	838	897	998	1,204	1,307
	Total	1,111	1,732	1,706	1,584	1,832	1,904	2,093	2,220	2,521	2,554
Import	Crude Oil	6,811	6,751	7,178	7,868	7,509	10,143	10,860	10,996	13,792	16,096
	Petroleum Products	3,575	2,367	2,151	3,258	4,326	5,268	7,660	7,974	8,092	9,072
	Total	10,386	9,118	9,329	11,126	11,835	15,411	18,520	18,970	21,884	25,168
Export	Petroleum Products	3	37	76	29	-	7	21	29	155	356
	Condensate	126	403	493	445	676	704	756	850	727	510
	Total	129	440	569	474	676	711	777	879	882	866
Total		11,368	10,410	10,466	12,236	12,991	16,604	19,836	20,311	23,523	26,856

Source:Thailand Energy Situation 1993

The country has been steadily increasing its domestic crude oil production since its start; however, the country is not so rich in natural resources, and the production amount in 1993 was lower than that in 1992. Thus the production is estimated to gradually decline in the future.

c. Natural gas

In 1981, commercial production of natural gas was started in the Gulf of Siam, and has been steadily expanding with the development of new gas fields. In 1993, 8,397 × 10^3 toe was produced from seven gas fields including inland ones.

The gas produced in the Gulf of Siam is carried by the submarine pipeline to the natural gas separation plant in Rayong, and then sent to power stations or factories.

Figure 2.4 Trend of Natural Gas Supply

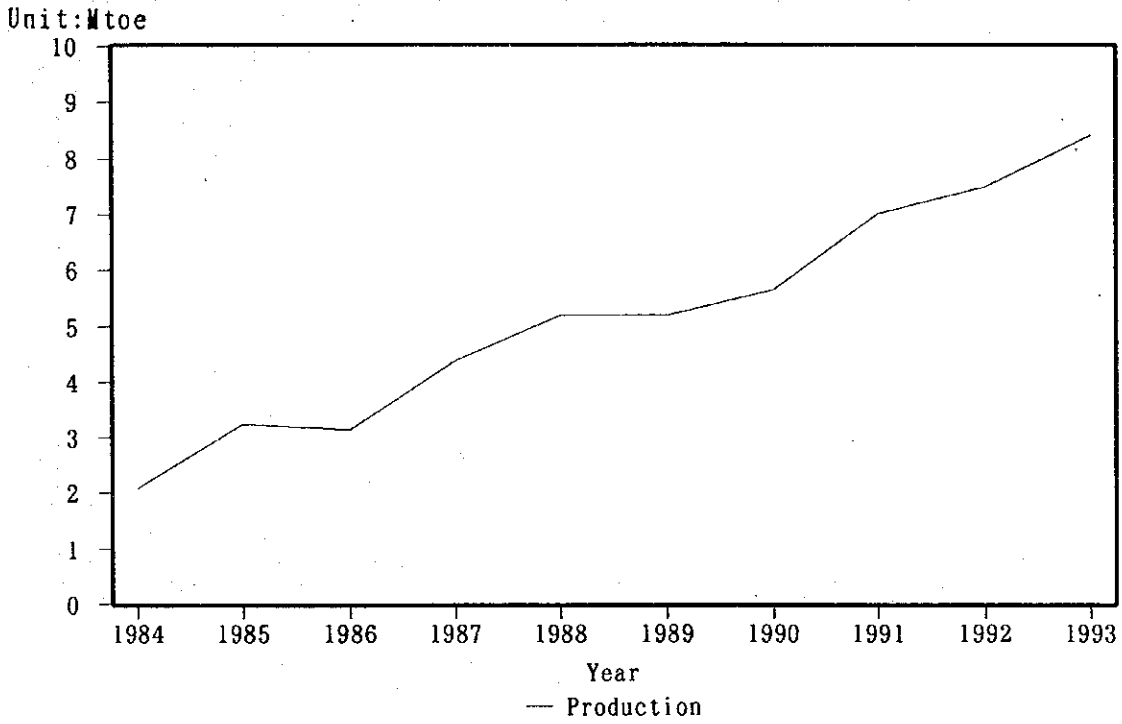


Table 2.5 Trend of Natural Gas Supply

Unit:1000toe

Sources	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Production	2,101	3,250	3,139	4,390	5,200	5,194	5,657	7,011	7,501	8,397

Source:Thailand Energy Situation 1993

Natural gas has greatly contributed as an alternative energy source. The production of natural gas is, however, estimated to reach its peak in the middle of the 1990's, and to gradually decline toward the year 2000.

d. Coal

Most of the coals produced in Thailand are brown coal (lignite), a low-grade coal, the calorific value of which is not more than 2,500 ~ 3,000 kcal. Lignite, which is mainly produced in the northern part of Thailand, is used for power generation, the cement industry and drying of tobacco.

Figure 2.5 Trend of Coal Supply

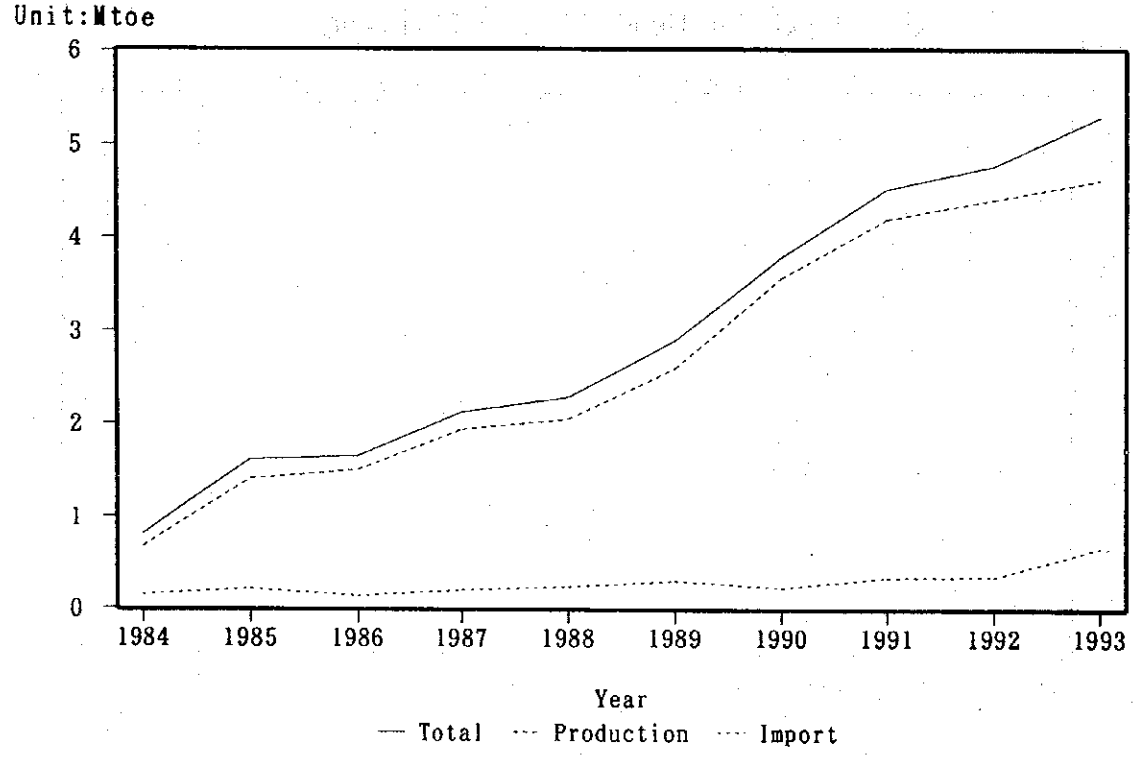


Table 2.6 Trend of Coal Supply

Unit:1000toe

Sources		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Production	Lignite	667	1,401	1,508	1,932	2,049	2,592	3,570	4,193	4,410	4,619
	Anthracite	-	-	-	-	-	-	-	-	16	12
	Total	667	1,401	1,508	1,932	2,049	2,592	3,570	4,193	4,426	4,631
Import	Steam Coal	88	151	112	156	185	237	120	192	16	-
	Anthracite	3	6	3	3	5	5	10	14	1	3
	Coke	53	56	26	38	50	55	60	56	48	54
	Other Coal	-	-	-	-	-	3	28	69	277	602
	Total	144	213	141	197	240	300	218	331	342	659
Total		811	1,614	1,649	2,129	2,289	2,892	3,788	4,524	4,768	5,290

Source:Thailand Energy Situation 1993

Electricity Generating Authority of Thailand (EGAT) is now proceeding with the construction project of Ao-Phai Thermal Power Plant (700 MW×4, coal-fired; No. 1 station is scheduled to start its operation in 1998.)

Since the production of natural gas now in progress is estimated to reach its peak in the middle of the 1990's and then to gradually decline, coal is considered to be an important power generating fuel for the long run.

e. Electric power

With the rapid industrialization since the latter half of the 1980's, electric power demand in Thailand has registered a remarkable annual growth at a 10% level in recent years. The power demand in 1993 is 64,000 GWh, an 11.2% increase over the previous year.

In response to such 2-digit growth in demand, EGAT plans to boost electricity supply capacity mainly of thermal power, under the long-term power development plan. EGAT expects to achieve a reserve rate of 17% in the year 2000.

Figure 2.6 Trend of Electric Power Supply

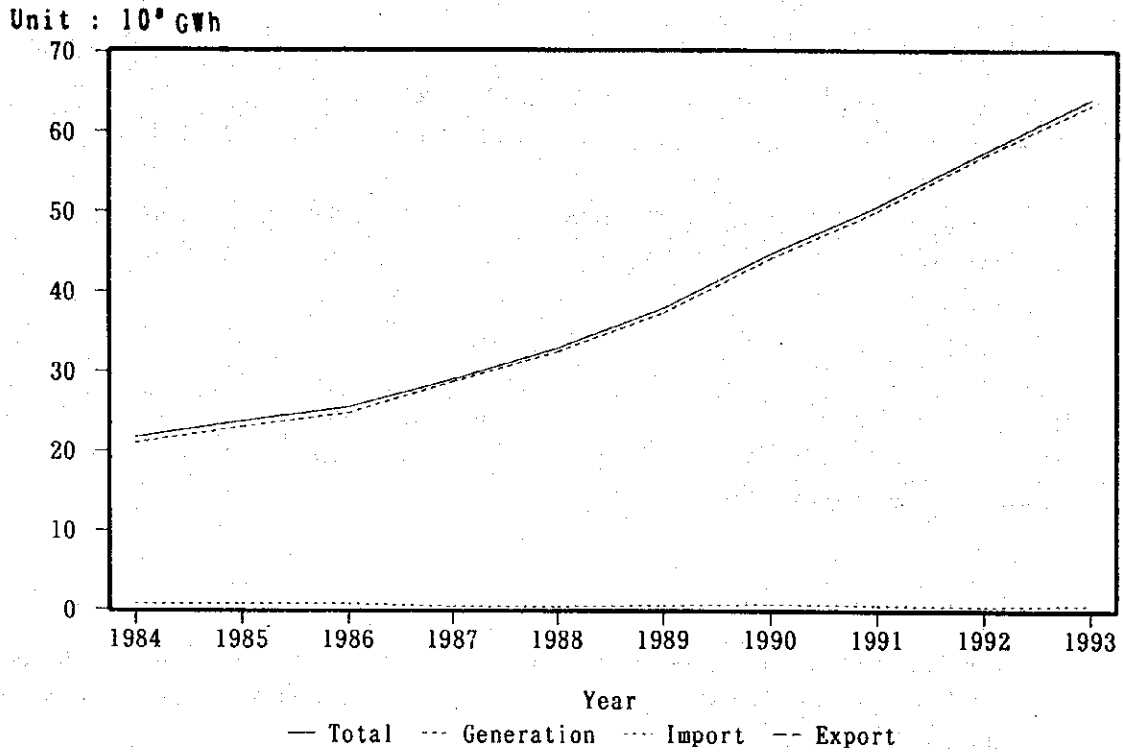


Table 2.7 Trend of Electric Power Supply

Unit:GWh

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Generation	21,024.6	23,074.4	24,716.8	28,652.2	32,464.4	37,406.4	44,175.0	50,185.9	57,098.4	63,404.8
Import	709.7	723.0	758.4	415.5	429.8	643.1	652.3	594.8	481.2	644.5
Export	22.0	20.1	17.2	18.0	19.9	23.1	30.7	39.9	41.1	48.6
Total	21,712.3	23,777.3	25,458.0	29,049.7	32,874.3	38,026.4	44,796.6	50,740.8	57,538.5	64,000.7

Source:Electric Power in Thailand 1993

Note:excluding private self-generation including electric purchase from small power producers since 1991

In 1993, energy resources for electric power generation include natural gas (44%), lignite (21%), petroleum (28%) and hydro power (5%), which shows an increasing use of natural gas.

Figure 2.7 Trend of Electric Power Generation by Energy Sources

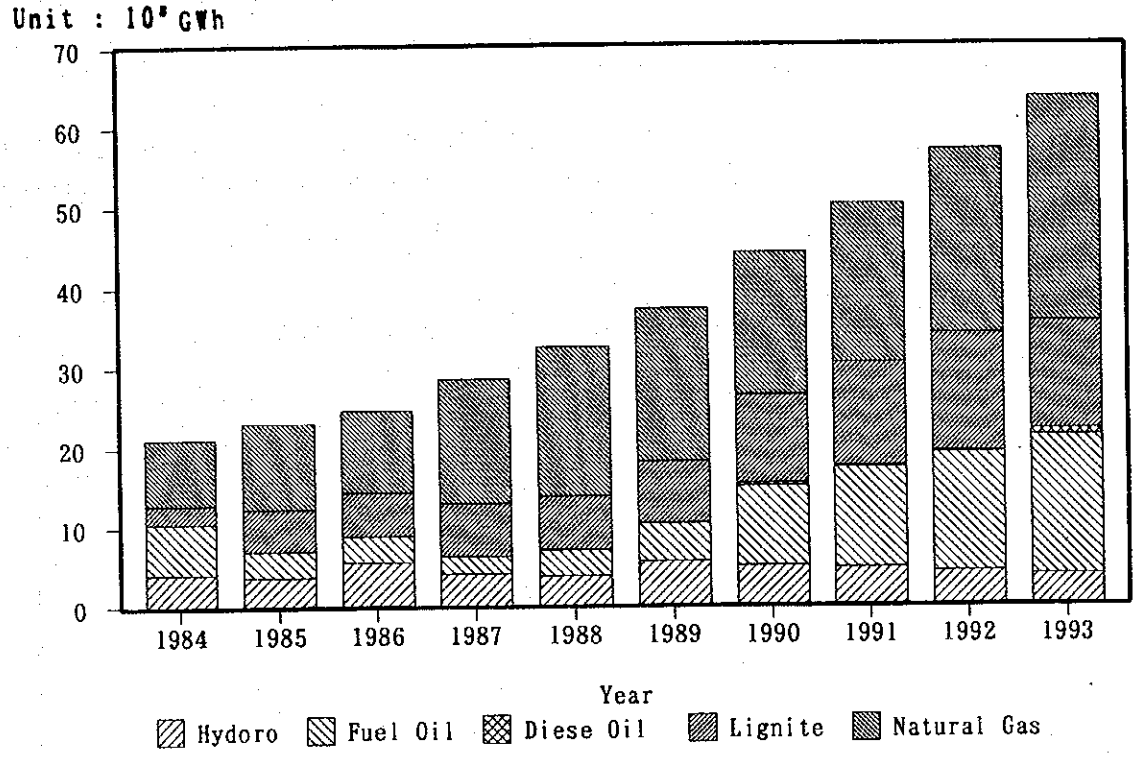


Table 2.8 Trend of Electric Power Generation by Energy Sources

Unit:GWh

Sources	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Hydro	4,081.4	3,692.2	5,554.4	4,075.3	3,779.0	5,570.8	4,975.5	4,586.5	4,238.5	3,700.1
Fuel Oil	6,335.2	3,379.7	3,332.0	2,188.4	3,142.2	4,738.8	10,012.6	12,636.4	14,928.9	17,494.5
Diesel Oil	28.1	23.9	33.8	66.8	23.8	23.4	365.5	125.6	171.8	752.0
Lignite	2,317.0	5,312.8	5,544.9	6,698.0	6,799.5	7,878.6	11,052.8	13,036.5	14,815.0	13,503.8
Natural Gas	8,262.9	10,665.8	10,251.7	15,623.7	18,719.9	19,194.8	17,767.6	19,799.9	22,943.1	27,953.3
Geothermal	-	-	-	-	-	-	1.0	1.0	1.1	1.1
Total	21,024.6	23,074.4	24,716.8	28,652.2	32,464.4	37,406.4	44,175.0	50,185.9	57,098.4	63,404.8

Source:Electric Power in Thailand 1993

f. Alternative and new energies

National Energy Policy Office is working on the development of alternative energies such as an efficient portable charcoal cooking stove, bio-gas made from animal excretion, and solar thermal energy.

Also, DEDP is testing and studying photovoltaic power generation while EGAT is working on geothermal, photovoltaic and wind power generation as well as fuel cells.

2.3 Current Situation of Final Energy Consumption in Industries, and Future Plans

(1) Final energy consumption rate by sectors

The final energy consumption in 1993 is $39{,}328 \times 10^3$ toe, an increase by 2.2 times that in 1984. The industrial sector accounts for 30.3% of energy consumption. In recent years, energy demand is remarkably increasing in the transportation sector.

Figure 2.8 Trend of Final Energy Consumption by Sectors

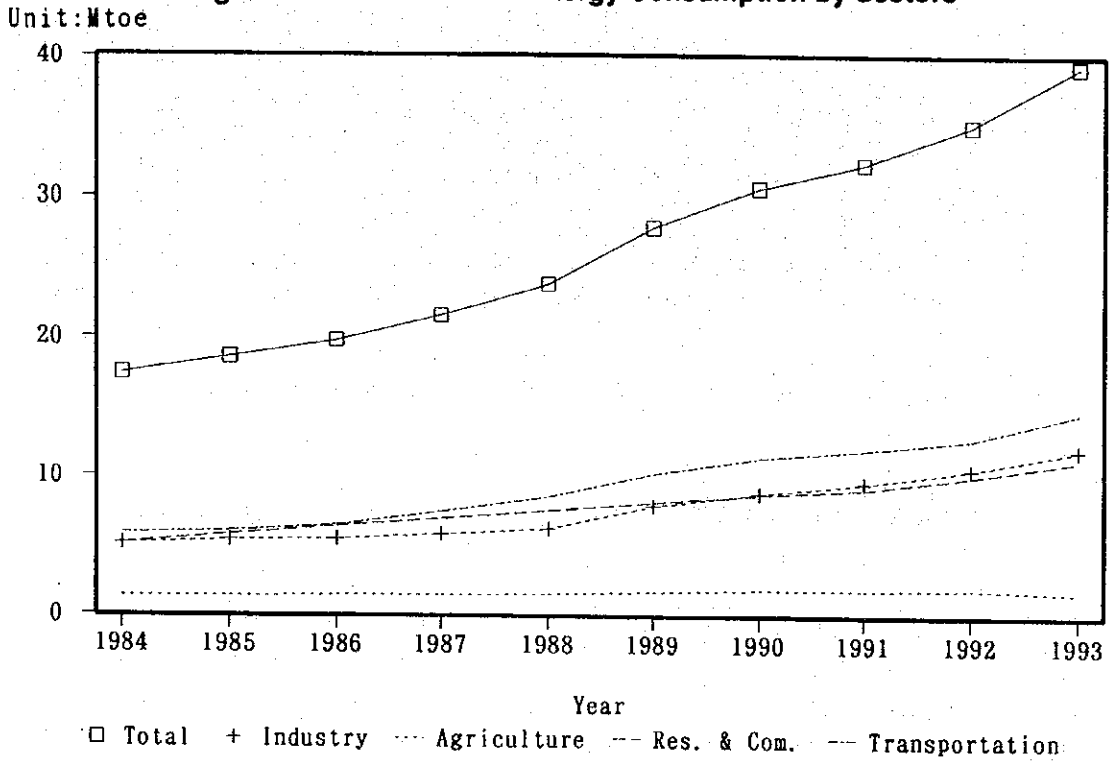


Table 2.9 Trend of Energy Consumption by Economic Sectors

Unit:1000toe

Sources	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Industry										
Mining	86	74	53	49	49	56	58	53	42	42
Manufacturing	4,929	5,219	5,249	5,599	6,062	7,712	8,541	9,288	10,238	11,687
Construction	100	125	123	111	99	109	147	194	220	182
Sub Total	5,115	5,418	5,425	5,759	6,210	7,877	8,746	9,535	10,500	11,911
Aguriculture	1,292	1,355	1,405	1,441	1,523	1,639	1,803	1,827	1,897	1,618
Res.& Com.	5,097	5,756	6,376	6,932	7,496	8,114	8,725	9,135	10,055	11,218
transportation	5,916	6,025	6,492	7,428	8,520	10,169	11,368	11,910	12,652	14,581
Total	17,420	18,554	19,698	21,560	23,749	27,799	30,642	32,407	35,104	39,328
Industry %	29.4	29.2	27.5	26.7	26.1	28.3	28.5	29.4	29.9	30.3

Source:Thailand Energy Situation 1993

(2) Energy consumption rate

Figure 2.9 and Table 2.10 show energy consumption rate of each sector per its GDP.

Thai entire domestic energy consumption versus GNP remains on the same level (shows no marked fluctuations), whereas the energy consumption of the industrial sector versus GNP in 1993 is 12.8 kgoe/1,000 Baht, which is 0.87 times as much as that in 1984. Thus, energy conservation in the industrial sector may well be said to have progressed for these 10 years.

Figure 2.9 Trend of Final Energy Consumption of the Sectors per GDP

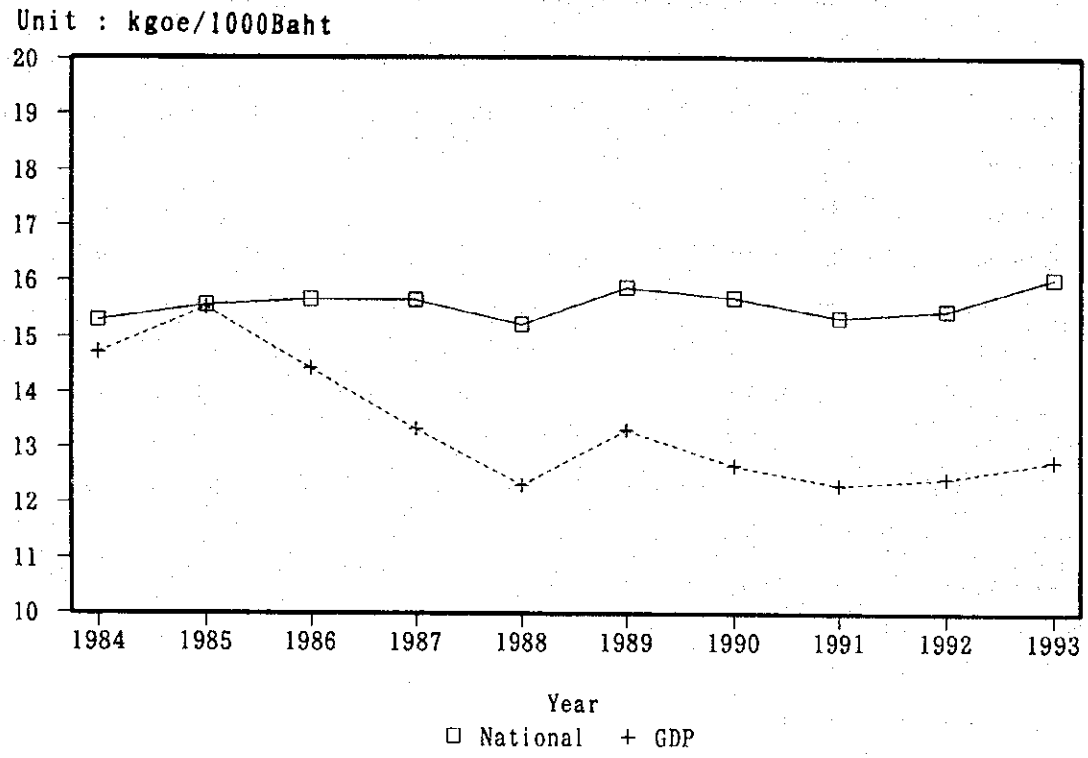


Table 2.10 Trend of Energy Consumption of the Sectors per GDP

	unit	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Industry											
Consumption	ktoe	5,115	5,417	5,425	5,759	6,210	7,877	8,746	9,535	10,500	11,911
GDP	Million Baht	347,402	348,955	376,170	431,917	504,082	591,413	690,326	773,422	844,343	933,208
Consumption/GDP	kgoe/1000Baht	14.7	15.5	14.4	13.3	12.3	13.3	12.7	12.3	12.4	12.8
Aguriculture											
Consumption	ktoe	1,292	1,355	1,405	1,441	1,523	1,639	1,803	1,827	1,897	1,618
GDP	Million Baht	217,518	227,324	228,191	228,346	252,346	276,569	266,227	279,493	290,586	297,500
Consumption/GDP	kgoe/1000Baht	5.9	6.0	6.2	6.3	6.0	5.9	6.8	6.5	6.5	5.4
Res.& Com.											
Consumption	ktoe	5,097	5,756	6,376	6,932	7,496	8,114	8,725	9,135	10,055	11,218
GDP	Million Baht	469,745	502,095	530,880	584,484	651,467	710,957	803,209	849,216	906,929	973,542
Consumption/GDP	kgoe/1000Baht	10.9	11.5	12.0	11.9	11.5	11.4	10.9	10.8	11.1	11.5
transportation											
Consumption	ktoe	5,916	6,025	6,492	7,428	8,520	10,169	11,368	11,910	12,652	14,581
GDP	Million Baht	80,548	85,922	92,046	100,585	116,611	128,754	146,753	157,035	171,277	183,877
Consumption/GDP	kgoe/1000Baht	73.4	70.1	70.5	73.8	73.1	79.0	77.5	75.8	73.9	79.3
National											
Consumption	ktoe	17,420	18,554	19,698	21,560	23,749	27,799	30,642	32,407	35,104	39,328
GDP(at'88 price)	Million Baht	1,138,353	1,191,255	1,257,177	1,376,847	1,559,804	1,749,952	1,953,382	2,110,978	2,270,527	2,449,899
Consumption/GDP	kgoe/1000Baht	15.3	15.6	15.7	15.7	15.2	15.9	15.7	15.4	15.5	16.1

Source:Thailand Energy Situation 1993

Note:Industry included manufacturing, mining and costruction

GDP 1989-1992 revised according to NESDB

(3) Energy consumption by sources

The trend of energy consumption by sources in Thailand is as shown in Figure 2.10 and Table 2.11. Energy consumption is significantly increasing in petroleum products.

Figure 2.10 Trend of Final Energy Consumption by Sources

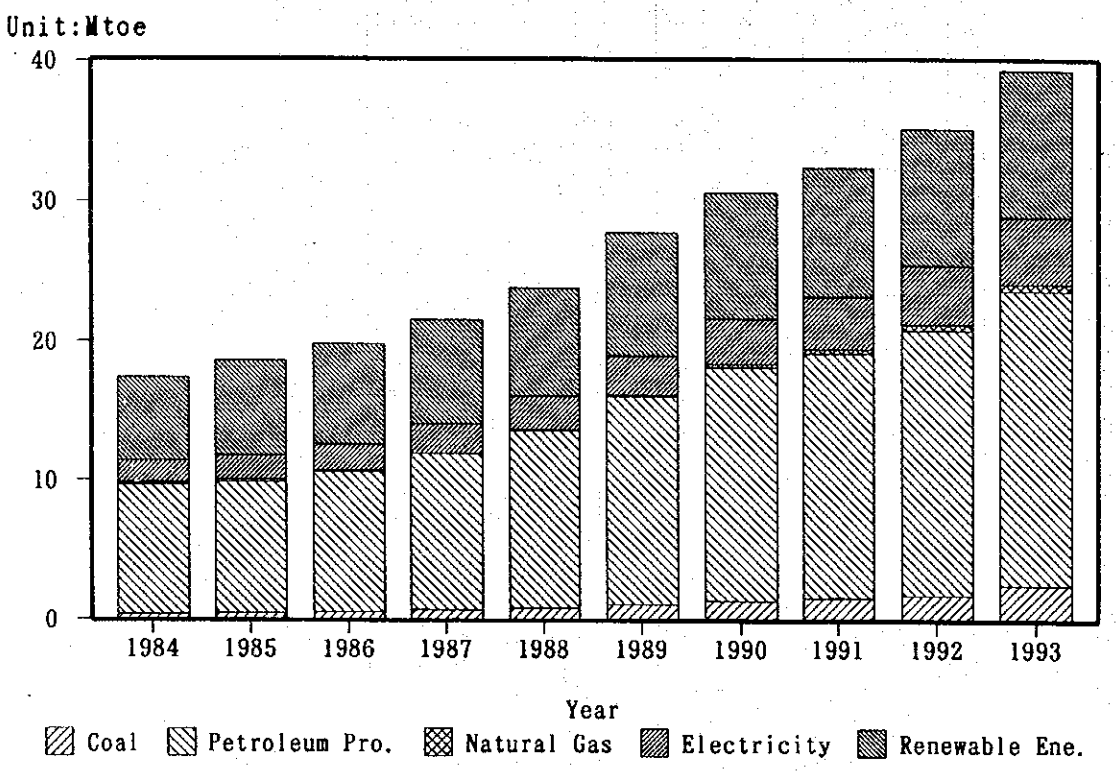


Table 2.11 Trend of Final Energy Consumption by Sources

Unit:1000toe

Sources	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Coal & Coke										
Steam Coal	88	151	112	156	185	237	120	192	16	-
Anthracite	3	6	3	2	5	5	10	14	14	16
Coke	53	56	26	38	50	55	60	56	48	54
Other Coal	-	-	-	-	-	3	28	69	277	602
Lignite	157	233	323	478	568	782	1,126	1,228	1,358	1,852
Sub Total	301	446	464	674	808	1,082	1,344	1,559	1,713	2,524
Petroleum Products										
LPG	606	718	757	807	899	1,009	1,098	1,184	1,321	1,428
PRE-Gasoline	626	632	695	829	968	1,142	1,304	1,409	1,657	2,052
PRG-Gasoline	952	924	995	1,106	1,209	1,337	1,442	1,495	1,576	1,612
Jet Fuel	985	1,012	1,120	1,218	1,500	1,774	1,931	2,083	2,182	2,334
Kerosene	237	126	117	105	103	98	101	92	93	89
HSD	4,423	4,675	4,874	5,451	6,130	7,219	8,213	8,413	8,741	9,934
LSD	88	69	60	80	84	111	101	121	137	173
Fuel Oil	1,425	1,307	1,453	1,667	1,854	2,311	2,619	2,784	3,355	3,493
Sub Total	9,342	9,463	10,071	11,263	12,747	15,001	16,809	17,581	19,062	21,115
Natural Gas	194	178	87	40	60	114	264	360	441	492
Electricity	1,583	1,707	1,878	2,121	2,408	2,798	3,267	3,698	4,201	4,795
Renewable Energy										
Fuel Wood	2,430	2,759	2,958	3,083	3,161	3,278	3,426	3,426	3,555	3,765
Charcoal	1,787	2,039	2,324	2,565	2,782	2,997	3,253	3,409	3,705	4,125
Paddy Husk	671	743	686	590	499	640	564	406	567	533
Bagasse	1,112	1,219	1,230	1,224	1,284	1,889	1,715	1,968	1,860	1,979
Sub total	6,000	6,760	7,198	7,462	7,726	8,804	8,958	9,209	9,687	10,402
Total	17,420	18,554	19,698	21,560	23,749	27,799	30,642	32,407	35,104	39,328

Source:Thailand Energy Situation 1993

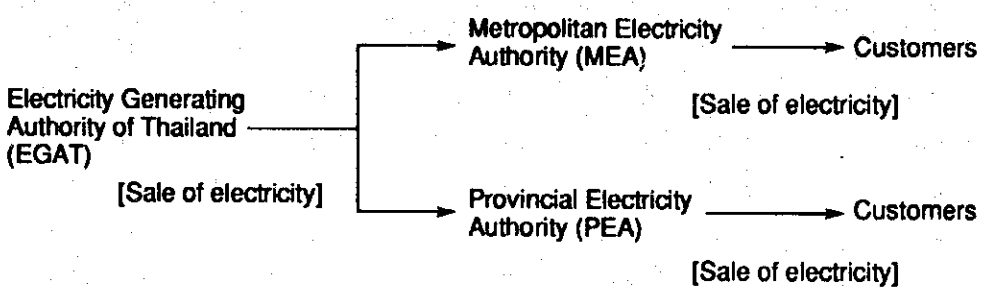
(4) Power demand and supply

1) Power supply system

The electricity supply system in Thailand is composed of two parts, i.e. generation, transmission and transformation of electricity, and distribution, as shown in Fig. 2.11. Under the system, EGAT takes charge of power generation and transmission, and the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) are responsible for distribution to their respective service areas.

EGAT applies different prices to MEA and PEA as part of public policy consideration (to promote decentralization of factories) that end users can use electricity at the same unit price.

Figure 2.11 Power Supply System in Thailand



EGAT's installed capacity in 1991 amounted to 9,610,000 kW, of which thermal power accounts for 75% and hydropower for 25%, indicating that thermal power is main and hydropower is sub. Hydropower is also purchased from a neighboring country, Laos.

2) Power consumption

In 1993, power consumption is 38% for industrial use, 39% for commercial business use and 21% for household use.

During the last decade (1989 to 1993), power demand has increased by 2.5 times for industrial use, by 4.5 times for commercial use and by 2.5 times for household use. Power consumption per capita in 1993 is 964.75 kWh.

According to a daily load curve (EGAT), power consumption reaches its peak between 7 – 9 pm when demand for lighting and TVs increases at home. Comparing the high-temperature period (March to November) and low-temperature period (December to February) during the year discloses that power demand increases shaply in March and moderately thereafter.

The elasticity of power consumption to gross domestic product (GDP) has been about 1.2 in the last 5 years (1989 to 1993), which means that power consumption has been growing faster than economic growth.

EGAT expects this increase trend to continue also during the 7th NESDP.

Figure 2.12 Trend of Electric Consumption by Sectors

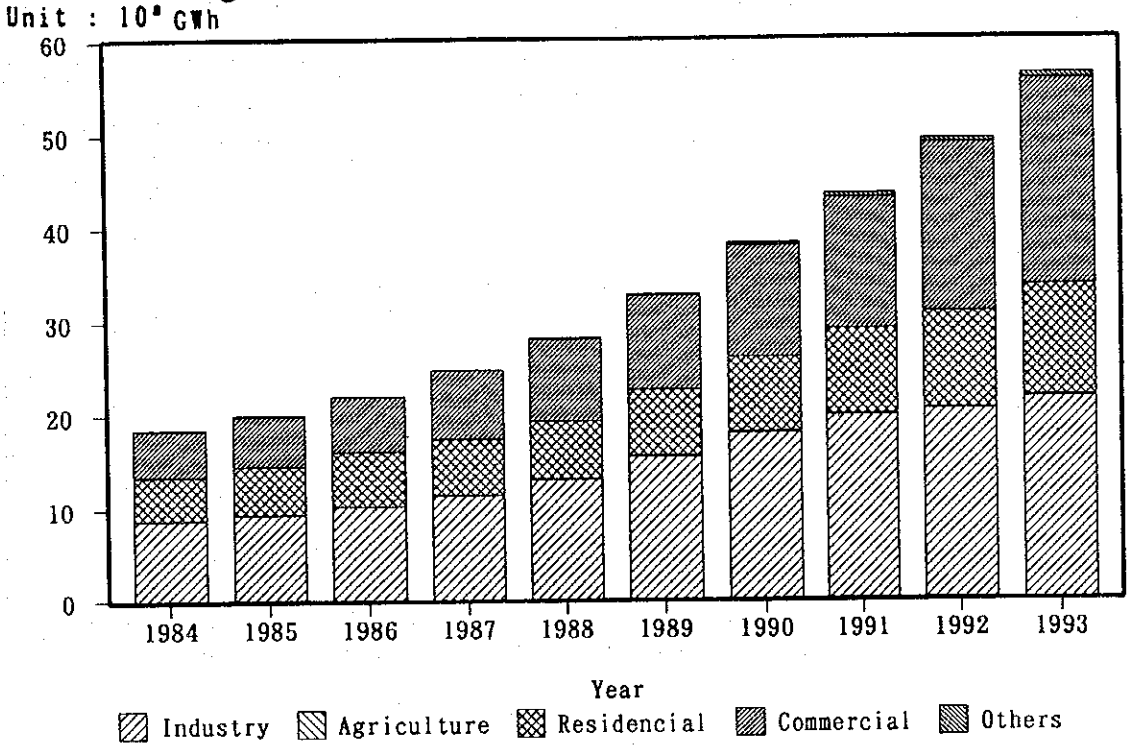


Table 2.12 Trend of Energy Consumption by Economic Sectors

Unit:GWh

Sources	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Industry	8723.5	9,298.0	10,162.7	11,319.4	12,951.8	15,431.0	17,928.0	19,813.3	20,406.1	21,629.3
Aguriculture	47.8	55.0	56.7	61.3	67.4	89.7	96.2	93.8	117.6	129.9
Residencial	4,731.5	5,164.7	5,795.1	6,135.5	6,253.5	7,024.6	8,087.6	9,152.1	10,258.8	11,932.7
Commercial	4,912.5	5,344.1	5,847.8	7,331.2	8,847.6	10,108.2	11,982.8	13,975.5	18,049.1	21,977.5
Others	156.9	170.1	172.1	46.8	132.4	180.3	247.6	362.9	472.1	610.0
Total	18,572.2	20,031.9	22,034.4	24,894.2	28,252.7	32,833.8	38,342.2	43,397.6	49,303.7	56,279.4

Source:Electric Power in Thailand 1993

Note:excluding private self-generation

classfied by TSIS code and including mining since 1992

(5) Estimated energy consumption

Figure 2.13 and Table 2.13 estimate energy consumption by sectors. Energy consumption in the year 2006 is estimated to be 106,433 × 10^3 ktoe, a 117% increase over that in the year 1993, out of which energy consumption in the industrial sector is expected to increase by 157%.

Figure 2.13 Estimated Energy Consumption by Sectors

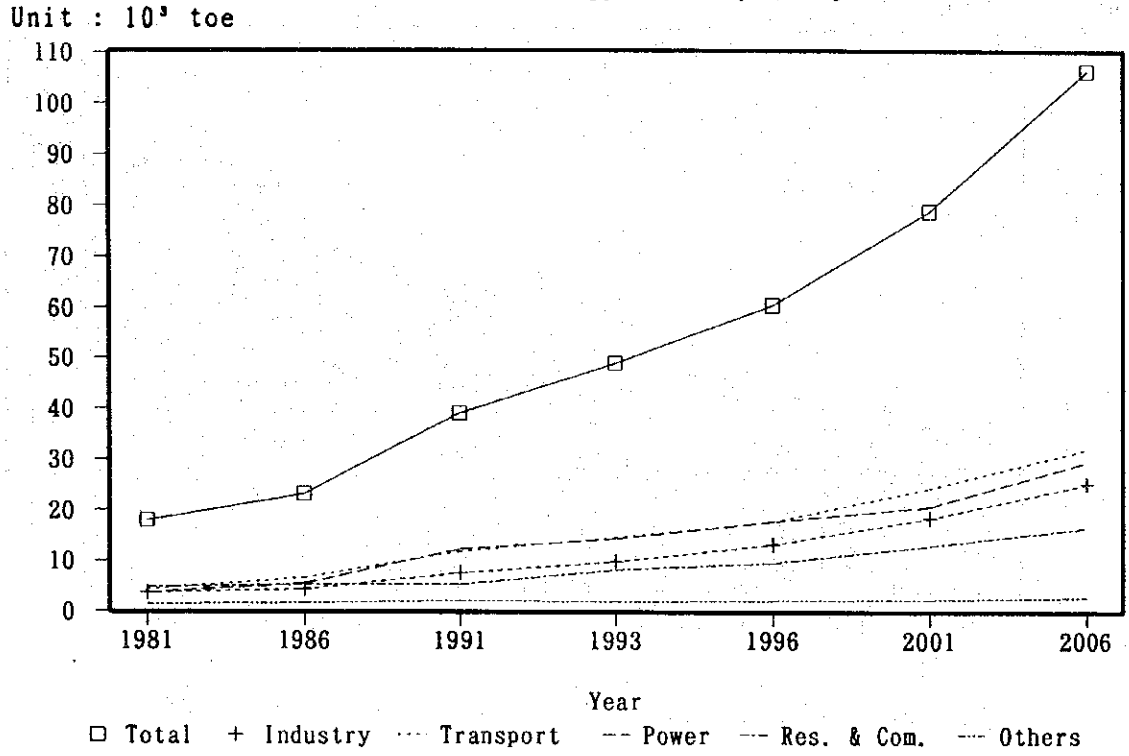


Table 2.13 Estimated Energy Consumption

Unit:1000toe

Sector	1981	1986	1991	1993	1996	96/93 %	2001	2001/93 %	2006	2006/93 %
Industry	3,691	4,384	7,598	9,826	13,146	33.79	18,433	87.59	25,278	157.26
Transport	4,431	6,492	11,910	14,581	17,792	22.02	24,276	66.49	32,204	120.86
Power	3,669	5,493	12,316	14,395	17,685	22.86	20,791	44.43	29,520	105.07
Res. & Com.	4,837	5,211	5,207	8,295	9,628	16.07	12,938	55.97	16,685	101.15
Others	1,267	1,574	2,066	1,831	2,052	12.07	2,372	29.55	2,746	49.97
Total	17,895	23,154	39,097	48,928	60,303	23.25	78,810	61.07	106,433	117.53

Source:Thailand Energy Situation 1993

Remark:Energy Consumption (excluding electricity) by end-use and for power generation

Moreover, with the rise of the income level per capita, traditional energy resources such as firewood, charcoal, etc will occupy less and less percentage, thus further accelerating transfer of their use to energy for commercial use.

2.4 Number of Factories Classified by Types of Product and Their Outputs

(1) Number of factories classified by types of product

Figure 2.14 Number of Factories Classified by Types of Product in Thailand (1993)

	Bangkok	Outside Bangkok
Beverage	60	181
Food	944	52,952
Textiles	448	805
Clothing	2,087	258
Leather	13	172
Wood & Furniture	1,367	3,347
Paper	7	215
Printing	99	-
Chemical	27	110
Rubber	237	403
Resin	8	46
Metal	4,216	2,292
Equipment	279	176
Auto Mobiles	755	1,283
Others	11,722	20,009
Total	22,269	82,240

Source : Industrial Statistics Yearbook 1993

(2) Outputs by kinds of product

Table 2.14 Trend of Main Manufactured Products

Product	Unit	1987	1988	1989	1990	1991	1992
Food, Beverage, Tobacco							
Sugar	1000 Mt	2,432	2,865	3,837	3,383	4,031	4,857
Beer	1000 L	97,293	130,261	180,085	263,482	284,048	325,202
Whiskey	1000 L	465,460	522,686	615,719	624,069	596,183	604,847
Tobacco	Mt	31,403	33,992	37,365	38,180	39,697	40,691
Fabrics							
Garment, textiles	Million Baht	48,555	58,625	74,027	84,472	109,524	111,837
Synthetic fiber	Mt	142,439	155,639	202,347	225,017	306,100	356,905
Construction materials							
Galvanized steel plate	Mt	171,666	189,996	200,616	208,483	213,323	217,332
Reinforcing bar	Mt	347,934	387,571	503,909	617,127	880,427	974,536
Cement	1000 Mt	9,850	11,514	15,025	18,054	19,164	21,711
Two-wheeled, Four-wheeled vehicles							
Motorcars	Unit	98,148	154,183	213,536	305,145	283,115	323,961
Motor cycles	Unit	302,195	488,669	587,216	715,115	668,436	863,185
Tires	Mt	42,205	50,786	59,427	66,891	73,661	88,035
Others							
Integrated Circuits (IC)	Million pieces	944	1,143	963	1,301	1,428	1,531
Tinplate	Mt	119,319	148,150	149,478	173,111	190,386	226,368
Paper (for printing and writing use)	Mt	110,830	115,485	140,370	157,600	–	–

Source: General Situation of the Kingdom of Thailand 1993