Table 9.3-6 DEMANDS FOR ENGINEERING PLASTICS IN THAILAND

(Unit: tons)

	1988	1989	1990	1991	1992
ABS	12,600	16,000	32,000	41,000	41,800
Polyacetal	2,000	2,700	4,100	4,600	5,000
Polycarbonate	580	830	1,200	1,300	1,400
Nylon 6, 66	800	1,100	1,470	1,600	1,800
MPPE/PPO	400	670	760	900	1,000
PBT	240	320	460	1,000	1,100
Total	15,620	19,500	28,900	31,400	36,300

Note: In Thailand, only ABS is produced by Thai ABS Co., Ltd. with a capacity of 18,000 tpa as of 1992.
Source: UNICO's data file.

9.3.3 Upstream (petrochemical complexes) in plastics industry

In Thailand, the plastics industry has developed from downstream to upstream. At first, plastics were molded by using imported pellets. Then, imported monomers were polymalized and pelletized. Finally, petrochemical complexes were constructed to produce various types of monomer (such as ethylene and propylene), when the demand for downstream products reached a profitable level. This approach, "upward linkage", is still followed in the country. In the petrochemical complex "NPC-C" under construction (expected to be completed in 1995), downstream plants will be earlier completed and start in operation by using imported materials, which will be replaced by domestic products, after a new complex "NPC-2" is completed. It is true for the petrochemical complex "NPC-1" which is already under operation (Completed in 1990). This complex also is not self-sufficient, but obliged to complement any shortage of supply with imported materials.

Figure 9.3-1 shows a general view of the petrochemical complex "NPC-1" being operated at Map Ta Phut. This complex uses natural gas produced (at Erawan gas field) in the Gulf of Siam. It produces ethylenes (C_2) and propylene (C_3) from the natural gas and uses them to produce plastics. However, it does not produce C_4 and Cs with higher numbers as well as BTX.

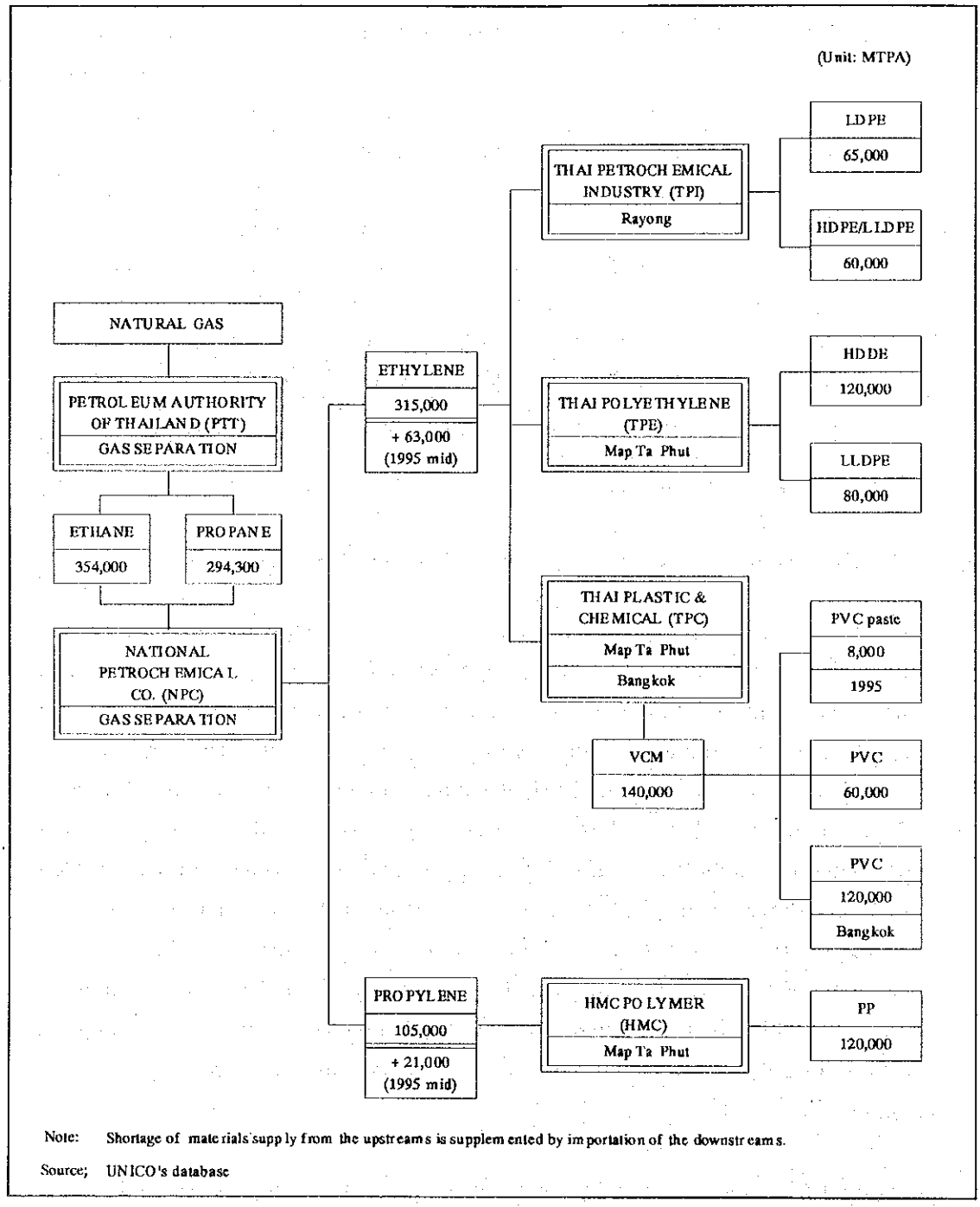
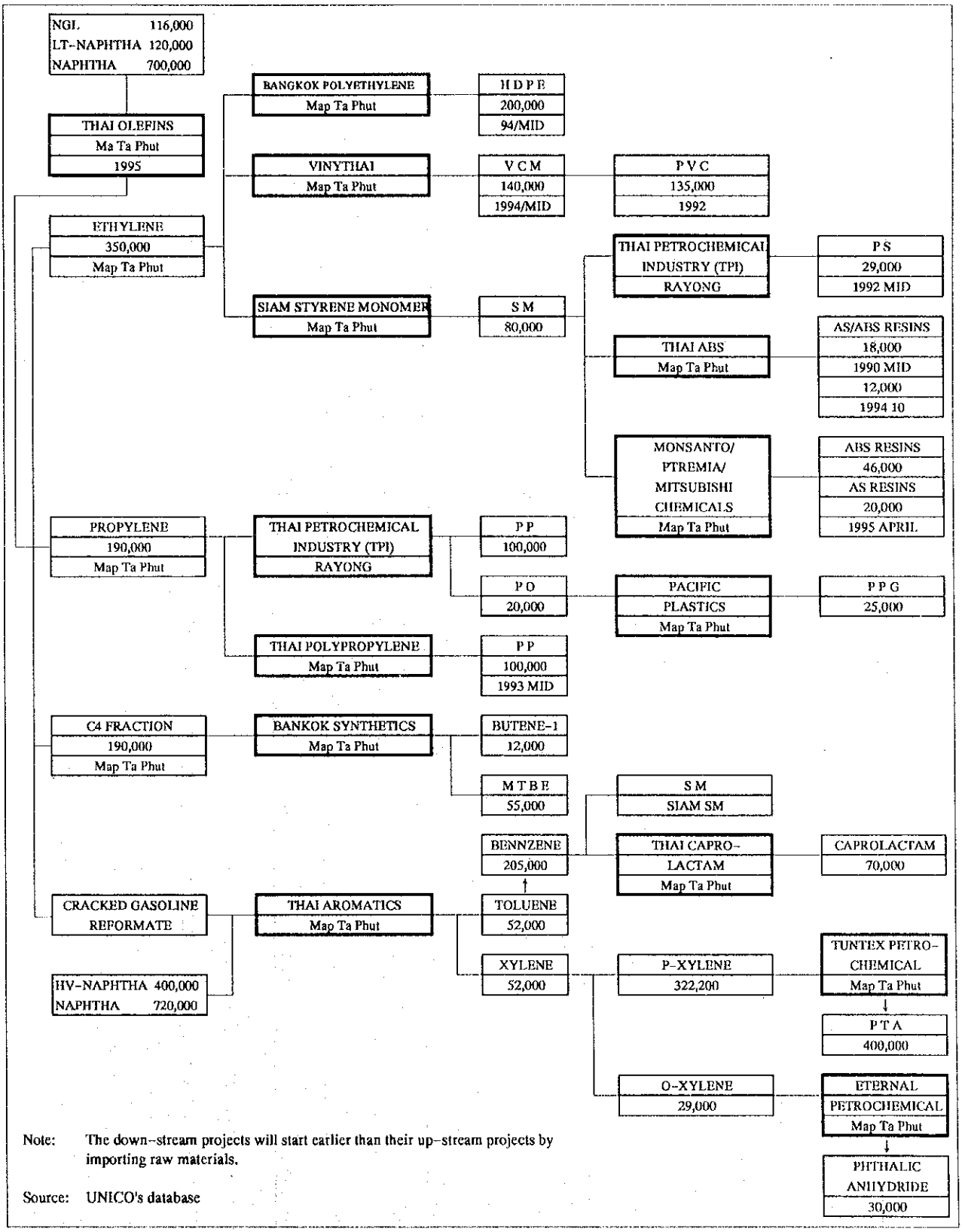


Figure 9.3-1 PRODUCTION SCHEME OF FIRST PETROCHEMICAL COMPLEX (NPC1)



Note: The down-stream projects will start earlier than their up-stream projects by importing raw materials.

Source: UNICO's database

Figure 9.3-2 PRODUCTION SCHEME OF SECOND PETROCHEMICAL COMPLEX (NPC 2)

Table 9.3-7 IMPORT AND CIF PRICE OF PLASTIC RESIN

	Import (Ton/month)	Major Origin				CIF (Bahts/kg)
PVC (Virgin)	4,675	Japan 48%,	Korea 20%,	U.S.A. 8%,	French 5%	18.1
PVC (Compound)	340	S'pore 20%,	Japan 19%	U.S.A. 18%,	Taiwan 11%	31.6
LDPE	4,671	Japan 32%,	French 16%,	Saudi 8%,	Taiwan 16%	23.5
HDPE	3,255	Japan 26%,	S'pore 21%,	Saudi 14%,	U.S.A. 9%	20.2
PP (Homo-polymer)	3,562	Korea 23%,	S'pore 16%,	Malaysia 10%,	U.S.A. 6%	19.0
PP (Co-Polymer)	2,268	Japan 59%,	S'pore 15%,	Australia 7%,	French 4%	30.5
ABS	2,511	Japan 64%,	U.S.A. 15%,	Taiwan 11%,	Korea 7%	40.0
PMMA	192	Japan 61%,	Taiwan 25%,	U.S.A. 8%,	Korea 3%	51.9
POM	424	Japan 82%,	S'pore 9%,	U.S.A. 6%,	Germany 3%	59.4
PC	349	Japan 48%,	U.S.A. 31%	Germany 16%,	Taiwan 2%	87.9
N6, N66	444	Germany 45%,	Japan 27%,	U.S.A. 14%,	Netherlands 6%	61.8

(Source) Price: JICA Team's interview survey

Import: Foreign Trade Statistics, Custom Department of Thailand

On the contrary, the new complex "NPC-2" which is being constructed at Map Ta Phut will use imported naphtha as base material so that it can also produce C_4 and PS for rubber as well as BTX for caprolactam. Figure 9.3-2 shows a general view of the complex "NPS-2".

Another project is a new complex "NPC-3", which will be constructed to respond to an increasing demand for plastics and other petrochemical products in the future. This is a more upstream to the petroleum refining industry using crude oil imported from Middle East. This project is considered as a part of the Southern Sea Board (SSB) Development Project undertaken in the areas around the Gulf of Siam. This Development Project will construct an oil refinery (using Middle East crude oil) at Krabi facing the Sea of Andaman as well as pipelines to transport petroleum products from Krabi to Khanon on the east coast. The pre-feasibility study is expected to be completed during 1994. However, it is supposed that it will take a considerable long time to realize the Development Project.

9.3.4 Prices and import duties of plastics

Table 9.3-7 indicates plastic resin imports (in the forms of pellets and compounds), their prices (CIF) and the main countries importing these products as of 1993. In Thailand, import tariffs are uniformly 40% on all the items of plastic resins as of 1993. Selling prices for domestic products are on the same level as those for the corresponding imports. The pricing system for domestic products is not related to the international competitiveness of these products, because import duties act a protective role for domestic products. However, the AFTA's policy of import duties reduction may drop the Thai import duties down to the level of 5% in the near future.

9.4 Rubber

9.4.1 Supply and demand of rubber in Thailand

Thailand has been the largest producer and exporter of natural rubber in the world, since Indonesian and Malaysian Governments adopted a policy of reducing the total gum tree culture area in each of their countries. In 1994, Thailand has yet no production of synthetic rubber, but its whole demand for this product depends upon imports.

The major applications for industrial rubber are tires and tubes for motor vehicles. Both natural and synthetic rubbers are used for these tires and tubes. In an interview survey, a tire maker reported that its consumption of rubber was 60% for natural rubber and 40% for synthetic rubber. The consumptions of natural and synthetic rubbers may depend upon the use of recycled rubber and the pricing system of rubber.

In other applications such as autoparts other than tires and tubes as well as electrical parts and electronic components, the consumption of synthetic rubber is higher than that of natural rubber. The subsequent sections report findings on rubber such as the supply and demand in Thailand. In these sections, "natural rubber imports" and "synthetic rubber exports" are omitted because they are negligible. In short, Thailand is an exporter of natural rubber and importer of synthetic rubber.

9.4.2 Production, exports and consumption of natural rubber

Tables 9.4-1, 9.4-2 and 9.4-3 give the annual production, exports and consumption of natural rubber respectively in Thailand. The production of natural rubber increased at the annual average rate of 9.9% for 5 years from 1988 to 1993, and reached 1.54 million tons (estimated) in 1993. Accordingly, natural rubber exports from Thailand grew at the annual average rate of 9.2% for the same period, and attained to 1.40 million tons (estimated), 91% of the production, in 1993. The ratio of exports to production was almost invariable annually for the six years. In 1993, the leading export destination of Thai natural rubber was Japan with 410,000 tons (29.2% of the total exports), followed by China (12.7%) and the United States (10.7%). For the same period, the consumption of natural rubber also increased steadily in Thailand, as the industrialization was developing there.

Table 9.4-1 PRODUCTION OF NATURAL RUBBER IN THAILAND

(1,000 tons)

	1988	1989	1990	1991	1992	1993 e
RSS	709.2	936.2	965.8	1,008.7	1,106.4	1,036.1
TTR	139.8	153.2	161.4	186.6	267.7	259.5
Latex	67.8	40.8	65.0	82.8	92.9	167.7
Crepe	32.0	30.8	24.6	23.1	22.2	24.5
ADS	14.0	15.7	19.5	22.6	22.2	27.8
Skim. R.	0.4	1.5	2.5	2.5	5.2	9.3
Others	0.7	0.3	11.2	8.8	14.6	18.5
Total	963.9	1,178.5	1,250.0	1,335.1	1,531.2	1,543.4

Note: RSS (Ribbed Smoked Sheet) TTR (Thai Tested Rubber)

Source: Rubber Research Institute of Thailand

Table 9.4–2 EXPORTS OF THAILAND'S NATURAL RUBBER BY DESTINATION

(1,000 tons)

	1988	1989	1990	1991	1992	1993 e
Japan	428.0	466.4	440.0	477.8	491.1	410.1
China	118.9	194.3	166.3	188.6	251.9	177.9
USA	95.5	98.4	99.8	127.0	177.8	150.4
Singapore	68.2	113.5	144.1	105.5	100.2	50.9
Malaysia	11.9	17.8	21.3	17.4	22.3	53.1
S.Korea	26.9	34.7	57.9	52.0	77.0	64.1
Taiwan	40.1	22.6	34.4	39.2	43.8	35.0
France	21.7	30.4	32.6	49.0	39.3	42.6
Germany	35.2	46.1	45.6	41.7	20.0	12.8
Others	60.0	76.4	108.7	133.7	189.1	407.8
Total	906.4	1,100.6	1,150.7	1,231.9	1,412.5	1,404.7

Source: Rubber Research Institute of Thailand

Table 9.4–3 DOMESTIC CONSUMPTION OF NATURAL RUBBER BY USE IN THAILAND

Group of Products	1988	1989	1990	1991	1992	1993 e
Vehicle tyre and inner tube (car, truck, airplane, etc.)	24.2	37.1	45.0	48.5	56.9	62.5
Retreading	1.6	1.2	1.1	1.8	2.0	2.2
Accessories part for motor and vehicle	2.3	2.3	3.3	3.4	3.8	4.2
Rubber band	4.6	10.1	11.4	11.5	11.9	13.1
Shoe and parts	7.3	7.0	9.5	9.8	11.5	12.6
Tue and hose	0.6	0.6	5.2	0.8	1.4	1.5
Battery body	0.5	0.6	0.5	0.5	0.6	0.6
Elastic thread	2.3	4.0	4.8	5.5	6.8	7.5
Foam products (cushion, carpet backing, other soft products)	0.5	0.8	1.3	1.2	1.1	0.6
Gloves (medical, household and industrial uses)	11.8	11.8	14.0	15.3	16.9	18.6
Others (eraser, lining, condom, balloon, toy, hash–cracker, belt, adhesive, etc.)	1.7	2.1	3.1	4.8	5.5	6.6
Total	57.4	77.6	99.2	103.1	118.4	130.0

Source: Rubber Research Institute of Thailand

The production, consumption and exports of natural rubber in 1993 can be summarized as follows:

Production:	1,543,400 tons
Exports:	1,404,700 tons
Consumption:	130,000 tons

The total consumption of natural rubber (1993) in Thailand is broken down by application as follows:

1 Tires and tubes	48.1%
2 Rubber gloves	14.3%
3 Rubber bands	10.1%
4 Sports shoes	9.7%
	82.2%

Thus, the 4 leading items or applications accounted for 82.2% of the total consumption in the country.

The export prices (on FOB basis) for natural rubber products in Thailand are as follows:

Smoked sheet	19.95 bahts/kg
Block	19.97 bahts/kg
Latex	18.11 bahts/kg

9.4.3 Imports of synthetic rubber

Table 9.4–4 indicates synthetic rubber imports in Thailand during 1992. SBR/BR, BR and BUTYL (IRR) recorded the highest levels of imports among all the items of synthetic rubber in the year. The main applications for the 3 items are tires and tubes for motor vehicles. Annually, about 60%, 75% to 80%, and 80% to 85% of SBR/BR, BR and BUTYL (IRR) imports respectively have been used for the production of tires and tubes for motor vehicles. SBR and BR have been also used for sports shoes and industrial parts, while NBR, EPDM and CR were mainly used for industrial parts.

Table 9.4-4 IMPORT OF SYNTHETIC RUBBER (UNVALCANIZED), 1992

Synthetic Rubber	Quantity (Tons)	Value (Million Bahts)
SBR (Styrene-Butadiene Rubber)	25,426.0	585.1
BR (Butadiene Rubber)	12,581.0	303.9
IIR (Isobutene-Isoprene Rubber)	7,531.0	403.6
CR (Chloroprene Rubber)	4,656.0	287.1
NBR (Nitrile-Butadiene Rubber)	4,014.0	158.0
IR (Isoprene Rubber)	465.0	16.5
EPDM (Etylene-Propylene-Diene-Methylene Rubber)	3,096.0	142.3
Other Synthetic Rubber	466.0	24.6
Total	58,235	1,921
Reclaimed, compounded rubber	4,226	252
Total import except natural rubber	62,461	2,173

Source: Foreign Trade Statistics, Custom Department of Thailand

Table 9.4-5 gives the production, exports and consumptions of natural rubber as well as the consumption (imports) of synthetic rubbers in 1992.

Table 9.4-5 CONSUMPTION OF RUBBER IN THAILAND (1992)

	(Unit: thousand tons)
Production (natural rubber)	1,531.2
Exports (natural rubber)	1,412.5
Consumption (natural rubber)	118.4
Consumption (synthetic rubber imports)	62.5

According to the table, the total consumption of rubber in Thailand is about 180 thousand tons, of which 2/3 are natural rubber, the rest (1/3) being imported synthetic rubber.

9.4.4 Future production projects of synthetic rubber

Petrochemical products such as butadiene are used as materials for the production of synthetic rubber. Thailand has 2 petrochemical complexes. The First Complex (NPC-1) is now producing PE (polyethylene), PP (polypropylene) and PVC (poly-vinyl chloride) by separating ethane and propane from natural gas.

The separation from natural gas cannot be used to produce synthetic rubber products containing C_4 and carbons with higher numbers. It can provide only petrochemical products containing C_3 and carbons with lower numbers. The Second Complex (NPC-2) under construction will be able to produce petrochemical products containing C_4 and carbons with higher numbers from naphtha. This complex may open up the domestic production of synthetic rubber in Thailand.

Note: For a more detailed information on NPC-1 and NPC-2, refer to Section 9.3 "Plastics".

In Thailand, a project is now being pushed forward to produce butadiene rubber (BR) by using mixed C_4, supplied by THAI OLEFINES CO., LTD. from its plant in NPC-2 (at Map Ta Phut). In this project, BANGKOK SYNTHETICS CO., LTD. will construct a new BR plant with a production capacity of 25,000/year. This company plans to complete the feasibility study by the end of 1994 and the

plant by the end of 1997. BANGKOK SYNTHETICS has a BR production plan and an outlook on demand for BR as follows:

Capacity:	25,000 tpa
Demand:	16,000 tpa
Tyre	60%
High impact polystyrene	20%
Sports shoes	20%
Golf Ball	Less than 1%

BANGKOK SYNTHETICS, created in 1992, is now constructing another plant that produces MTBE (Methyl Tertiary Butyl Ether, one of additives to gasoline), buthane–1 and LPG. To produce these products, this plant (that is expected to be completed at the end of 1994) also will use mixed C_4 supplied by THAI OLEFINS.

9.5 Glass

9.5.1 Glass parts and their materials

Safety glass is the largest of glass parts used in the automobile industry, which uses also lamps and mirrors. Glass parts used in the electrical/electronic industry are cathode-ray tubes (CRTs) for TV sets as well as those for word processors and computers (called "glass parts for monitors"). Safety glass is produced by processing and working flat glass, while CRTs are manufactured by molding dissolved glass materials such as silica sand. Unlike steel, plastics and rubber, the manufacture of glass parts uses no general-purpose nor intermediate material, except flat glass used for auto safety glass. The subsequent sections describe the actual production situations of flat glass, CRTs and safety glass in Thailand, though these are slightly deviated in viewpoint from the supply and demand of materials for autoparts, electrical parts and electronic components.

9.5.2 Flat glass

(1) Demand for flat glass

The total demand for flat glass in Thailand is broken down by application as follows:

Housing (window glass)	77%
Safety glass (for motor vehicles)	15%
Fabrication (for furniture and consumer electronic products)	8%
	100%

In Thailand, the total demand for flat glass is estimated about 5.8 million cases in 1993 and 6.3 million cases in 1994. The weight of flat glass by case is 45 kg. three fourths of the total demand for flat glass is in the form of window glass for office buildings, condominiums and housing. Therefore, the demand for flat glass has a close correlation with the business trend in the building industry. It is reported that the demand for flat glass depends upon that for cement with a delay of one year. The industry expects that the demand for flat glass will expand at an annual rate of 7% to 8% in a long term. It also forecasts that the demand will have a fluctuation every one year,

that is, a downturn both in the second half of 1993 and the first half of 1994, and a upturn in the second half of 1994.

(2) Production and exports & imports of flat glass

There are 4 flat glass makers in Thailand. Their production capacities are as given in Table 9.5-1.

Table 9.5-1 PRODUCTION CAPACITY OF FLAT GLASS IN THAILAND

COMPANY	CAPACITY (Million cases/Y)	SHARE
THAI-ASAHI GLASS	3.95 1/	36.7%
BANGKOK FLOAT GLASS	3.3 2/	30.7%
SIAM GUARDIAN	2.9	27.0%
SIAM PLATE GLASS	0.6	5.6%
TOTAL	10.75	100.0%

(NOTE) 1/ A line of 1.2 million cases/year is excluded because of the recent shut-down of the line.
2/ 50% of the total production shall be exported under a BOI condition for approval.
(Source) JICA team's interview survey.

The total production capacity of flat glass which can be devoted to the Thai market is about 8.9 million cases/year, except 50% of the production assured by BANGKOK FLOAT GLASS being obligatorily exported. The domestic demand for flat glass is estimated at 6.3 million cases in 1994. Thus, the flat glass industry in Thailand is now in over supply state.

In the flat glass industry, furnaces, once fired, must continue to be almost fully operated for 24 hours a day and 365 days a year during their lifetime of 9 years. Therefore, it is very difficult to adjust their production. The industry is obliged to export any excessive production. Thus, about 2% of the total production are now exported to Singapore, Hong Kong, Vietnam and Laos.

In addition, flat glass parts made in Indonesia which is also in over supply state are imported at lower prices into Thailand, and account for slightly

more than 10% of the total glass consumption in the country. Thus, there is a severe competition between domestic and imported glass parts. It should be noted that import duties on flat glass were reduced from 50% to 30% in relation to AFTA.

(3) Materials for flat glass

In Thailand, materials for flat glass such as silica sand, dolomite and feldspar are domestically supplied, while soda ash, sodium sulfate and other chemicals are imported. Of the total supply, domestic materials account for about 80% in weight and 50% in cost.

9.5.3 Safety glass

(1) Demand for safety glass

Table 9.5-2 indicates the annual demands for auto safety glass in Thailand for recent years.

Note: The consumption of OEM safety glass is 4 m_2 per passenger car and 2 m_2 to 2.5 m_2 per pickup truck. Assuming that the total production of motor vehicles is 420 thousand units in 1993, of which 40% are passenger cars with 60% of pickup trucks, and that the consumption of OEM safety glass is 4 m_2 per car and 2.5 m_2 per pickup truck, the total demand for OEM safety glass is estimated at 1,302,000 m_2. This figure is almost equal to the actual demand for OEM safety glass,1,287,000 m_2, in 1993, as given in Table 9.5-2.

Table 9.5-2 DEMAND OF AUTO SAFETY GLASS IN THAILAND

	1986	1987	1988	1989	1990	1991	1992	1993	Annual Growth 1986 - 1993
OEM Safety glass	179	258	416	607	925	861	1,031	1,287	
(Annual growth)	(-)	(44%)	(61%)	(46%)	(52%)	(-7%)	(20%)	(25%)	32.6%
REM Safety glass 1/	73	96	134	180	225	271	243	266	
(Annual growth)	(-)	(32%)	(40%)	(34%)	(25%)	(20%)	(-10%)	(9%)	20.3%
Total	252	354	550	787	1,150	1,132	1,274	1,553	
(Annual growth)	(-)	(40%)	(55%)	(43%)	(46%)	(-2%)	(12%)	(22%)	29.7%
Share of OEM	71%	73%	76%	77%	80%	76%	81%	83%	

Note: "REM represent Replacement Equipment Manufacturing for after market use.
Source: JICA team's interview survey

The demand for OEM safety glass expanded at the annual average rate of 32.6% for 7 years from 1986 to 1993. Of course, this rate of growth was proportional to that in the total production of motor vehicles. The demand for after-market REM safety glass increased at the annual average rate of 20.3% for the same period. Glass fibers for remodeled pickup trucks (with FRP-covered beds) accounted for about 30% of the demand for after-market REM safety glass. Similarly, the total demand for safety glass grew at the rate of 29.7% for the same period, and reached 1.55 millions m2 in 1993. OEM safety glass had a share of 70% to 80% annually in the total demand for safety glass.

(2) Production and exports & imports of safety glass

In Thailand, auto safety glass is included in the items on which the compulsory local contents are imposed. As a result, the total demand for safety glass is domestically satisfied. No OEM safety glass part is exported from or imported into Thailand, for the reasons that the export or import requires additional transportation costs, that safety glass is liable to be damaged and flawed during transportation, that fine adjustments are required for safety glass parts, which have slight differences in sizes between countries even for the same model of motor vehicle, and that safety glass parts are locally supplied by nature. On the other hand, a part of locally produced REM safety glass parts for after-market use is exported. The leading safety glass suppliers and their estimated production shares in Thailand are as given in Table 9.5-3.

Table 9.5-3 SAFETY GLASS PRODUCTION SHARE BY MAJOR SUPPLIER

	SHARE (%)	
COMPANY	OEM	REM
THAI SAFETY GLASS CO., LTD.	85 - 87%	60%
SANGA DUMRONKA INDUSTRY CO., LTD.	13 - 14%	30%
A.T.P. INDUSTRY CO., LTD.	1%	-
PET MONGKOL CO., LTD.	-	10%

Source: JICA team interview survey.

(3) Procurement of materials for safety glass

In Thailand, two processes are used to produce safety glass; one process comprises tempering and quenching flat glass to produce toughened glass. The other comprises inserting polyvinyl butylate between 2 sheets of flat glass, and heating and molding them to produce sandwitch glass. In Thailand, all the safety glass makers purchase flat glass as main material from local flat glass suppliers.

9.5.4 Cathode-ray tubes (CRTs)

(1) Panels and funnels

A CRT has two glass parts; a panel comprising a screen, and a funnel behind the panel. The funnel is also called "tube" or "glass bulb". Only funnels are produced in Thailand, and all panels in demand are imported. A CRT is assembled as finished product by inserting an electron gun into a funnel and mounting the assembly of electron gun and funnel on a panel.

(2) Demand and production of color CRTs

The total production of color CRTs in Thailand is estimated about 5 million pieces in 1994, of which 1 million color CRTs are supplied to the local market, the rest, 4 millions, being exported.

Table 9.5-4 PRODUCTION OF CRT IN THAILAND

(Unit: 1000 sets)

1989	100
1990	1,700
1991	2,300
1992	3,100
1993	4,200
1994	5,000

Source: JICA team's interview survey.

In Thailand, CRTs are produced by 2 companies. THAI CRT CO., LTD. has a production capacity of about 1.8 million CRTs/year, and plans to supply 1

million CRTs to the local market in 1994. TOSHIBA DISPLAY DEVICES (THAILAND) CO., LTD. has a production capacity of 3.20 million CRTs/year, and plans to export the total production in the same year.

(3) Production of funnels

As described above, all panels in demand are imported into Thailand, where only funnels are produced. SIAM-ASAHI TECHNO GLASS CO., LTD. is only one funnel supplier in the country, and supplies the total quantity of funnels required by the above-mentioned CRT makers, THAI CRT and TOSHIBA DISPLAY DEVICES. In 1994, SIAM-ASAHI TECHNO GLASS plans to supply 1.8 million funnels to THAI CRT and 3.2 million pieces to TOSHIBA, and export 5 million funnels directly to other Asian countries such as Malaysia, Taiwan, Singapore and Japan. Thus, SIAM-ASAHI TECHNO GLASS has a production capacity of 10 million funnels/year, and supplies 5 million pieces to local users and exports 5 million pieces. Figure 9.5-1 shows the supply and export flows of funnels and CRTs.

(4) Procurement of materials

Materials such as silica sand, lime stone and dolomite are domestically supplied. Materials such as chemicals, rare metals, lead and potassium carbonate are imported. Rubber and sintered carbon blocks as well as repair parts for machinery and equipment are also imported. The use of domestically produced materials per funnel is 70% in weight and about 20% in cost.

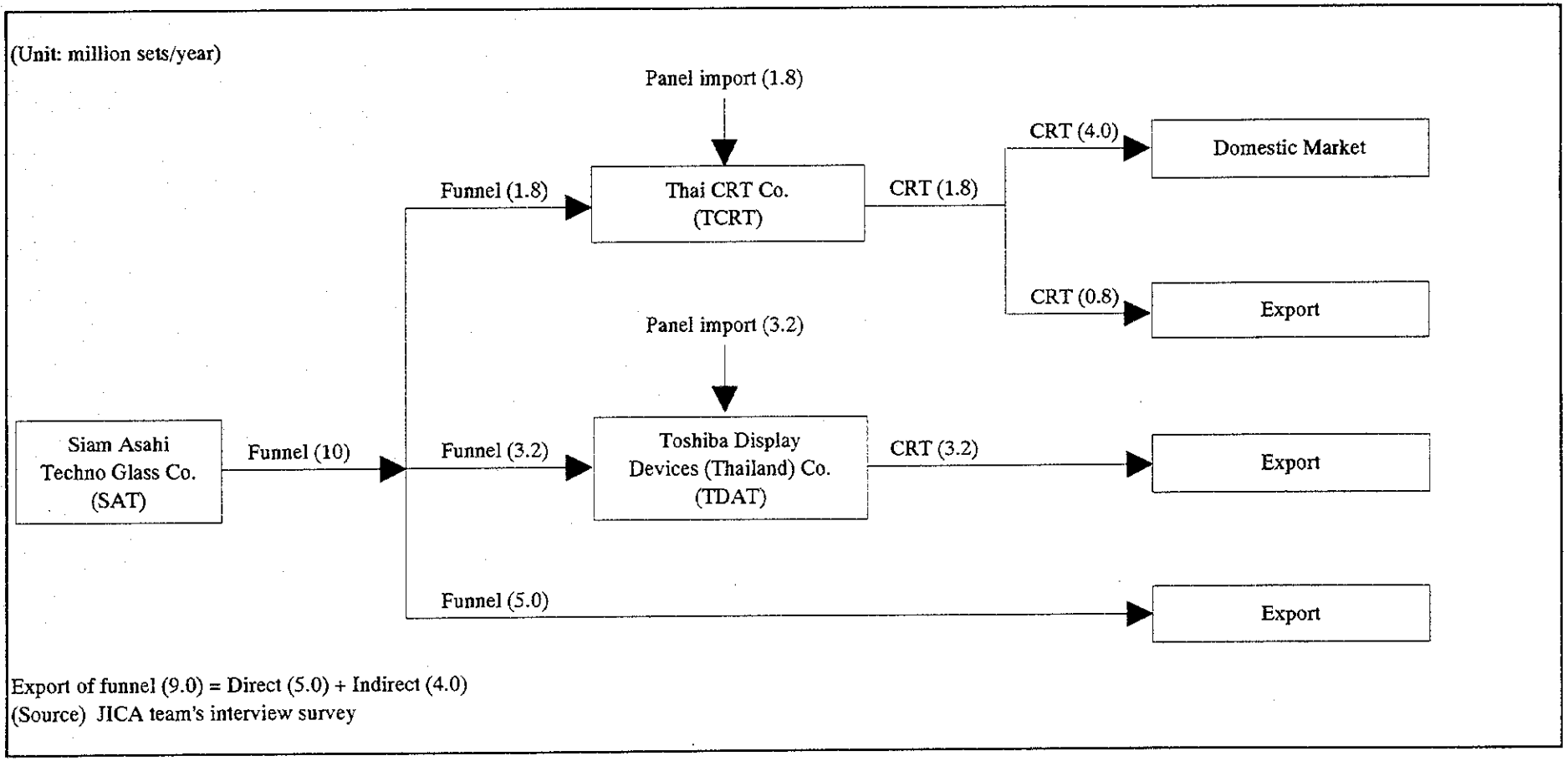


Figure 9.5-1 PRODUCTION, CONSUMPTION AND EXPORT OF FUNNEL AND CRT IN THAILAND

Chapter 10 Current and Future Development Plan of Infrastructure

10.1 Industrial Estate

10.1.1 Development and management of industrial estate

The industrial estates in Thailand are classified by the types of developers and modes of management into the following three categories:

(1) Industrial estates directly developed and managed by the Industrial Estate Authority of Thailand (IEAT);
(2) Industrial estates developed jointly by IEAT and private corporations and managed by IEAT; and
(3) Industrial estates developed and managed by private corporations.

IEAT was established in 1972 as a semi-public government agency to implement the industrial development policies of the Government, and developing, operating and managing industrial estates fully equipped with infrastructural facilities, including roads, power supply, water supply, and sewerage, together with environmental protection facilities.Most of industrial estates where are developed by IEAT are granted tax incentives by the Board of Investment (BOI), and IEAT itself is providing privileges to the investors such as quick processing of the applications for the rights to use land, construction permits, etc.

The Government also encourage private investment in the development of industrial estates. At present there are about twenty-five industrial estates approved by BOI as eligible for its incentives, and there are already some private developers who have concluded joint venture contracts or management contracts with IEAT. Development of these industrial estates are required to meet strict specifications for industrial facilities, environmental protection facilities as well as associated infrastructural facilities.In addition, many industrial estates have a special area for processing of exports. The Improvement and Conservation of National Environmental Quality Act as amended in 1992 has introduced the Polluter-Pays-Principle (PPP), together with rigorous enforcement of regulations and obligations on the part of developers to conduct environmental assessments, making it more and more difficult for private developers to enter upon the

business of industrial estates development.

10.1.2 Present situation of industrial estates

The existing industrial estates in Thailand are summarized in Tables 10.1-1 (1/5 - 5/5) and in Figure 10.1.-1.

Number 15 and 16 in Table 10.1-1 are omitted from the list. The projects of these number are supposed to become extinct. There are 37 development projects of industrial estates in the country, number of industrial estates by the established year are summarized as follows;

	~1980	1981-1985	1986-1990	1991~ (including plan)
Zone 1	2	2	7	3
Zone 2	0	0	3	16
Zone 3	0	1	0	3
Total	2	3	10	22

In the latter half of 1980, 7 industrial estates were developed in Zone 1 then another 3 industrial estates has been developed since 1991. 16 industrial estates has been developed since 1991 in Zone 2, it is far above the average. Most of industrial estates in Zone 2 are located nearby or surround of Zone 1 and in the Eastern Sea Board area. There are 3 industrial estates in Zone 3. Since BOI provides more incentives as its decentralization policy, number of industrial estates were increased in Zone 2.

10.1.3 Industrial estates development projects

IEAT has the following industrial estates development projects in progress or on tap in an attempt to invigorate local economies.

Chalung Industrial Estate

Location	:	40 km from Songkla deep-sea port
Area	:	2,380 Rai
Major uses	:	Manufacturing bases to Thailand, Malaysia and Indonesia for small- and medium-scale supporting industries

Project period : 1992–1996

Khon Kaen Industrial Estate

Location : Nam Pong area, Khon Kaen
Area : 2,661 Rai
Project period : 1995–1997

Udon Thani and Pichit Industrial Estate

Location : Samphrao District, Udon Thani
Major uses : Textile industry using raw materials imported from Laos
Project period : 1994–1997

Pichit Industrial Estate

Location : Sangham District, Pichit Province
Area : 1,000 Rai
Major uses : Apparel industry, etc.

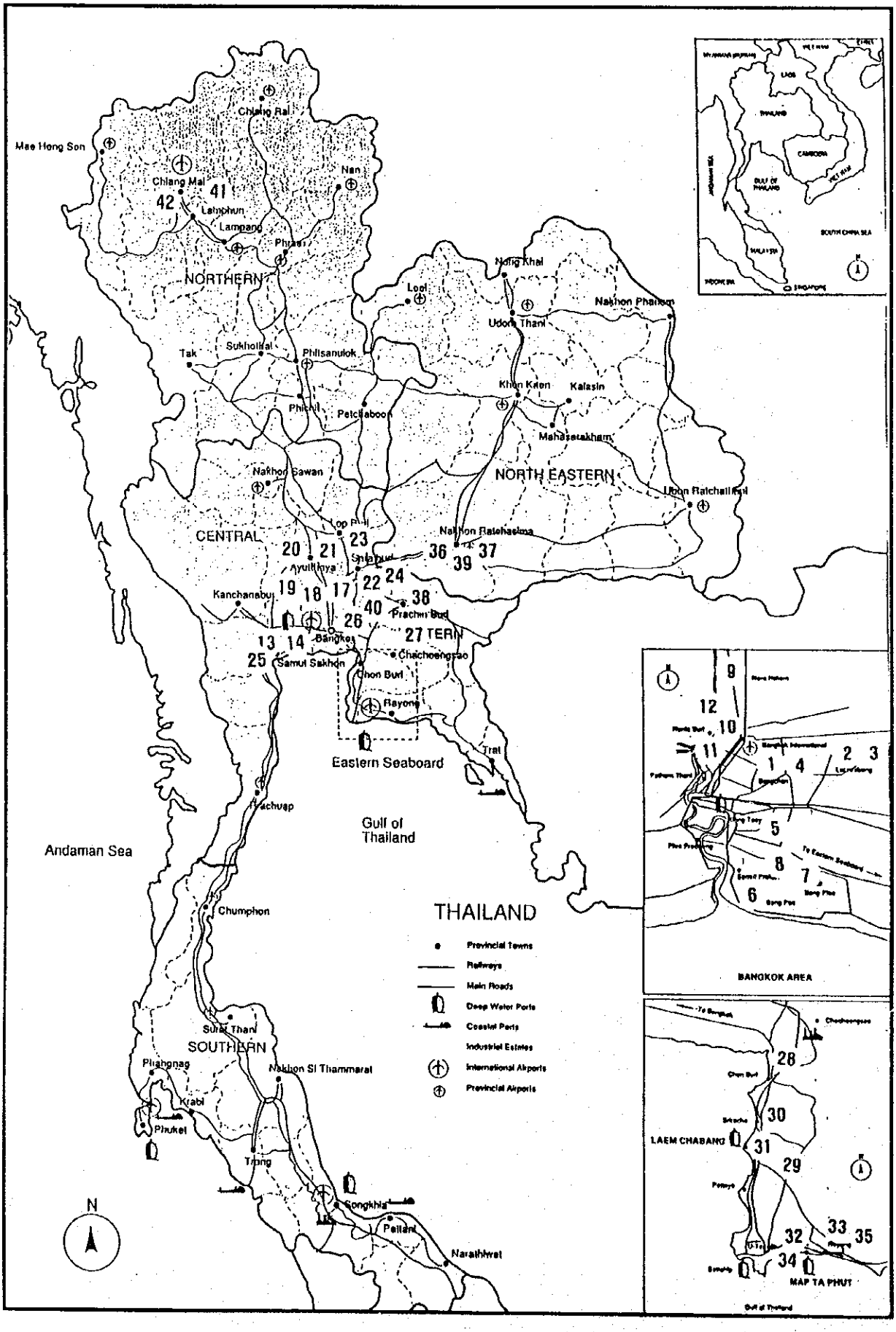


Figure 10.1-1 LOCATION OF INDUSTRIAL ESTATE

Table 10.1-1 EXISTING INDUSTRIAL ESTATE (1/5)

	Year of Completion	Location	Area (rai) Total	Area (rai) Available	Selling Price (baht/rai) (1 rai=0.4 acres)	Contract Address
ZONE 1						
Bangkok						Promotion and Service
1. Bangchan	1972	Minburi Bangkok				Investment Division
Central Industrial Zone		30 kms/East	677	–	2,240,000	The Industrial Estate
2. Lat Krabang (Phase I-II)		Lat Krabang,				Authority of Thailand
General Industrial Zone	1983	Bangkok	761	–	750,000	Tel.2530561 ext.105-6
Export Processing Zone	1983	35 kms/East	188	–	1,360,000	2532965
						Fax. 2534086
3. Lat Krabang (Phase III)	1989	Lat Krabang,				International Resource
General Industrial Zone		Bangkok	416	–	1,400,000	Development Co., Ltd. (IRD)
Export Processing Zone		35 kms/East	495	–	2,800,000	Tel.2353103, 2350164
						Thai Factory Development Co., Ltd. (TFD),
						Tel.2530346-9
						Fax.2544519
4. Minburi		Minburi,				Prachapol Co., Ltd.
General Industrial Zone (Phase I)	1988	Bangkok	270	–	1,200,000-1,500,000	Tel.3288364-5
General Industrial Zone (Phase II)	1990	40 kms/East	300	300	2,200,000-2,500,000	Fax.2592394
5. Gemopolis Industrial Estate	1996	Between Bangna-	74	74	8,800,000	I.G.S. Co., Ltd.
General Industrial Zone		Trad Highway &				Tel.237-5110
		Sukaphibal 2				Fax.237-5119
ZONE 1						
Central and Western Region Samut Prakarn						
6. Bang Poo Industrial Estate		Bangpoo,				Thailand Industrial
General Industrial Zone (Phase I)	1977	Smut Prakarn	3491	–	950,000	Estate Development Co., Ltd.
Export Processing Zone (Phase I)	1977	34 kms/East	272	149	1,500,000	Tel.2525692-7
General Industrial Zone A (Phase II)	1993		500	360	2,900,000	Fax.2534449
General Industrial Zone B (Phase II)	1993		1,500	1500	2,900,000	
7. Bang Plee Industrial Estate		Bang Plee				Public Services Division
General Industrial Zone (Phase I)	1984	Smut Prakarn	470	–	1,200,000	The National Housing Authority
General Industrial Zone (Phase II)	1989	40 kms/East	534	–	forming	Tel.3772010-9, 3775501

Table 10.1-1 EXISTING INDUSTRIAL ESTATE (2/5)

	Year of Completion	Location	Area (rai) Total	Area (rai) Available	Selling Price (baht/rai) (1 rai=0.4 acres)	Contract Address
8. Theparak Industrial Estate General Industrial Zone	1990	Bangna-Trad Rd. Samut Prakarn 34 kms/East	826	-	3,600,000	M.Thai Industrial Estate Co., Ltd. Te.2512028-9 Fax.2551821
Pathum Thani						
9. Navanakorn Industrial Estate General Industrial Zone	1988	Navanakorn, Pathum Thani 46 kms/North	3,250	129	3,500,000-4,000,000	Navanakorn Co., Ltd. Tel.5290131-5, 2795395 Fax.2794928
10. Bangkadi Industrial Park General Industrial Zone	1989	PathumThani 40 kms/North	1,173	-	2,500,000-3,000,000	Industrial Park Co., Ltd. Tel.5011581-2
11. Mah Boonkrong General Industrial Zone	1988	Pathum Thani 40 kms/North	1,410	728	forming	Mah Boonkrong Industrial Estate Te.2179111 ext.278 Fax.2179443
ZONE 1						
Nonthaburi						
12. Mueng Thong Thani Industrial Park General Industrial Zone	1990	Parkret, Nonthanburi	680	680	forming	Bangkok Airport Industrial Park Co., Ltd. Tel.2541026-31 Fax.2541026, 2541045
Smaut Sakhon						
13. Samut Sakhon Industrial Park	1992	Samut Sakhon				Mahachai Land Development Ltd.
General Industrial Zone		50 kms/East	640	56	2,400,000	Te.3980027, 3991720-8
Special Area for Dyeing Food, Chemical Indsutries			401	312	3,200,000	Fax.3991768-9
14. Jogsatit Industrial Park General Industrial Zone	1993	Kratoomban, Samur Sakhon	930	200	reserved	Jongsatit Co., Ltd. Tel.4634001-4 Fax.4634000
ZONE 2						
Ayudhaya						
17. Rojana Industrial Park	1990	Utai,				Rojana Industrial Park Co., Ltd.
General Industrial Zone (Phase I)		Ayuthaya	820	450	2,000,000	Tel.2601248, (035)330000-8
General Industrial Zone (Phae II-III)		70 kms/North	605	40	2,000,000	Fax.2592394

Table 10.1-1 EXISTING INDUSTRIAL ESTATE (3/5)

	Year of Completion	Location	Area (rai) Total	Area (rai) Available	Selling Price (baht/rai) (1 rai=0.4 acres)	Contract Address
18. Hi-Tech Industrial Estate	1992	Bang-Pa-In,				Thai Industrial Estate Corp. Ltd.
General Industrial Zone (Phaes I-II)		Ayuthaya	1,100	487	2,200,000	Tel.(035)244650
Export Processing Zone (Phase I-II)		45 kms/North	500	180	2,700,000	Fax.2544139
19. Bang-Pa-In Industrial Estate	1991	Bang-Pa-In,				Bang-Pa-In Land Development Co., Ltd.
General Industrial Zone		Ayuthaya	540	-	2,000,000	Tel.2776852, 2776839, 2776460
Export Processing Zone		45 kms/North	130	-	2,700,000	Fax.2544139
20. Saharattananakorn Industrial Estate	1995	Bangpahan,				Saharattananakorn Co., Ltd.
General Industrial Zone		Ayuthaya	837	-	860,000	Tel.2912577
Export Processing Zone		90 kms/North	561	561	forming	Fax.2912103
21. Ayuthaya Industrial Park	1994	Utai,	960	960	2,000,000	Ayuthaya Industrial Park Co., Ltd.
General Industrial Zone		Ayuthaya				Tel.2560124-6, 2592402-3
		70 kms/North				Fax.2551821
ZONE 2						
Saraburi						
22. Saraburi Industrial Estate	1995	Kaeng Khoi,				Saraburi Industrial Park Co., Ltd.
General Industrial Zone		Saraburi	1,050	750	1,500,000	Tel.2796718, 2785996, 2701907
Export Processing Zone		100 kms/North	255	255	1,500,000	Fax.2714416
23. Nong-Kae (Saraburi) Industrial Estate	1992	Nong-Kae				Thai-German Ceramic Industrial Co., Ltd.
General Industrial Zone		Saraburi	1,523	1,523	2,200,000	Tel.5168611-6, (036)37172-1,
Export Processing Zone		60 kms/North	n.a.	n.a.	2,400,000	Fax.5872199
24. Siam Cement Industrial Land	1992	Nong-Kae	1,450	1,100	reserved	Siam Cement Industrial land Co., Ltd.
General Industrial Zone		Saraburi				Tel.5864290-1
						Fax.5872199
ZONE 2						
Ratchburi						
25. Ratchburi Industrial Park	1992	Mueng,				Sahapatana Inter-Holding Co., Ltd.
Project		Ratchburi				Tel.3181132-3, 3191667-8
General Industrial Zone		150 kms/West	1,072	1,072	forming	Fax.3181127
Export Processing Zone			330	330		

Table 10.1-1 EXISTING INDUSTRIAL ESTATE (4/5)

	Year of Completion	Location	Area (rai) Total	Area (rai) Available	Selling Price (baht/rai) (1 rai=0.4 acres)	Contract Address
Easter Region						
Chachoengsao						
26. Well Grow Industrial Estate		Bangpakong,				Well Grow Industry Co., Ltd.
General Industrial Zone (Phase I-II)	1991	Chachoengsao	2,000	2	3,000,000	Tel.2842801-3, 2945522
General Industrial Zone (Phase III)	1993	40 kms/East	1,000	1,000	forming	Fax.2945511
27. Gateway City Industrial Estate	1993	Plang Yao,				MDX Co., Ltd.
General Industrial Zone		Chachoengsao	3,580	1,960	1,900,000	Tel.2530430-6, (038)575111-2
Export Processing Zone		80 kms/East	860	500	1,900,000	Fax.2714416
ZONE 2						
Chonburi						Bangpakong Industrial Park Phase II
28. Bangpakong Industrial Park (Phase II)	1994	Chonburi				Tel.3192555-64
General Industrial Zone		57 kms/East	899	170	2,700,000	Fax.3181096
29. Chonburi (Bo-Win) Industrial Estate	1991	Sriacha,				Hemaraj Land and Development Co., Ltd.
General Industrial Zone		Chon Buri	1,555	997	2,000,000	Tel.2606510-24
Export Processing Zone		120 kms/East	457	287	2,400,000	Fax.2945511
30. Sriracha Industrial Park	1988	Sriracha				Sahapatana Inter-Holding Co., Ltd.
General Industrial Zone		Chonburi	1,202	-	10,0000 (rent)	Tel.3181132-3, 3191667-8
		110 kms/East				Fax.3181127
31. Laem Chaban Industrial Estate	1990	Chon Buri				Industrial Estate Authority of Thailand
General Industrial Zone		130 kms/East	2,312	-	59,000(lease)	Tel.253-0561 Fax.253-4086
Export Processing Zone			1,098	878	73,750(lease)	
ZONE 3						
Raong						
32. Easter Industrial Estate	1993	Mat-Ta-Phut,				Eastern Industrial Estate Co., Ltd.
General Industrial Zone		Rayong	1,152	1,005	2700000	Tel.(038)683962-3
		190 kms/Southeast				
33. Rayong Industrial Park	1993	Rayong				Rayong Industrial Park Co., Ltd.
General Industrial Zone		150 kms/East	600	90		Tel.255-6771-2, Fax.255-6773
34. Map Ta Phut Industries Estate	1993	Rayong				Industrial Estate Authority of Thailand
General Industrial Zone		190 kms/East	6,000	970	5,900 (lease)	Tel.253-0561, Fax. 253-4086
Export Processing Zone			1,490	1,490	73,750 (lease)	

Table 10.1-1 EXISTING INDUSTRIAL ESTATE (5/5)

	Year of Completion	Location	Area (rai) Total	Area (rai) Available	Selling Price (baht/rai) (1 rai=0.4 acres)	Contract Address
35. TPI Industrial Estate	1991	Rayong				Thai Petrochemical Industry Co., Ltd.
General Industrial Zone		180 kms/East	5,000	-	reserved	Te. 23504310-9 Fax.2363110
ZONE 2						
Northeastern Region						
Nakhon Rachasima						
36. Suranaree Industrial Zone	1995	Nakhon Ratchasima				Suranaree Industrial Zone Co., Ltd.
General Industrial Zone		260 kms/Northeast	25,000	1,000	1,000,000	Tel.(044)212223, 212249-50
Export Processing Zone			300	300	1,000,000	Fax.(044)212132
37. P.C.S.	1990	Nakhon Ratchasima				P.C.S. Co., Ltd.
General Industrial Zone		Kms/Northeast	754	754	forming	Tel.(044)254034, 254036
Prachinburi						
38. Kabinburi Industrial Zone	1995	Kabinburi,				Kabinburi Industrial Zone CO., Ltd.
General Industrial Zone		Prachinburi	1,500	600	950,000	Tel.3915375, 3921338
Export Processing Zone		160 kms/East	338	338	1,150,000	
39. Prachinburi Industrial Park Project	1991	Kabinburi,				Sahapatana Inter-Holding Co., Ltd.
General Industrial Zone		Prachinburi	960	960	forming	Tel.3181132-3, 3191667-8
Export Processing Zone		170 kms/East	960	960		Fax. 3181127
40. Prosperity		Srimahaphoe,				Prosperity Industrial Estate Co., Ltd.
		Pracheanburi	3,000	3,000	forming	Tel.2580617-20
		125 kms/East				
ZONE 3						
Northern Region						
41. Northern Region (Lamphun)	1985	Lamphun				Industrial Estate Authority of Thailand
General Industrial Zone		600 kms/North	356		1,200,000	Tel.253-0561
Export Processing Zone			785	45	1,200,000	Fax.253-4086
42. Saha Group Industrial Park (Lamphun)	1992	Lamphun				Sahapatana Inter-Holding Co., Ltd.
General Industrial Zone		600 kms/North	826	-	reserved	Tel.3181132-3, 3191667-8
						Fax.3181127

Source: Industrial Estate Authority of Thailand, Board of Investment

10.2 Electricity

10.2.1 Present situation of electric power supply

(1) Electricity supply service

In Thailand, power supply service is undertaken mainly by three public corporations namely the Electricity Generating Authority of Thailand (EGAT), Metropolitan Electricity Authority (MEA), Provincial Electricity Authority (PEA), and the Department of Energy Development and Promotion (DEDP). The power generated by private independent plant for own use is merely 8.4% as of 1992.

EGAT is a state-run corporation under the control of the Office of Prime Ministry (OPM), and has power plants and substations interconnected by transmission lines all over the country to wholesale energy to MEA and PEA. In addition, it feeds electricity directly to major users, buying excess power from Laos and exchanging power with Malaysia.It employs 35,200 (as of 1992).

MEA is a state-run corporation under the control of the Ministry of Interior (MOI), and is distributing power purchased from EGAT to the users in metropolitan area, including Bangkok, Samutprakarn, and Nonthaburi. It employs 13,617. While it owns transmission, distribution and substation facilities, it has no generating facilities.

PEA is a state-run corporation under the control of MOI.
It covers 72 provinces where not served by MEA, feeding about 510,000 km2 (or 99% of the national land). PEA receives power mainly from EGAT, and partly from mini-hydroelectric power stations owned by DEDP. It operates diesel power plants and mini-hydroelectric power plants for depopulated areas not served by EGAT grids.
As of the end of FY 1993, it served 8,047,465 houses, having 1,287 offices and 30,884 workers.

DEDP is under the control of the Ministry of Science, Technology and Energy (MOSTE), and has its mission to work out energy policies for the entire country.It is authorized to supervise and promote energy-saving

measures.

It also undertakes part of hydroelectric power generation, transmission and distribution as electricity supply business.

(2) Power generating facilities

In 1992, the total installed generating capacity in Thailand was 12,806 MW (11,732 MW by public utilities and 1,074 MW by private independent plants) (see Table 10.2-1); 19% was accounted for by hydroelectric, 53% by steam, 22% by combined cycle, 2% by gas turbine, and 4% by diesel in 1992 (Table 10.2-2). The generation mix provided by the electric power supply companies was contributed 21% by hydro, 52% by steam, 24% by combined cycle, 2% by gas turbine and 1% by diesel.

EGAT is the largest power supply owning 99% of all the power generating installations. Private generators are only supplying about 8% of the total generating capacity.

Table 10.2-1 INSTALLED CAPACITY BY TYPES OF POWER PLANTS (1983 - 1992)

Unit: MW

Year	Installed Capacity*1						Private Self-Generation				Grand Total
	Hydro	Steam	Gas Turbine	Diesel	Combined Cycle	Total*2	Steam	Diesel	Gas Engine	Total*3	
1983	1,501	2,477	250	84	720	5,032	290	226	-	516	5,548
1984	1,714	3,327	265	102	720	6,128	377	237	-	614	6,742
1985	2,004	3,628	265	88	720	6,705	411	279	-	690	7,395
1986	2,096	3,608	265	96	720	6,785	488	274	3	765	7,550
1987	2,256	3,608	267	82	772	6,985	528	284	4	816	7,801
1988	2,268	3,608	267	82	772	6,997	562	311	2	875	7,872
1989	2,271	3,982	267	74	772	7,366	590	355	3	948	8,314
1990	2,274	4,307	1,308	75	761	8,725	603	396	3	1,002	9,727
1991	2,455	4,906	1,514	71	761	9,707	625	436	3	1,064	10,771
1992	2,459	6,107	238	68	2,860	11,732	625	446	3	1,074	12,806

Source: DEP, EGAT and PEA

Note: *1: excluding private self-generation.
*2: excluding geothermal 0.3 MW since 1990.
*3: excluding private-owned hydro generator 0.43 MW since 1978.

Table 10.2–2 INSTALLED CAPACITY BY TYPES OF POWER PLANTS (1992)

Unit: MW

Type of power plant	EGAT	PEA	DEDP	Public utilities combined	Privately owned	Total
Hydro	2,416	4	39	2,459 (21%)	–	2,459 (19%)
Steam	6,107	–	–	6,107 (52%)	625	6,732 (53%)
Combined cycle	2,860	–	–	2,860 (24%)	–	2,860 (22%)
Gas turbine	238	–	–	238 (2%)	3	241 (2%)
Diesel	29	39	–	68 (1%)	446	514 (4%)
Total	11,650	43	39	11,732 (100%)	1,074	12,806 (100%)

Source: Based on DEDP/ELECTRIC POWER IN THAILAND 1992.

EGAT GENERATING FACILITIES

As shown in Table 10.2–3, EGAT's generating capacity was 12,178.3 MW as of September 1993, of which 2,429.2 MW (20.0%) was contributed by hydroelectric power plants, 6,101.5 MW (50.1%) by steam, 3,423.6 MW (28.1%) by combined cycle and 224.0 MW (1.8%) by gas turbine.

Table 10.2-3 EGAT EXISTING INSTALLED GENERATING CAPACITY
(AS OF SEPTEMBER 1993)

Plant Type		No. of Unit	Capacity (MW)		Average Energy Capability(GWh/Yr)
			Installed	Ultimate	
A. Hydroelectric Plant					
Bhumibol		7	535.0	710.0	950.0
Sirikit		3	375.0	500.0	550.0
Ubolratana		3	25.2	25.2	56.0
Sirindhorn		3	36.0	36.0	86.0
Chulabhorn		2	40.0	40.0	95.0
Kang Krachan		1	17.5	17.5	78.0
Nam Pung		2	6.0	6.0	15.0
Srinagarind		5	720.0	720.0	1,158.0
Bang Lang		3	72.0	72.0	200.0
Tha Thung Na		2	38.0	38.0	165.0
Khao Laem		3	300.0	300.0	760.0
Huai Kum		1	1.1	1.1	2.0
Bang Santi		1	1.3	1.3	6.0
Mae Ngat		2	9.0	9.0	29.0
Khiridharn		2	12.7	12.7	27.0
Rajjaprabha		3	240.0	240.0	300.0
Ban Yang		3	0.1	0.1	
Ban Khun Klang		2	0.2	0.2	1.0
Chong Klang		1	0.0	0.0	
Huai Kui Mang		1	0.1	0.1	0.0
Total		50	2,429.2	2,729.2	4,478.0
B. Thermal Power Plant					
North Bangkok		3	237.5		1,250.0
South Bangkok		5	1,330.0		9,320.0
Mae Moh		11	2,025.0		13,310.0
Krabi		2	34.0		180.0
Surat Thani		1	25.0		170.0
Khanom		2	150.0		1,050.0
Bang Pakong		4	2,300.0		16,118.0
計		28	6,101.5		41,398.0
C. Combined Cycle Power Plant					
Bang Pakong	- Block 1 & 2	10	760.6		5,330.0
	- Block 3 & 4	6	614.0		4,303.0
Rayong	- Block 1 - 4	12	1,232.0		8,634.0
Nam Phong	- Block 1	3	355.0		2,488.0
	- Block (2) (GT)	2	242.0		1,696.0
South Bangkok	- Block 1 (GT)	2	220.0		1,540.0
Total		35	3,423.6		23,991.0
D. Gas Turbine Power Plant					
Udon Thani		1	14.0		31.0
Hat Yai		3	42.0		92.0
Surat Thani		2	28.0		62.0
Lan Krabu		8	140.0		858.0
Total		14	224.0		1,043.0
Grand total		**127**	**12,178.3**		**70,910.0**

Source: EGAT, DEDP
Note: Excluding diesel plants of 13.6 MW

(3) Transmission and distribution facilities

In Thailand, transmission is undertaken by EGAT and distribution by MEA and PEA.EGAT's transmission systems, for the most part, are rated at 115 kV or higher, and the 500 kV and 230 kV lines are used chiefly for trunk services, while the 115 kV lines are used for regional systems. The 69 kV lines are gradually being phased out by 115 kV transmission lines. MEA operates high-voltage distribution networks at 24/12 kV and majority of PEA's high-voltage distribution lines are rated at 22 kV. (Table 10.2-4)

Table 10.2-4 AGGREGATE LENGTHS OF TRANSMISSION AND DISTRIBUTION LINES BY VOLTAGE LEVELS (SEPTEMBER 1992)

Unit: circuit-kilometers

	Voltage	EGAT	MEA	PEA	Total
Transmission and distribution lines	500kV	1,201	–	–	1,201
	230kV	7,399	15	–	7,414
	132kV	9	–	–	9
	115kV	10,652	176	304	11,132
	69kV	479	585	32	1,096
High-voltage distribution lines	33kV	–	–	27,537	27,537
	24/12kV	–	9,088	–	9,088
	22kV	–	–	144,139	144,139
	3.5kv	–	–	61	61
Low-voltage distribution lines	380/220,440/2220V	–	16,813	218,705	235,518

Source: EGAT ANNUAL REPORT 1992, MEA ANNUAL REPORT 1993, PEA ANNUAL REPORT 1992.

EGAT's transmission voltages are standardized at 500 kV, 230 kV, 115 kV and 69 kV, and the power frequency is 50 Hz.

As of September 1993, EGAT operated the aggregate lengths of transmission lines and the number of substations as shown below.

Voltage	Aggregate length (circuit-kilometers)	Number of substations
500kV	1,201	3
230kV	7,617	40
115kV	10,844	122
69kV	343	8
Total	20,005	173

The total installed capacity of transformers is 26,351 MVA.

10.2.2 Power demand – present and future

(1) Transition of power demand

Table 10.2-5 shows the transition of maximum power demand, power generation, power consumption and per capita consumption over 10 years from 1983 to 1992.

In this ten-year period, the maximum power demand rose from 3,200 MW to 8,828 MW, the electric energy generated from 18,857 Gwh to 57,098 Gwh, electric energy consumed from 16.906 Gwh to 49,304 Gwh, and per capita consumption from 342 kWh to 853 kWh, representing annual average growth rates of 11.9%, 13.1%, 12.6% and 10.7%, respectively.

Table 10.2-5 TRANSITION OF MAXIMUM POWER DEMAND AND POWER CONSUMPTION

YEAR	MAXIMUM POWER DEMAND (MW)	POWER GENERATED (GWh)	POWER CONSUMED (GWh)	POPULATION (x 1000)	PER CAPITA CONSUMPTION (kWh/person)
1983	3,200	18,857	16,906	49,433	342
1984	3,545	21,025	18,572	50,853	365
1985	3,826	23,074	20,032	51,796	387
1986	4,202	24,717	22,034	52,969	416
1987	4,842	28,652	24,894	53,873	462
1988	5,414	32,464	28,253	54,961	514
1989	6,208	37,406	32,834	55,888	587
1990	7,167	44,175	38,342	56,303	681
1991	7,990	50,186	43,398	56,961	762
1992	8,828	57,098	49,304	57,789	853

Note: All electric utilities
Source: Prepared from DEDP/ELECTRIC POWER IN THAILAND 1992

Table 10.2-6 shows power consumption by uses and by area in 1992, and the annual average growthy of power consumption the ten-year period from 1983 to 1992.

For industrial use shows the highest share in types of users, however annual growth rate is below the average. Business use shows high growth ratio and ranks

second in share. Household consumption accounted for 20.8%, its growth ratio is almost same as industrial use and below the average. Power consumption share for agriculture use is very small and no affect to the whole consumption structure. By regional area, metropolitan area ranks top at 45.2%, a growth ratio is little below the national average. Central area ranks second but growth ratio is highest at 16.4%. While North, South and North-east shows almost same level of consumption share, growth ratio of North and South is over the national average but North-east is below the average.

Table 10.2-6 USE AND AREA STRUCTURE OF POWER CONSUMPTION

(Unit: %)

Uses	Share in 1992	Annual Growth Ratio 2)
Industrial	41.4	10.9
Business 1)	36.6	16.3
Household	20.8	10.5
Agriculture	0.2	12.4
Others	1.0	35.5
Total	100.0	12.6

Area	Share in 1992	Annual Growth Ratio 2)
Metropolitan	45.2	10.2
Central	33.5	16.4
North	7.2	14.5
South	7.1	13.4
North-East	7.0	12.0
Total	100.0	12.6

Notes: 1) Business means for public offices, hotel and stores, etc.
2) Annual growth ratio from 1983 to 1992.

(2) Load forecast

In September 1991, the Load Forecast Working Group (LFWG) represented by EGAT and other electricity-related organizations in Thailand announced new load forecast based on the 7th National Economic and Social Development Plan (NESDP).

According to which the load forecast was made as shown in Table 10.2-7. It is estimated that the load will reach 13,075 MW by the end of 1996. It is also expected that the annual average load growth will fall from 14.06% recorded in the 6th Development Plan (1987-1991) to 10.20% in the 7th Development Plan (1992-1996).

The predictions for more longer periods show further declines in annual average growth rate, indicating 7.76% and 6.07% for the 8th Development Plan and the 9th Development Plan, respectively.

Table 10.2–7 TOTAL EGAT GENERATION REQUIREMENT (1991 LFWG FORECAST)

Fiscal Year	Peak Generation			Energy Generation			Load Factor
	MW	Increase		GWh	Increase		
		MW	&		GWh	&	%
			Actual				
1983	3,204.30	366.30	12.91%	19,066.30	2,184.35	12.94%	67.92
1984	3,547.30	343.00	10.70%	21,066.44	2,000.14	10.49%	67.79
1985	3,878.40	331.10	9.33%	23,356.57	2,290.13	10.87%	67.75
1986	4,180.90	302.50	7.80%	24,779.53	1,422.96	6.09%	67.66
1987	4,733.90	553.00	13.23%	28,193.16	3,413.63	13.78%	67.99
1988	5,444.00	710.10	15.00%	31,996.94	3,803.78	13.49%	67.09
1989	6,232.70	788.70	14.49%	36,457.09	4,460.15	13.94%	66.77
1990	7,093.70	861.00	13.81%	43,188.79	6,731.70	18.46%	69.50
1991	8,045.00	951.30	13.41%	49,225.03	6,036.24	13.98%	69.85
1992	8,876.90	831.90	10.34%	56,006.44	6,781.41	13.78%	72.02
1993	9,730.00	853.10	9.61%	62,179.73	6,173.29	11.02%	72.95
Average Growth 1984–1993		652.57	11.75%	–	4,311.34	12.55%	–
			Forecast				
1994	10,892.00	1,162.00	11.94%	69,407.00	7,227.27	11.62%	72.74
1995	11,945.00	1,054.00	9.68%	74,342.00	4,935.00	7.11%	71.04
1996	13,075.00	1,129.00	9.45%	81,681.00	7,339.00	9.87%	71.31
1997	14,205.00	1,130.00	8.64%	88,677.00	6,996.00	8.57%	71.26
1998	15,354.00	1,149.00	8.09%	95,961.00	7,284.00	8.21%	71.35
1999	16,531.00	1,177.00	7.67%	104,229.00	8,268.00	8.62%	71.98
2000	17,765.00	1,234.00	7.46%	112,593.00	8,364.00	8.02%	72.35
2001	19,000.00	1,235.00	6.95%	121,023.00	8,430.00	7.49%	72.71
2002	20,219.00	1,219.00	6.42%	129,395.00	8,372.00	6.92%	73.06
2003	21,482.00	1,263.00	6.25%	138,379.00	8,984.00	6.94%	73.53
2004	22,795.00	1,313.00	6.11%	147,683.00	9,304.00	6.72%	73.96
2005	24,150.00	1,355.00	5.94%	157,311.00	9,628.00	6.52%	74.36
2006	25,515.00	1,365.00	5.65%	167,173.00	9,862.00	6.27%	74.79
Average Growth							
1982–1986	–	318.44	10.06%	–	1,763.91	9.20%	–
1987–1991	–	772.82	13.99%	–	4,889.10	14.71%	–
1992–1996	–	1,006.00	10.20%	–	6,491.19	10.66%	–
1997–2001	–	1,185.00	77.60%	–	7,868.40	8.18%	–
2002–2006	–	1,303.00	60.70%	–	9,230.00	6.67%	–

Souce: EGAT/REVISED PDP 92–01 (1)

10.2.3 Future plan for power supply

(1) EGAT electric power development program

In September 1993, EGAT announced a revised electric power development program (Revised PDP 92-01(1)).

According to the program, it is expected that by 2006, 20,204 MW of new generating facilities inclusive of those under construction will be added, and 1,431.1 MW of overage facilities decommissioned, to make up a total generating capacity of 30,951.2 MW with an existing generating capacity of 12,178.3 MW. Projects for 1993-2006 shows in Table 10.2-8. The generating capacity vs. types of power source for the period from 1994 to 2006 is projected in Table 10.2-9. This is combined with the load forecast in Table 10.2-7 to provide a long-term demand-supply profile as shown in Figure 10.2-1.

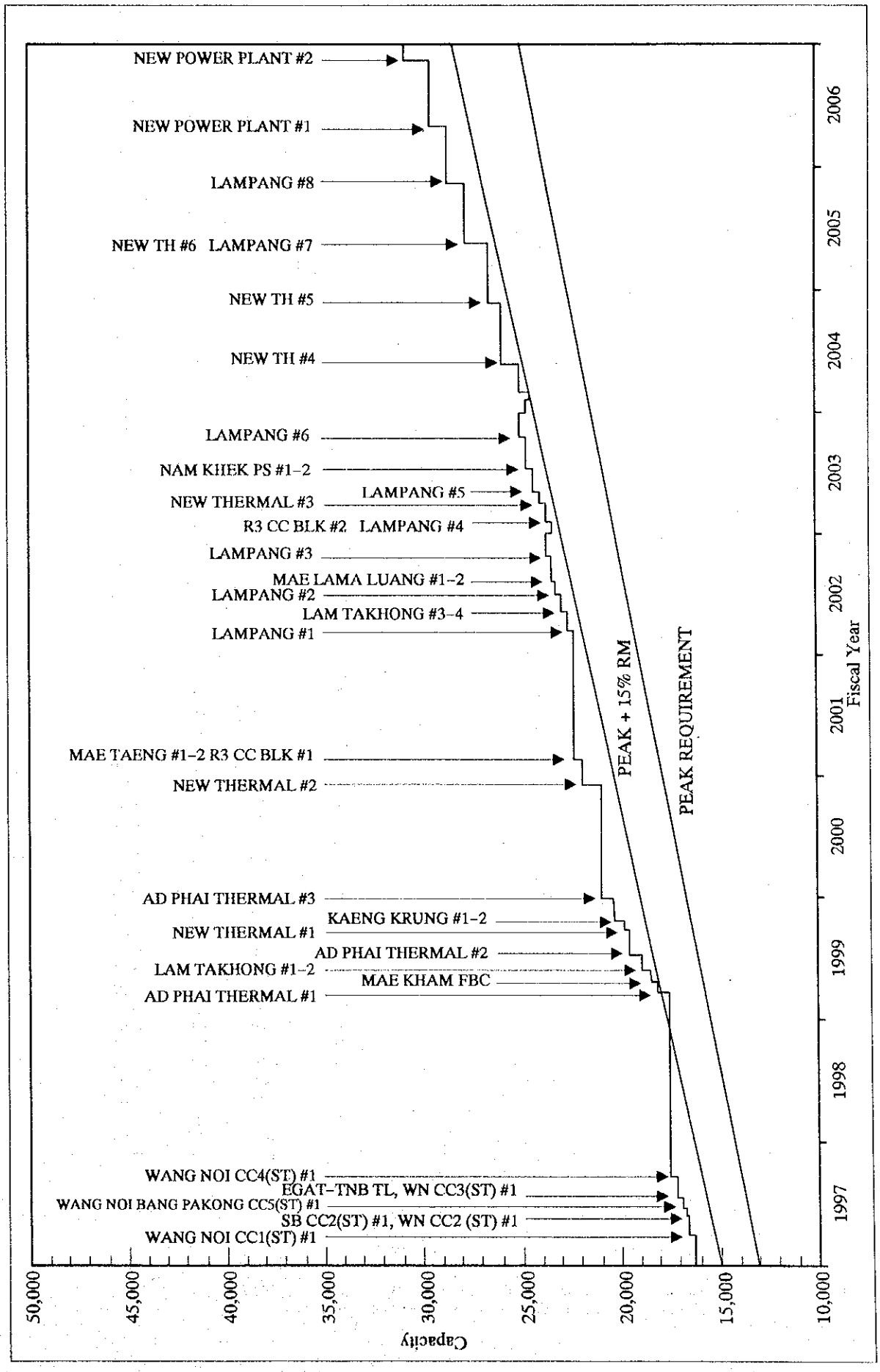
According to Figure 10.2-1, it is forecast that during a period from mid-1998 to early 1999, the supply capacity will fall below from the peak requirement + 15%RM (Reserve Margin) to peak requirement + 13%RM. This suggests that although unstable, the power supply situation seems unlikely to go into shortages because the peak requirement can be met and also because the peaks are considered to take place for short periods. If power available from Laos is counted in, the supply capacity will amount to 800 MW in the year 2000 and 700 MW in the year 2001, demonstrating that EGAT's power supply system is virtually stable.

(2) Transmission system development program

The EGAT's transmission system development program for the period 1990-2006 includes additional installation of 500, 230 and 115 kV transmission lines and substations to respond to the growing need for power. A 500 kV extrahigh-voltage transmission system is being constructed for extra-long distance, large-capacity transmission of base-load power to the load centers in and around Bangkok from the thermal power plants to be constructed in Mae Moh, Lampang, Ao Phai and west of Gulf of Thailand

In this long-term transmission system development program, emphasis is placed on the following areas:

- Eastern area: Bang Pakong, Rayong, and Ao Phai power plants, and eastern seaboard area.
- Western area: Industrial complexes in Samut Sakhon, samut Songkhram and Ratchaburi.
- Central ndustrial complexes in Pathum Thani, Ayutthaya and Saraburi.
- Northern Moh and Lampang earmarked for construction of power plants, and Chiang Mai, Mae Hong Son and Chiang Rai designated for development of tourism industry.
- Northeastern area: Electric power development site in Mam Phong, and industrial complex development sites in Nakhon Ratchasima and Ratchathani.
- Southern area: Lignite mining site including Southern Coastal Land Bridge Development area, and the site designated for the construction of Sab Yoi power plant.



Source: EGAT/REVISED PDP 92-01(1)

Figure 10.2-1 LONG-TERM SUPPLY DEMAND PROFILE (1997-2006)

Table 10.2-8 LIST OF PROJECTS FOR RECOMMENDED PDP (1993-2006)
(LONG TERM PROFILE)*1

	Power Plant	Fuel Type	Unit Number	Rating (MW)	Total (MW)	Commissioning Date	
On-Going Projects	Khanom CC 1 (GT)	Gas	1-4	112	448	Nov.	1993
	Nam Phong CC 2 (ST)	-	1	113	113	May	1994
	Pak Mun	Hydro	1-4	34	136	Jun. 94	Nov. 94
	South Bangkok CC 1 (ST)	-	1	115	115	Aug.	1994
	Khanom CC 1 (ST)	-	1	226	226	Sep.	1994
	Sirikit	Hydro	4	125	125	Mar.	1995
	Mae Moh	Lignite	12	300	300	May	1995
	Mae Moh	Lignite	13	300	300	Nov.	1995
	Bhumibol Pumped-Storage	Hydro	8	175	175	Dec.	1995
	Kaeng Krung	Hydro	1-2	40	80	Sep.	1999
	Nong Chok Gas Turbine	Diesel	1	100	100	Jan.	1995
	Nong Chok Gas Turbine	Diesel	2	100	100	Feb.	1995
	Nong Chok Gas Turbine	Diesel	3	100	100	Mar.	1995
	Nong Chok Gas Turbine	Diesel	4	100	100	Apr.	1995
	Sai Noi Gas Turbine	Diesel	1	100	100	May	1995
	Sai Noi Gas Turbine	Diesel	2	100	100	Jun.	1995
	Wang Noi CC 1 (GT)	Gas	1-2	100	200	Dec.	1995
	Wang Noi CC 2 (GT)	Gas	1-2	100	200	Feb.	1996
	Wang Noi CC 3 (GT)	Gas	1-2	100	200	Apr.	1996
	South Bangkok CC 2 (GT)	Gas	1-2	200	400	May	1996
	Wang Noi CC 4 (GT)	-	1-2	100	200	Jun.	1996
	Bang Pakong Combined Cycle 5 (GT) *2	-	1-2	200	400	Jun.	1996
	Wang Noi CC 1 (ST)	-	1	100	100	Dec.	1996
	Wang Noi CC 2 (ST)	-	1	100	100	Feb.	1997
	South Bangkok CC 2 (ST)	-	1	200	200	Feb.	1997
	Bang Pakong Combined Cycle 5 (ST) *2	-	1	200	200	Mar.	1997
	Wang Noi CC 3 (ST)	-	1	100	100	Apr.	1997
	EGAT-TNB Stage II Interconnection	-	-	300	300	Apr.	1997
	Wang Noi CC 4 (ST)	-	1	100	100	Jun.	1997
	Ao Phai Thermal	Oil/Coal	1	700	700	Oct.	1998
	Mae Kham FBC	Lignite	1	300	300	Nov.	1998
	Lam Takhong Pumped-Storage	Hydro	1-2	250	500	Jan.	1999
	Ao Phai Thermal	Oil/Coal	2	700	700	Apr.	1999
	New Thermal	Oil/Coal	1	1000	1000	Jul.	1999
	Ao Phai Thermal	Oil/Coal	3	700	700	Oct.	1999
	New Thermal	Oil/Coal	2	1000	1000	Jul.	2000
	Region 3 Combined Cycle	Gas	1	300	300	Oct.	2000
	Mae Taeng	Hydro	1-2	13	26	Oct.	2000
	Lampang	Lignite	1	300	300	Nov.	2001
	Lam Takhong Pumped-Storage	Hydro	3-4	250	500	Feb.	2002
	Lampang	Lignite	2	300	300	Mar.	2002
	Mae Lama Luang	Hydro	1-2	80	160	Apr.	2002
	Lampang	Lignite	3	300	300	Jul.	2002
	Region 3 Combined Cycle	Gas	2	300	300	Nov.	2002
	Lampang	Lignite	4	300	300	Nov.	2002
	New Thermal	Oil/Coal	3	1000	1000	Jan.	2003
	Lampang	Lignite	5	300	300	Mar.	2003
	Nam Khek Pumped-Stroage	Hydro	1-2	150	300	Apr.	2003
	Lampang	Lignite	6	300	300	Jul.	2003
	New Thermal	Oil/Coal	4	1000	1000	Jan.	2004
	New Thermal	Oil/Coal	5	1000	1000	Jul.	2004
	Lampang	Lignite	7	300	300	Jan.	2005
	New Thermal	Oil/Coal	6	1000	1000	Jan.	2005
	Lampang	Lignite	8	300	300	Jul.	2005
	New Power Plant	Oil/Coal/LNG/Nuc	1	1000	1000	Jan.	2006
	New Power Plant	Oil/Coal/LNG/Nuc	2	1000	1000	Jul.	2006

Existing Capacity by September 1993	=	12,178.3 MW
Total Added Capacity (Up to 2006)	=	20,204.0 MW
Plants Retirement	=	1,431.1 MW
Total Capacity by Year 2006	=	30,951.2 MW

Note: *1: Power Purchase from Hydroelectric projects developed in Laos of 1,500 MW will be in years 2000/2001
*2: Sitting will be changed to Wang Noi for combined cycle Blocks 5-6 rated 300MW each.
Source: EGAT/REVISED PDP 92-01(1)

Table 10.2-9 FORECAST OF EGAT GENERATING CAPACITY

Type of Power Plant	Hydroelectric		Oil-Field		Gas/Oil-Field		Lignite-Field		Oil/Coal-Field		*1 New Power Plant		Combined Cycle		Gas Turbine & Interconnection		Total	
Unit / Fiscal Year	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%
1994	2,497.2	19.0	262.5	2.0	3,780.0	28.8	2,059.0	15.7	0.0	0.0	0.0	0.0	4,325.6	32.9	210.0	1.6	13,134.3	100.0
1995	2,690.2	18.9	262.5	1.8	3,780.0	26.6	2,359.0	16.6	0.0	0.0	0.0	0.0	4,325.6	30.4	810.0	5.7	14,227.3	100.0
1996	2,865.2	17.7	262.5	1.6	3,780.0	23.3	2,625.0	16.2	0.0	0.0	0.0	0.0	5,925.6	36.6	740.0	4.6	16,198.3	100.0
1997	2,865.2	16.6	262.5	1.5	3,780.0	21.9	2,625.0	15.2	0.0	0.0	0.0	0.0	6,725.6	38.9	1,040.0	6.0	17,298.3	100.0
1998	2,865.2	16.6	262.5	1.5	3,780.0	21.9	2,625.0	15.2	0.0	0.0	0.0	0.0	6,725.6	38.9	1,040.0	6.0	17,298.3	100.0
1999	3,445.2	16.8	237.5	1.2	3,780.0	18.4	2,925.0	14.2	2,400.0	11.7	0.0	0.0	6,725.6	32.7	1,040.0	5.1	20,553.3	100.0
2000	3,445.2	15.5	237.5	1.1	3,780.0	17.0	2,925.0	13.1	4,100.0	18.4	0.0	0.0	6,725.6	30.2	1,040.0	4.7	22,253.3	100.0
2001	3,471.2	15.4	237.5	1.1	3,780.0	16.7	2,925.0	13.0	4,100.0	18.2	0.0	0.0	7,025.6	31.1	1,040.0	4.6	22,579.3	100.0
2002	4,131.2	17.1	237.5	1.0	3,780.0	15.7	3,825.0	15.8	4,100.0	17.0	0.0	0.0	7,025.6	29.1	1,040.0	4.3	24,139.3	100.0
2003	4,431.2	17.0	237.5	0.9	3,780.0	14.5	4,725.0	18.1	5,100.0	19.5	0.0	0.0	6,945.3	26.6	900.0	3.4	26,119.0	100.0
2004	4,431.2	16.2	0.0	0.0	3,780.0	13.8	4,575.0	16.7	7,100.0	26.0	0.0	0.0	6,565.0	24.0	900.0	3.3	27,351.2	100.0
2005	4,431.2	15.3	0.0	0.0	3,780.0	13.1	5,175.0	17.9	8,100.0	28.0	0.0	0.0	6,565.0	22.7	900.0	3.1	28,951.2	100.0
2006	4,431.2	14.3	0.0	0.0	3,780.0	12.2	5,175.0	16.7	8,100.0	26.2	2,000.0	6.5	6,565.0	21.2	900.0	2.9	30,951.2	100.0

Note: *1 Type of power plant will be identified later

10.3 Industrial Water

10.3.1 Waterworks and industrial water

In Thailand, all water supply services are undertaken by two public corporations: Metroplitan Waterworks Authority (MWA) and Provincial Waterworks Authority (PWA).MWA, which is under the control of the Ministry of Interior, covers Bangkok Metropolitan Area and Samutprakarn Province, and PWA, which is also controlled by MOI, is in charge of all the national land with the exception of MWA coverage.Irrigation water is supplied by the Royal Irrigation Department (RID).

Industrial establishments are required to consult with MWA, PWA, Ministry of Industry to find water sources, water intake, and water treatment and supply systems for their own where drinking water from MMA and PWA or irrigation water from RID are not available for them. Many of the industrial estates developed by IEAT have their own water sources and water supply systems.Water sources available for industrial purposes include rivers, lakes and swaps, irrigation canals, water reservoirs and ground water.

10.3.2 Water supply service by MWA and PWA

MWA takes water at Som lae Pumping station (Pathum Thani Province) 95.7 km upstream of the estuary of the Chao Phraya River, feeds it to Bangkhen Treatment Plant by about 20 km of opened canal, and to Sam Sem Treatment Plant and Thonburi Treatment Plant by about 10 km of opened canal, to produce potable water, which is then distributed from 10 distributing stations to respective consuming areas.

In 1993, the above three water treatment plants produced 1,224.9 mil. m3 of city water, or 94.2% of the total potable water production in Thailand, with the remainder extracted from groundwater, etc. During the 1989–1993 period, the total water production increased at an annual average rate of about 6% as against water sales which rose at an annual average rate of 8%. During the same period, the population in the served areas remained almost the same, suggesting that the production increase would simply reflect the expansion of waterworks. (Table 10.3–1)

Table 10.3-1 MWA WATER PRODUCTION AND SALES (1989-1993)

	1989	1990	1991	1992	1993
Water Production (mil. m^3)	934.3	1,049.3	1,109.2	1,175.5	1,224.9
- 3 Treatment Plants (mil. m^3)	870.4	1,013.6	1,061.7	1,116.8	1,154.3
- Others (($mil. m^3$)	63.9	35.7	47.5	58.7	70.6
Water Sales (mil. m^3)	628.2	718.7	781.3	823.4	836.1
Percentage of Water Sales (%)	67.2	68.5	70.5	70.1	68.3
Service Area (km^2)	625	680	710	740	784.4
Population in the area (mil)	7.3	7.1	7.2	7.1	7.2

Source: MWA ANNUAL REPORT

PWA has 10 regional offices to cover the entire country, and 213 distributing stations which are classified into 4 classes according to the rate of leakage and supply waer. During the 1987-1991 period, the water production rose at an annual average rate of 9.2% from about 267,000 m^3 in 1987 to about 380,000 m^3 in 1991. The water sales increased at an annual rate of 9.6% from 185,000 m3 in 1987 to 266,000 m3 in 1991. The leakage loss remained almost constant at about 30%, and the number of subscribers increased at an annual rate of 12.8%. (Table 10.3-2)

Table 10.3-2 PWA WATER PRODUCTION AND SALES (1987-1991)

	1987	1988	1989	1990	1991
Water Production (mil. m^3)	267.307	287.297	305.846	332.978	379.527
Water Sales (mil. m^3)	184.616	195.804	212.645	237.404	266.381
Rate of Water Loss (%)	30.9	31.8	30.5	28.7	29.8
No. of Customer (connection)	474,997	515,175	588,801	678,197	769,215

In 1991, the population in the metropolitan area was 7.2 million (see Table 10.3-1), and the national total population was about 57 million. This means that 49.8 million are covered by PWA.The per capita water production in the provincial areas is figured out to be 8 liters, or about 1/21 of the 170 liters for the metropolitan area.

10.3.3 Waterworks improvement projects

The following is a list of on-going and planned waterworks projects by MWA.

- The Fourth Bangkok Water Supply Improvement Project (1991-1996): Bang Khen Water Treatment Plant, 400,000 m^3/day; service coverage, 180 km^2.
- The Fifth Bangkok Water Supply Improvement Project (1992-1996): Maha Sawat Water Treatment Plant, 400,000m^3/day to serve Bang Kruai District, Nonthaburi Province.
- The Sixth Bangkok Water Supply Improvement Project (1993-1998): To increase the capacity of Maha Sawat Water Treatment Plant by an additional 400,000 m3/day.
- The West Bangkok Water Canal Project (1993-1995): To feed water from the Tha Chin River to Maha Sawat Water Treatment Plant over a distance of about 36 km.
- Mobile Plants Installation Project: 200 m^3/h water treatment plant x 12 units.
- The Networks System Improvement Project (1994-1997): Installation of water supply pipes for the 5th and 6th Water Supply Improvement Projects.

10.3.4 Development of industrial water

MWA, PWA and RID provide no special services for supplying industrial water.In practice, therefore, IEAT, private developers of industrial estates, or factory owners are required to develop industrial water by themselves. It may be fair to say that availability of a water source is one of the essential factors for the siting of industrial estate or factory.

10.4 Telecommunications

10.4.1 Telecommunication industry

Telecommunication services in Thailand are provided by the Telephone Organization of Thailand (TOT), Communications Authority of Thailand (CAT), and the Post and Telegraph Department (PTD), all of which are under the control of the Ministry of Transportation and Communications (MOTC).

TOT provides domestic telephone service (including facsimile communication service) and transborder telecommunication services with Laos and Malaysia.

CAT provides domestic and international telegraph, telex, radio paging, and mobile telephone.CAT is competing with TOT in mobile telephone service.

PTD's services include the management of frequency assignments for domestic radio telecommunications, representing Thailand in international conventions dealing with international telecommunications, formulation of national policies and standards for telecommunications, approval, licensing and control of private networks.

10.4.2 Present and future of telephone services

(1) Telephone services

The number of telephone subscribers in Thailand was 1.79 million as of September 30, 1992 (see Table 10.4–1).Of these, about 65% live in the metropolitan area.The number of telephones per 100 population is 16.9 in the metropolitan area, while it is as small as 1.33 in the provincial areas.During the period from 1985 to 1992, the installed capacity of telephone lines in Thailand increased at an annual average rate of 14.7% from about 830,000 circuits in 1985 to about 2.17 million circuits.During the same period, the annual average growth rate in the metropolitan area was 11%, and that in the provincial areas showed a slightly higher value of 16.2%. (See Table 10.4–2.)

Table 10.4-1 THE DEVELOPMENT OF THE THAI TELEPHONE SYSTEM

As of September 30,

		1989	1990	1991	1992
Main Telephone Station (in thousands)	Bangkok	792	901	1,044	1,159
	Provinces	366	424	509	631
	Toatl	1,158	1,325	1,553	1,790
Main Telephone Station per (100 population)	Bangkok	10.4	12.11	14.45	16.13
	Provinces	0.76	0.90	1.08	1.33
	Total	2.90	2.41	2.88	3.33

Source: TT&T

Table 10.4-2 TRANSITION OF INSTALLED TRANSMISSION CAPACITY

Unit: Line

Year	Metropolitan Tel. Area	Provincial Tel. Area	Whole Kingdom
1985	586,180	244,300	830,480
1986	670,782	337,227	1,008,009
1987	861,782	389,710	1,251,102
1988	861,392	439,106	1,385,680
1989	946,574	481,940	1,493,438
1990	1,011,498	559,358	1,684,960
1991	1,204,106	665,163	1,869,269
1992	1,354,410	811,591	2,166,001

(2) Telephone demand and supply plan

TOT is addressing the 7th National Economic and Social Development Plan (1992-1996) in the so-called BOT system (Build, Operation and Transfer). Under this plan, 3 million subscriber lines will be added; of them, 2 million subscriber lines are being installed by Telecom-Asia for the metropolitan area. The remaining 1 million subscriber lines are being extended by TT&T (Thai Telephone and Telecommunications) to serve the provincial areas.

The National Economic and Social Development Board (NESDB), however, predicates a further addition of 1.1 million circuits to meet a long waiting list by September 1996. At present the telephone coverage is 1 circuit per 32 persons, and NESDB claims it necessary to add 1.1 million circuits for the purpose of increasing the coverage to 1 circuit per 10 persons.Now, there are 1.8 million subscribers on a waiting list, and the list is growing at an annual

average rate of 600,000 subscribers. This means that about 3.6 million subscribers will be required by 1996.

Currently, TOT is considering the way of adding 1.1 million telephone circuits.According to informed sources, it is said that TOT will be granted a permit to proceed to a 6 million circuit installation project under the 6th Development Plan (1997–2001) if the current 1.1 million circuit expansion project is successfully completed by 1996.

(3) Penetration of portable telephones

In Thailand, the portable telephone is penetrating the market at a tremendous rate, particularly in the Bangkok metropolitan area notorious for chronic traffic jams where it is gaining popularity as an indispensable communication means of business. Table 10.4–3 shows how rapidly portable mobile telephones are growing in Thailand.

Portable mobile telephone services available in Thailand are classified by frequency into three types: 470 MHz and 970 MHz offered by TOT, and 800 MHz by CAT. The number of subscribers for portable mobile telephone service was about 79,000 with TOT and about 44,000 with CAT as of the end of 1991, showing a growth of 150 times in the aggregate in a span of 6 years.

Table 10.4–3 PENETRATION OF PORTABLE MOBILE TELEPHONES

Year	TOT		CAT	Total	No. of Mobile/100 person
	470 MHz	900 MHz	800 MHz		
1986	822			822	0.002
1987	4,413		1,116	5,579	0.01
1988	10,612		6,972	17,584	0.03
1989	20,936		14,171	35,107	0.06
1990	31,981		31,242	63,223	0.11
1991	42,712	36,486	44,243	123,541	0.22

Source: TOT, August 1992

10.4.3 Trend of New Communication System

(1) Data communications network

In Thailand, in recent years, demand for high-quality digital transmission of information and data has been growing steadily.There are at least 11 common carriers providing these kinds of services in Thailand.These services are provided by networks including Datanet, ISDN and ISBN.Demand for these networks is projected to increase in line with the growth of computers, and it is reported that the number of VAN services is on a steady rise.

(2) Long-distance transmission service

Thailand faces the challenge of putting local telecommunication networks together into an integrated one, and is pushing forward with several long-distance transmission projects in this effort.
The networks currently in use include microwave networks, optical fiber cable networks, railway optical fiber cable networks, satellite networks, and submarine optical fiber system interconnecting the telephone networks on the east and south coasts of Thailand.

(3) Satellite service

Thaicom is the first satellite project developed by the Thai Government, and its 30-year concession is granted to Shinawatra Satellite Co., Ltd.
It is planned to launch two satellites in the first phase of the project (93/94) and another two in the second phase (2008).

10.5 Roads

10.5.1 Classification of roads and authorities responsible for their management

The roads in Thailand are classified into special highways or motorways, national highways, rural roads, municipal roads, sanitary rural roads (roads in small municipal areas), concession roads and expressways according to the authorities which manage them. (See Figure 10.5-1.)

Special highways, which are managed by DOH, are high-standard national highways for which the access and use of feeder roads. The special highway is committed to arterial use with heavy traffic; coming under this category are 4 routes – Route 32, running between Phrapradaeng and Bang Pa-in, Route 35 between Thonburi and Pak Tho, Route 340 between Phrapradaeng and Bang Bua Thoy, and Route 338 between Bangkok Noi and Nakohonchaisr.

National highways are managed by DOH, and are regarded to be of the highest strategic importance for economic development, administration and national defense in Thailand.

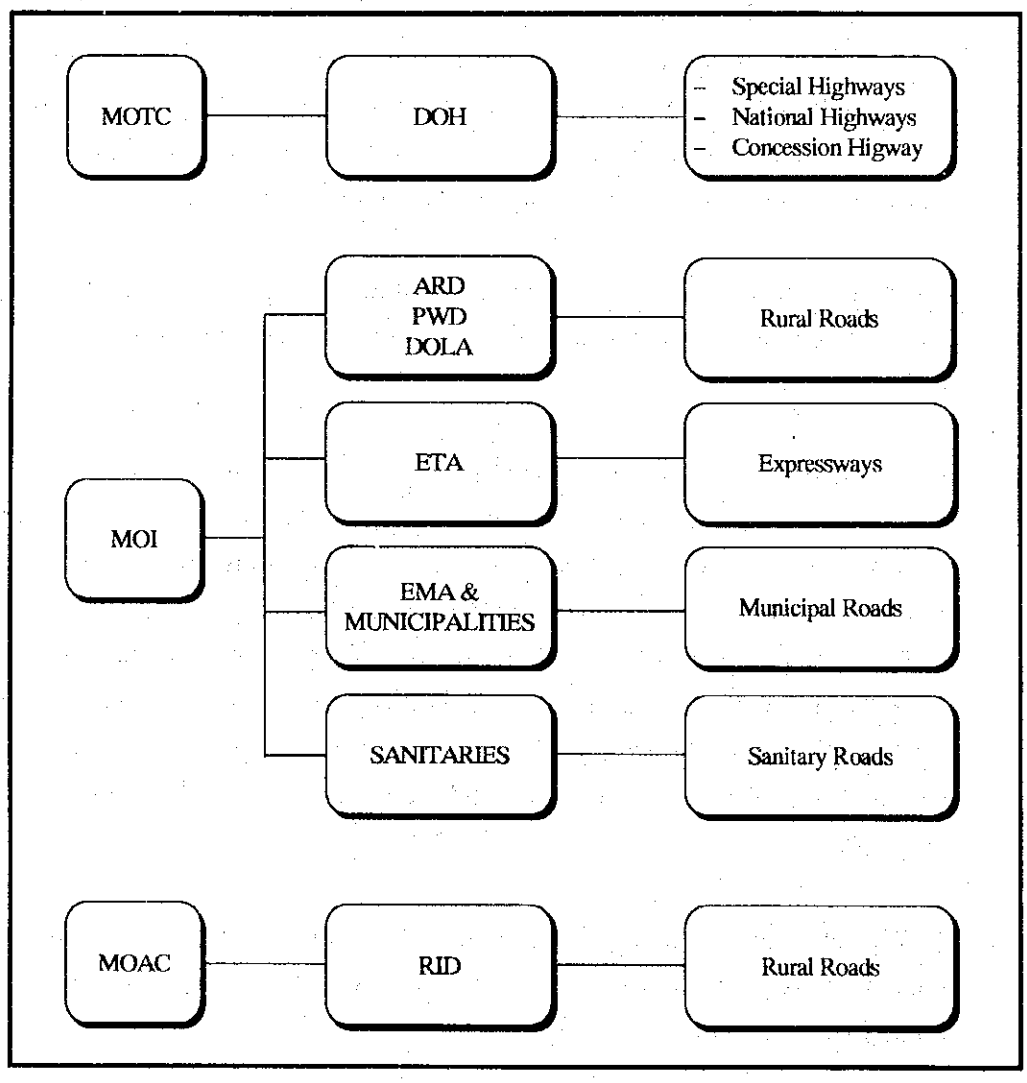
Rural roads hold life-line importance at the provincial levels, and their construction and management are undertaken by the Public Works Department (PWD) of the Ministry of Interior, Provincial Administration Organization (PAO), Regional Accelerated Development Bureau (RADB) of the Ministry of Interior, and the Department of Local Administration (DOLA) of the Ministry of Interior.There are also rural roads constructed by the Department of Forestry (DOF), Ministry of Agricultural Cooperatives, Royal Irrigation Department (RID), and the National Security Command (NSC) of the Ministry of Defense for special purposes.

Municipal roads are the main roads within the bounds of respective administrative units such as cities and towns, and are constructed and managed by respective municipalities.

Sanitary rural roads are those roads within the purlieus of respective sanitary districts which are smaller in size than cities and towns, and are constructed and maintained by respective sanitary districts.

Concession roads are developed by private developers according to a contact with the government.Tolls are collected to pay back the construction and management costs.After expiration of the term of the contract, the concession roads come into public possession.There were two concession roads about 30 km in aggregate length in the past, but there are none at present.

Expressways are toll motorways constructed and managed by the Expressway & Transport Authority (ETA) chartered under the auspices of the Ministry of Interior, and are used for mitigating traffic congestion in Bangkok.



Source: DOH

Figure 10.5-1 AGENCIES RESPONSIBLE FOR ROADS

10.5.2 Aggregate lengths of roads

In 1993, the aggregate lengths of roads in Thailand are 47 km of expressways, 292 km of special highways, 56,610 km of national highways, 140,504 km of rural roads, 14,724 km of municipal roads (2,800 km in the Bangkok metropolitan area, 11,924 km in provincial areas), amounting to 226,901 km in all. (Table 10.5-1)

Table 10.5-1 AGGREGATE LENGTHS OF ROADS BY CLASSES (1993)

Classification of roads	Aggregate length (km)
Expressway	47
Special highway	292
National highway	56,610
Concession road	-
Rural road	140,504
Municipal road	14,724
Metropolitan	2,800
Provincial	11,924
Grand total:	226,901

Source: DOH

10.5.3 DOH's road development plan

The long-term road improvement effort in Thailand started with the formulation of the 7-year Road Development Program (1965-971) under the 1st National Economic and Social Development Plan.Later, in 1972, DOH formulated the 3rd 5-year Road Development Program (1972-1976) intended for the development and improvement of arteries such as national and provincial roads.Since then, DOH has been updating its five-year road development program in tune with every national economic and social development plan.At present, DOH is implementing its 7th Program (1992-1996).In the 1st Program, emphasis was placed on the construction of national highways, and in 3rd and 4th Programs (1977-1981) the thrust was changed toward the construction of provincial roads.In the 5th Program, efforts continued to develop provincial roads while at the same time to improve and repair the existing roads.

For the 6th Program (1982-1991), it was originally planned to invest 29,331

million bahts, but to meet increases in traffic demand due to accelerated economic growth, unplanned projects, including the construction of the Bangkok–Chonburi Road, were added to send up the budget to a considerable 74,672 million bahts.The growth of national and provincial roads during the period from 1965 when the 1st Program started to the end of the 6th Program in 1991 is outlined in Table 10.5–2.It is seen that the aggregate length of roads grew 1.9 times during the period, and that the paved roads increased 7.3 times.As shown in Table 10.5–3, the 7th Program has 667 projects to construct 14,681 km of new roads at 95,833 million bahts. Figure 10.5–2 shows extension plan of road width in the country.

Table 10.5–2 DEVELOPMENT CONDITION OF NATIONAL AND PROVINCIAL ROADS

Year	Paved road	Un–paved road	Under construction	Total
1965	5,435	7,059	10,044	22,538
1971	11,462	5,643	16,106	33,211
1976	16,244	5,353	17,448	39,045
1981	24,715	5,301	13,900	43,916
1986	33,000	4,724	8,824	46,548
1991	39,581	6,068	6,801	52,450

Source: DOH/HIGHWAYS IN THAILAND 1992

Table 10.5-3 HIGHWAY CONSTRUCTION AND REHABILITATION PLAN BETWEEN 1992 – 1996 (ONLY NEW PROJECT)

Projects	Number	Distance (km.)	Construc. Cost (Mil. baht)	Amount of each Fiscal Year (mil. baht)					Under Construction Between 1992–96		Carry Forward to 8th Plan (mil. baht)
				1992	1993	1994	1995	1996	km.	Mil. baht	
1. Inter–city Motorway	5	198	14,800	–	–	700	2,800	5,700	122	9,200	5,600
2. Widening Project	98	2,394	30,036	935	3,177	6,176	7,330	7,070	1,891	24,688	5,348
3. Interchanges and Flyovers Construction Project	38	14	6,004	–	362	1,124	1,703	1,613	15	4,802	1,202
4. New Alignment Construction Project	61	987	6,882	75	743	1,600	1,674	1,583	790	5,675	1,207
5. Paved Road Construction Project	215	5,086	15,221	89	1,200	2,832	3,552	4,235	4,002	11,908	3,313
6. Flyovers Across the Railway	15	7	627	–	–	60	199	230	6	489	138
7. Reconstruction and Rehabilitation Highway Project	235	5,995	22,263	–	1,472	4,517	6,444	5,557	4,793	17,990	4,273
8. Total	667	14,681	95,833	1,099	6,954	17,009	23,702	25,988	11,619	74,752	21,081

Source: DOH/Highway In Thailand 1992

10.5.4 ETA's expressway development projects

ETA was established in 1972 as a subordinate agency of the Ministry of Interior to construct the expressway for the first time in Thailand.ETA's responsibilities include the planning, construction, management and operation of elevated railways, and cover the entire country. At present, ETA is operating with emphasis on the Bangkok metropolitan area suffering from all sorts of traffic problems.ETA's expressway development projects are summarized in Table 10.5-4.

Table 10.5-4 OUTLINE OF EXPRESSWAY DEVELOPMENT PROJECTS

Title of the project	Aggregate length (km)	Commissioned
1.Chalerm Maha Nakorn Expressway (1st phase)		
Din Daeng-Port	8.9	1981
Bang Na-Port	7.9	1983
Dao Kanong-Port	10.3	1987
Sub-total	27.1	
2. 2nd phase expressway		
Rama IX Road-Pracha Nukul	12.4	1993
Pracha Nukul-Chaeng Wattama	8.0	1993
Phya Thai Interchange-Bank Khlo	9.4	
Urupong-Rajadamri Road	2.0	
Rama IX Road-Sri Nakarin	8.0	
Sub-total	39.8	
3. Ramindra-At Narong Expressway	18.7	1996 (scheduled)
4. 3rd phase expressway	36.5	1998 (scheduled)
5. Bang Na-Bang Pli-Bang Pakong Expressway	55.0	1996,1997
6. Phya Thai-Buddha Monthon-Nakorn Pathom Expressway	40.0	
7. Chaeng Wattana-Bang Poon-Bang Sai Expressway	30.0	
8. Sri Nakarin-Bang Na Expressway	8.0	
9. Klong Tpm-Bang Chan-Min Buri Expressway	18.4	
10. Dao Kanong-Gang Khum Thian-Samut sakom Expressway	20.4	
Total	293.9	

Source: ETA/EXPRESSWAY SYSTEM NETWORK IN BANGKOK METROPOLITAN AND NEAR BY PROVINCES

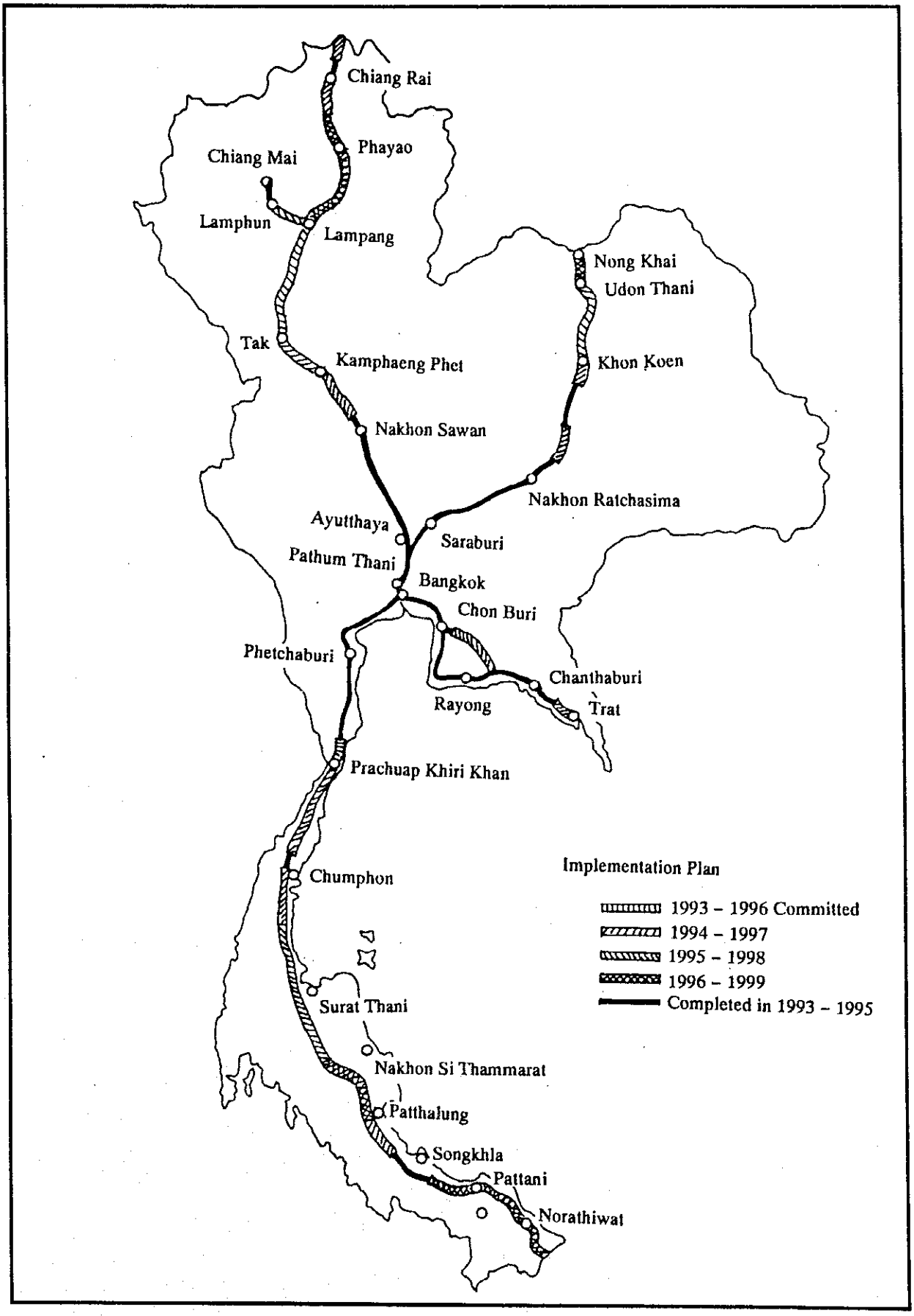


Figure 10.5-2 HIGHWAY WIDENING PROJECTS

10.6 Railways

10.6.1 Railway operations

In Thailand, all the railways are operated by the State Railway of Thailand (SRT). The SRT was established by Rama V in 1890 as a royal railway, and was reorganized into the current status according to the enactment of the State Railway of Thailand Act in 1951. The policy-making and management of all the affairs of SRT are undertaken by a Cabinet-appointed board consisting of 4 to 6 members and a chairman.The president of the SRT is also a member of the board. The SRT is put under the general supervision of the Minister of Transportation and Communications.

The SRT is operated by 26,499 employees (as of the end of September 1990), of whom 22,619 are full-time workers, and 3,880 part-time workers. The track maintenance department is the largest with 9,190 employees (including 6,336 full-time workers), followed by the engineering department with 7,132 employees (including 6,744 full-time workers), and the train operation department with 6,968 employees (including 6.440 full-time workers). There are 814 railway policemen, all of whom are full-time workers.

10.6.2 Railways

The aggregate length of the major lines operated by the SRT is 3,861 km (as of September 30, 1990). The majority of them are single-tracked; the only double-tracked section is the line extending 90 km north from Bangkok to Banpachi. The combined total length of major single-track lines and double-track line is 3,951 km, which together with 658 km of side tracks provides a total aggregate installed length of 4,609 km. The national land area covered by km of railway track is 133 km2.Served with railways are 42 out of 73 provinces. (See Table 10.6-1.)

The data above refer to the statistics as of the end of 1990.Later about 9.3 km of branch line was constructed between Si Racha and Laem Chabang, and there are projects under way to construct about 24 km of branch line between Kaochichan near Sattahip and Map Ta Phut (scheduled for completion by the end of 1992), and about 85 km of trunk line between Krongship Khao and Guengkoi (scheduled for completion by the end of 1995). When all these projects are completed, the total track length will reach 4,794.3 km.

The track gauge is standardized at 1 meter. The railways are not electrified, and all trains are operated by diesel locos and diesel cars. Bangkok Central Station is the hub of the SRT, from which the north main line, northeast main line, east main line, south main line and west main line are extended radially.

10.6.3 Rolling stock

The SRT is equipped with 7 steam locos (all in service), 279 diesel locos (of which 202 are in service), and 181 diesel cars (of which 140 are in service). Namely, the rolling stock in service is 349 (= 7+202+140) in all. The average age of rolling stock (including those laid up) is 41.1 years for steam locos, 20.4 years for diesel locos, and 11.0 years for diesel cars. There are 1,155 coaches (of which 1,037 are in service), and 8,751 boxcars and flatcars (of which 8,148 are in service). Their average ages are 21.1 and 29.3, respectively.

10.6.4 Passenger and freight transportation

In 1990, passenger trains were operated 504,000 hours, freight trains 281,000 hours, and mixed trains 24,000 hours, or 809,000 hours in the aggregate. The annual average hours run per car is calculated to be 2,318 hours (= 809,000/349 cars). The average operating speed is 51 km/h (maximum allowable speed: 90 km/h) for passenger trains, 30 km/h (maximum allowable speed: 70 km/h) for freight trains, and 34 km/h (maximum allowable speed: 55 km/h) for mixed trains. The annual total number of passengers is 85.3 million of which 81.6 million are accounted for by third-class passengers and 2.8 million by second-class passengers. The passengers transported reach 11,611.6 million passenger-kilometers; the average travel distance per passenger is 136.1 km. The annual total tonnage of cargoes transported is 7.9 million tons, including 7,861,136 tons of carloads and 24,680 tons of fractional carloads, or 3,291 million ton-kilometers in case of carload freight.

Table 10.6-1 ROUTE KILOMETRES AND STATIONS IN EACH PROVINCE

Province	No. of Stations	No. of Stopping Place	Route Kilometres
Autthaya	12	2	70
Bangkok Metropolis	20	2	113
Buri Rum	9	1	80
Chachoengsao	6	4	73
Chai-ya Phum	6	5	88
Chiang Mai	2	-	16
Chonburi	8	4	114
Chumphon	19	7	160
Kanchanaburi	7	13	121
Khon Kaen	12	5	144
Lampang	10	3	120
Lamphun	6	-	34
Lop Buri	14	7	142
Nakhon Nayok	1	-	13
Nakhon Pathom	9	5	76
Nakhon Ratchasima	39	12	300
Nakhon Sawan	16	2	110
Nakhon Si Thammarat	22	6	163
Nara Thiwas	11	1	81
Nong Khai	2	2	31
Pathum Thani	2	-	24
Pattani	4	-	26
Phatthalung	9	5	77
Phetchaburi	12	1	80
Phichit	10	-	74
Phisanulok	11	-	79
Prachin Buri	14	8	159
Prachuab Khiri Khan	25	4	198
Prae	7	3	75
Ratchaburi	13	2	76
Saraburi	15	4	104
Si Sa Ket	9	1	77
Songkhla	14	1	160
Sukhothai	2	3	21
Suphanburi	1	6	42
Surat Thani	20	13	170
Surin	8	-	65
Trang	3	8	73
Ubon Ratcha Thani	3	1	20
Udon Thani	7	3	92
Uttaradit	12	2	84
Yala	5	2	36
Total	437	148	3,861

Source: SRT/INFORMATION BOOKLET 1991

10.6.5 Double-tracking projects

The overwhelming majority of railway tracks in Thailand are of the single-track type, and the train speed is as slow as 50 km/h on the average. Double-tracking will increase the train operating speed to 100 km/h (max. 130 km/h) and reduce the travel time by about 40% as the wasteful side-tracking time otherwise required to pass trains each other can be eliminated. The budget for this double-tracking project is 80 billion bahts for completion in the year 2000. In passing, the project will use a 1 m gauge which is standard with the existing railway system in Thailand. This is why the widening of the tracks to 1.4 m will skyrocket the budget from 80 billion bahts to 300 billion bahts only to lose the economic viability of the project.Besides all existing locos, freight cars and coaches will have to be abandoned, increasing the spending for new rolling stock. To recover the cost, it is required to increase the fares, and increased fares will reduce the boarding efficiency to affect the earning power of the railway. Worse, widening of the tracks will prevent trackage with southern China, Myanmar, Cambodia, Malaysia, Singapore and other neighboring countries.

10.6.6 Construction plan for new urban railway system

In the metropolitan area, traffic congestion is getting more and more exacerbated year after year. To save the situation, there are under consideration of the following three project the SRT has come up with HOPEWELL project, the Bangkok Metropolitan Agency with TANAYON project, and the METROPOLITAN RAPID TRANSIT AUTHORITY (MRTA) with the sky train project, respectively. These mass transit system construction projects are outlined below.

The HOPEWELL project is an elevated road and railway construction project according to a build-operate-transfer contract concluded between SRT and HOPEWELL corp. It is under way since 1992 when earthbreaking ceremony was held.In this project, three-deck superstructure will be constructed to have a six-lane expressway on the top deck, with the second deck space for urban railway and existing railway. It will run over a distance of about 60 km, and will cost US$3,200 million. The project is implemented in five phases each spanning 4 years, and is scheduled for completion in 2001. This new system is expected to convey 3 million passengers a day.In this May (1994), the government decided to install the new transit systems underground, but the Hopewell project was

approved to be constructed above ground over the entire line as originally planned because of technical constraints.

TANAYON project is designed to construct an elevated railway between Pra Khanong and Pathom-wan and between Mor Chit and Silom according to the contract between BMA and Bangkok Transit System Corp. (BTSC) of the Tanayon goup. This two-route 23.7-km elevated railway project costs US$700 million. Like HOPEWELL, this project was excused from the government decision, and was permitted to construct elevated railway structures as originally planned. But a strong local protest against the construction of car depot caused delays and changes to the routing plan. The elevated railway, which might be completed in 1997, is now expected to be available for service in the beginning of 1998 at the earliest. The project is expected to increase the capacity of the metro transit systems by 700,000 to 1,000,000 passengers a day.

Skytrain project is also an elevated railway construction project for which MRTA is supposed to conclude a contract with Mass Transit Corp. of the Bangkok Land Group this year (1994). Of the total 20 km route (Hua Lamphong - Sirikit Conference Center - Bang Su), a 600-m section was originally planned to be constructed underground. But in response to the government policy of promoting subway network in the metropolitan area, subway section was increased to 11.3 km; a resultant cost increase of 16,500 million bahts will be compensated for by the government. According to the original plan before changes to the subway section, the project period is 5 years after commencement, and one-way transport capacity is estimated at 60,750 passengers per hour.

10.7 Ports Facilities

10.7.1 Types of ports

Ports in Thailand are roughly classified into coastal ports on the Gulf of Thailand and the Andaman Sea and river ports developed along the Chao Phraya River, the Tha Chang River, and the Mae Klong River.Functionally, the ports are also classified into inland water ports serving as a base river port for shipping by barge, coastal ports for domestic trade and trade with nearby countries such as Malaysia, and deep-sea ports where large ocean-going vessels for foreign trade can be accommodated.

Inland water ports are available at Non Thaburi, Ayutthaya, Chai Nat, and Pathaum Thani along the Chao Phraya River, at Samut Sakhon and along the Tha Chin River, and at Ratchaburi along the Mae Klong River, etc, and are used mainly for the shipping of sand, gravel, cement and other construction materials, and cassava, maize and other crops.

Major coastal ports are: Si Racha, Chumphon, Surat Thani, Sichon, Pak Panang, and Pattani on the Gulf of Thailand.Mainly handled at these ports are oil products, fertilizer, sugar, etc.

Deep-sea ports, or foreign trade ports, include: Bangkok Port, Laem Chabang Port, Map Ta Phut Port, Sattahip Port, and Songkhla Port, all situated on the Gulf of Thailand, and Phuket Port on the Andaman Sea.Bangkok Port is an international port handling the largest turnover of cargoes in Thailand; Laem Chabang Port, and Map Ta Phut Port are ports developed to serve as a foothold for the development of eastern industrial estates. Songkhla Port and Phuket Port are developed for exporting rubber, tin and other primary products produced in the south.

Figure 10.7-1 shows location of main ports.

10.7.2 Management and operation of ports

In Thailand, there are several organizations responsible for management and operation of ports. Bangkok Port and Laem Chabang Port, which play the central part of foreign trade in Thailand, are managed and operated by the Port Authority

of Thailand (PAT), whereas Sattahip Port is under the control of the Royal Navy. Map Ta Phut Port is managed and operated by the Industrial Estate Authority of Thailand (IEAT), and Phuket Port and Songkhla Port in the south are managed and operated by CT International Line Ltd, a private corporation under the control of the Ministry of Treasury.

Other small to medium ports are usually developed by the Department of Port(DOP), Ministry of Transport and Communications, and their management and operation are undertaken by local authorities or DOP.The dredging of navigable inland waters such as rivers, safety management of navigation, and piloting service are also undertaken by DOP.

10.7.3 Ports and cargo handling volume

As shown in Table 10.7-1, the total cargo volume handled by ports in Thailand was 100.9 million tons in 1992; with 71 million tons accounting for a little more than 70% of the total, the international shipping volume leads the list of water transport.Exports to overseas countries account for two thirds of international shipping volume, imports one third. During the periods from 1989 to 1992, the cargo volume handled by ports increased at an annual growth rate of 6.4%.Although the inland water trade volume remained almost the same, coastal shipping and export volume increased at an annual growth rate of 13% and 12%, respectively.It should be noted, however, that imports are declining at an annual rate of 4%.

Table 10.7-1 FREIGHT TRAFFIC BY WATER TRANSPORT (1989-1992)

Unit: 1,000 tons

TYPE OF WATER TRANSPORT		1989	1990	1991	1992
Inland Water ways		11,532	11,906	13,000	12,116
Coastal Shipping		12,132	15,387	14,705	17,592
International	Outbound	33,513	38,593	40,880	47,644
Shipping	Inbound	26,573	23,235	22,740	23,593
	Subtotal	60,086	61,828	63,620	71,237
Total		83,750	89,121	91,325	100,945

Source: TMIS[1] /TRANSPORT STATISTICS, Data for 1992

Note:1) Transport Management Information System Sub-division (TMIS), Transport and Communications Economics Division, Office of the Permanent Secretary, Ministry of Transport and Communications

As shown in Table 10.7–2, Singapore was on top of the list of exporters to Thailand, supplying 10.9 million tons, or 22.8%, of Thai imports.The next largest exporter was Malaysia with 5.3 million tons (11.1%), followed by Japan with 4.4 million tons (9.2%) and Korea with 3.1 million tons (6.6%).All top four were Asian countries.Coming fourth was Saudi Arabia, the oil exporter, with 2.9 million tons (6.2%).

Table 10.7–2 INTERNATIONAL SHIPPING 1989 TO 1992 (INBOUND)

Unit: 1,000 tons

FROM	1989	1990	1991	1992
Singapore	9,296	11,922	9,924	10,874
Malaysia	3,023	4,484	4,693	5,308
Japan	2,700	3,449	3,754	4,382
Korea	1,033	1,347	2,839	3,139
Others	9,405	8,163	9,597	11,194
Asia	25,457	29,365	30,807	34,897
Saudi Arabia	1,588	1,697	2,091	2,945
Others	3,583	4,163	4,285	4,808
Mediterranean & Mid. East	5,171	5,860	6,376	7,753
Europe	1,126	1,456	1,514	1,749
North Amerida	464	559	973	739
Central America & W. Indies	18	107	74	93
Africa	192	222	436	512
Australia	240	133	152	899
Unclassified	400	586	184	64
Total	33,515	38,593	40,878	47,644

Source: TMIS/TRANSPORT STATISTICS, Data for 1992

In 1992, Thailand exported 16.7 million tons to Asian countries, which accounted for 70.7% of the total exports. (See Table 10.7–3.) Singapore was the largest customer of Thailand, importing 5.4 million tons (22.8%), followed by Japan with 2.9 million tons (12.5%), and the Netherlands with 2.4 million tons (10.2%).It is reported that for Thailand, the Netherlands is the largest buyer of tapioca (starch produced from cassava).

Table 10.7–3 INTERNATIONAL SHIPPING 1989 TO 1992 (OUTBOUND)

Unit: 1,000 tons

FROM	1989	1990	1991	1992
Singapore	6,165	5,148	4,845	5,391
Malaysia	1,634	1,358	1,415	900
Japan	2,870	2,901	2,646	2,950
Korea	1,241	1,195	787	1,483
Others	5,851	5,128	6,642	5,965
Asia	17,761	15,730	16,335	16,689
Mediterranean & Mid. East	1,121	1,138	508	1,332
Netherlands	1,654	1,209	2,361	2,412
Others	4,297	3,240	1,695	1,984
Europe	5,951	4,449	4,056	4,396
North Amerida	183	230	133	227
Central America & W. Indies	229	293	116	135
Africa	1,144	899	709	664
Australia	52	24	23	37
Unclassified	100	380	707	32
Total	26,575	23,233	22,742	23,593

Source: TMIS/TRANSPORT STATISTICS, Data for 1992

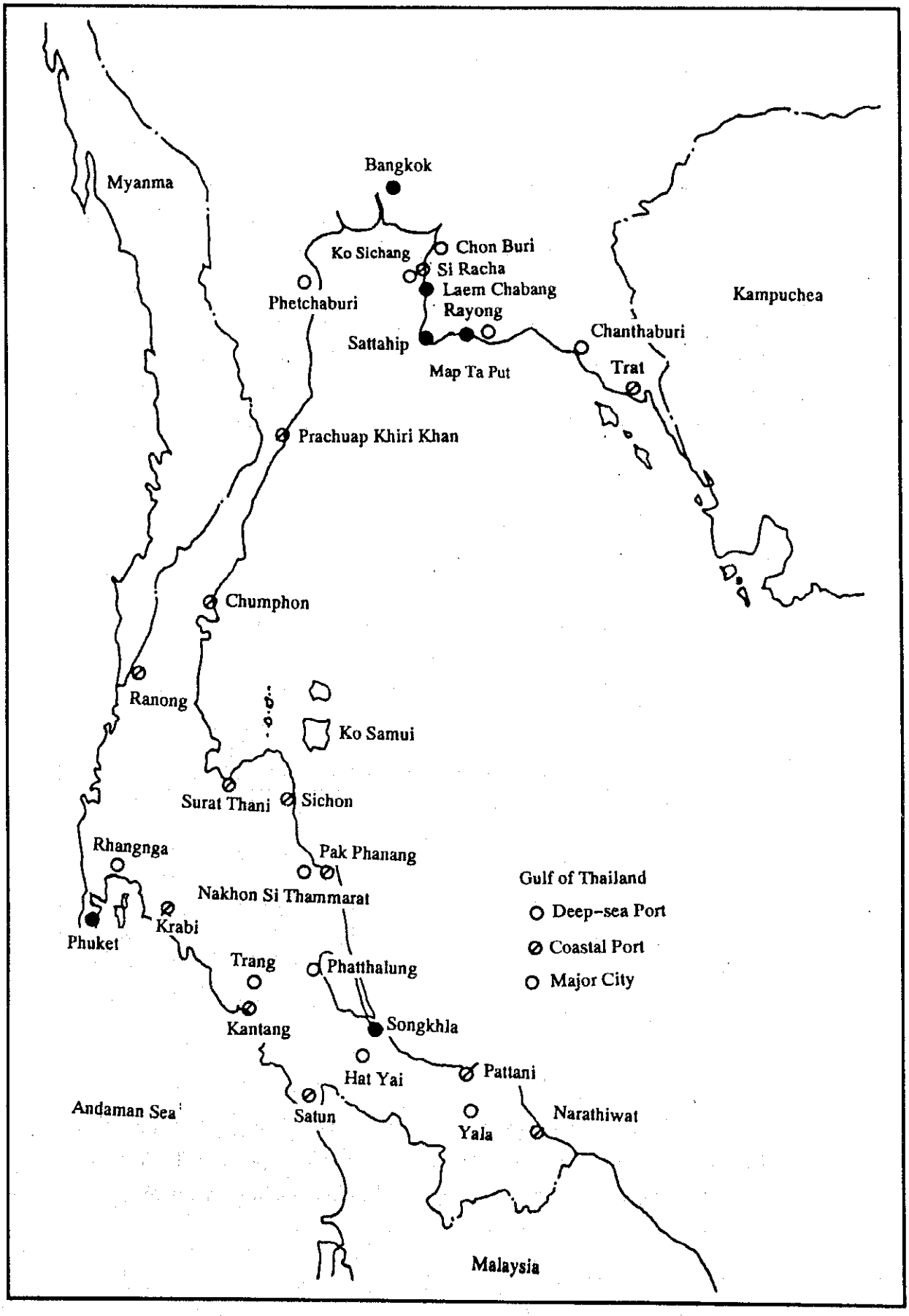


Figure 10.7-1 SEA COASTAL PORT

10.7.4 Major commercial ports and industrial ports

(1) Bangkok Port

Bangkok Port is situated in Klong Toi, Bangkok, 26 to 29 km upstream of the estuary of the Chao Phraya River.The approach fairway is 18 km long, 100 m wide (250 m at curved section), and 8.5 m deep.This river port limits access to ships not greater than 12,000 DWT, not longer than 172 m in length and not asking more than 8.2 m in depth.For this reason, most of cargoes shipped to and from Bangkok are transshipped at transit ports in Singapore or Hongkong.The port area is 364 ha of which 65 ha is occupied by cargo sheds and container yards.The Port has been managed and operated by PAT since its dedication.

Major port facilities are as follows.

Berthing facilities:

Bangkok Port has the berthing facilities listed in Table 10.7-4.

Table 10.7-4 BERTHING FACILITIES

Berthing/Dolphin	Length (m)	Quantity	Quantity	
			Length/draught (ft)	Quantity
West Quay	1,660	11	565/27	10
			400/27	1
East Quay	1,528	8	565/27	7
			300/16.5	1
Klongtoey Dolphins	1,377	36	565/27	7
Bang Hua Sua Dolphins	1,535	25	565/27	8
Mooring Buoys at Sathupradit	1,555	5	450/26	5

Source: PAT

Cargo handling facilities:

Cargo handling is undertaken by PAT, ETO (Express Transportation Organization, a state-run corporation), and a private corporation.Table 10.7-5 shows the types and capacity of the cargo handling facilities available.

Table 10.7-5 HANDLING EQUIPMNET

Equipment	Capacity (ton)	Quantity
Rail Mounted Gantry Crane	32	
Semi Portal Crane	3～5	
Transtainer/Rubber Tyred Gantry Crane	30	
Top Loader	40	
Mobile Crane	10～50	
Container Stacker	30～40	
Fork Lift for Empty Container	6～10	
Fork Lift Truck	3.15～4.5	
Trailer	10	
"	5	
"	10	
Towing Tractor	3.6～5.4	
Container Chassis	30	
Tractor for Container	30	
Multi-purpose trailer	10	
Motor Truck	5～7	

Source: PAT

Warehousing:

Transit sheds and warehouses:... 170,500 m^2

Cargo sheds and container yards:.. 630,000 m^2

Service boats:

The capacity and number of service boats available in Bangkok Port are as follows.

Table 10.7-6 SERVICE BOAT

Item	Capacity (HP)	Unit
Tug boat	1,000～1,800	
Garbage boat	160	
Rope boat	30～120	
Water boat	425	

Source: TAP

No significant changes in the number of ships calling at Bangkok Port have been experienced over the last three years.The number of vessels which called at Bangkok Port in 1993 was 2,516, up 94 in 3 years from 1991

(annual growth rate: 1.9%).The import and export cargoes handled totaled 15.6 million tons in 1991 and 16.6 million tons in 1993, giving an annual average growth rate of 3.3% over the 3-year period.Container cargoes grew 5.2%, but the conventional cargoes declined at an annual average rate of 2.7%.The number of containers handled was 1.2 million TEUs (1) in 1991 and 1.3 million TEUs in 1993, showing an annual growth rate of 4.2% in the three-year period. (See Table 10.7-7.) Handling capacity in Bangkok Port is almost full.

Note (1): TEU = 20-foot equivalent unit

(2) Laem Chabang Port

Situated on the east of the Gulf of Thailand, this commercial port in Si Racha, Chon Buri Province, is about 130 km northeast of Bangkok.Laem Chabang Port is designed to accommodate large container vessels that cannot enter Bangkok Port, and has an area of about 1,000 ha to serve as a foothold for the littoral industrial development of the eastern district.The first phase port construction project started in 1987 and completed in 1991. The total investment cost was about 2,455 million bahts.The general management of the Port is undertaken by PAT.The port facilities include: 7.25 mil.-ton-a-year berths equipped with 6 gantry cranes for container use; 14-m deep, 2.5 k-long fairway; 1,300 m breakwaters, etc.The berthing facilities available are as follows.

- Multi-purpose terminal (1 berth): 300 m long by 14 m deep, capable of accommodating 30,000DWT class general cargo carriers, and having an annual handling capacity of 510,000 tons.
- Container terminal (3 berths): Berth box (50 m wide x 900 m long x 15 m deep) capable of accommodating 30,000DWT - 500,000DWT container vessels and having an annual handling capacity of 450,000 TEUs.
- Coastal shipping terminal (1 berth): 200 m long x 6.5 m deep, capable of accommodating 1,000DWT class ships and having an annual handling capacity of 150,000 tons.
- Service boat berth (1 berth): 100 m long x 6.5 m deep, for 1,000DWT class service boats.
- Bulk terminal (2 berths): 650 m long x 14 m deep, capable of accommodating 40,000DWT-50,000DWT class cargo vessels and having

an annual handling capacity of 2.1 million tons.

The multi-purpose berth was put into commission in January 1991. Now all three container berths are also put into service.The multi-purpose berth and No. 2 berth are operated by PAT, but No. 3 berth and No. 4 berth are leased to private firms according to the privatization policy of the government.Both No. 3 berth and No. 4 berth are operated by Thai-Japanese joint ventures, ESCO (Eastern Sea Laem Chabang Terminal Co., Ltd.) and TIPS.The bulk berth on the south of the north quay is also leased to a private firm, and the north space is leased to a private shipbuilding company, which now is constructing a shipbuilding yard.

During the period from 1991 to 1993, the number of ships that called at Laem Chabang Port was 110 in 1991 and increased 7.3 times to 788 in 1993, showing an annual average growth rate of 268% in three years.
The cargoes handled also increased from about 1 million tons in 1991 to about 2.5 million tons in 1993, showing an annual average growth rate of 57.8% over three years.Container volume also increased to 218,516 TEUs in 1993, up 91 times versus 2,406 TEUs in 1991. (See Table 10.7-8.)

(3) Map Ta Phut Port

Map Ta Phut Port, an industrial port in Map Ta Phut district, Rayong Province, about 220 km along the national road from Bangkok, lies down the eastern coast of the Gulf of Thailand.A chemical industrial estate operating on natural gas and a 325 ha housing park form the hinterland of the Port.This port was developed as a base for the development of eastern littoral area.The entire port area is managed by IEAT, but the port facilities are operated by private firms.

The first phase port construction project began in October 1989, and was completed in February 1992, providing one multi-purpose berth (330 m long x 10 m deep) for 20,000DWT class vessels, two berths (320 m long x 9 m deep) for 8,000DWT class liquid carriers, breakwaters with an aggregate length of about 1.3 km, a 125 m fairway (9 m to 10.5 m deep), and revetments with an aggregate length of about 5 km.

Table 10.7-7 BANGKOK PORT STATISTICE 1991-1993

BANGKOK PORT (KLONGTOEY WHARF)		UNIT	YEAR		
			1991	1992	1993
1. VESSEL		CALL No.	2,442	2,514	2,516
2. CARGO					
IMPORT	CONVENTIONAL	TONS	3,727,357	3,486,882	3,551,598
	CONTAINERISED	TONS	4,259,329	4,827,984	5,026,387
	TOTAL	TONS	7,986,686	8,314,866	8,577,985
EXPORT	CONVENTIONAL	TONS	20,239	-	-
	CONTAINERISED	TONS	7,569,244	8,326,816	8,057,935
	TOTAL	TONS	7,589,483	8,326,816	8,057,935
IMPORT + EXPORT	CONVENTIONAL	TONS	3,747,596	3,486,882	3,551,598
	CONTAINERISED	TONS	11,828,573	13,154,800	13,084,322
	TOTAL	TONS	15,576,169	16,641,682	16,635,920
3. CONTAINER	INWARD	T.E.U.	546,180	615,326	597,856
	OUTWARD	T.E.U.	624,517	687,982	675,940
	TOTAL	T.E.U.	1,170,697	1,303,308	1,273,796

Source: PAT/EVALUATION PLAN 15 MAR, '94

Table 10.7-8 LAEM CHABANG PORT STATISTICES 1991-1993

LAEM CHABANG PORT		UNIT	YEAR		
			1991	1992	1993
1. VESSEL		CALL No.	110	306	788
2. CARGO					
IMPORT	CONVENTIONAL	TONS	982,811	1,048,484	389,074
	CONTAINERISED	TONS	1,540	136,317	880,473
	TOTAL	TONS	984,351	1,184,801	1,269,547
EXPORT	CONVENTIONAL	TONS	11,721	15,401	18,849
	CONTAINERISED	TONS	3,623	149,325	1,202,835
	TOTAL	TONS	15,344	164,726	1,221,684
TRANSIT	CONVENTIONAL		-	1,606	1,850
	CONTAINERISED	TONS	19,869	219	42,930
	TOTAL	TONS	19,869	1,825	44,780
IMPORT + EXPORT	CONVENTIONAL	TONS	994,532	1,065,491	409,773
	CONTAINERISED	TONS	25,032	285,861	2,126,238
	TOTAL	TONS	1,019,564	1,351,352	2,536,011
3. CONTAINER	INWARD	T.E.U.	177	16,507	101,663
	OUTWARD	T.E.U.	405	17,140	113,239
	TRANSHIPMENT	T.E.U.	1,824	58	3,624
	TOTAL	T.E.U.	2,406	33,705	218,526

VESSEL: EXCLUDING PASSENGER VESSEL AND BARGE

Source: PAT/EVALUATION PLAN 15 MAR, '94

10.7.5 Future port development projects

(1) Eastern Seaboard development project

The commercial port of Laem Chabang and the industrial port of Map Ta Phut wait Phase 2 construction projects, respectively, to consolidate the base for the eastern littoral development.For Laem Chabang Port, No. 5 container berth will be constructed by 1996 to increase the container handling capacity from the present 450,000 TEUs a year level to 600,000 TEUs a year level.It is also planned to construct 2 additional quays in the south.For the industrial port, Map Ta Phut, there are plans to construct a berth for 60,000DWT class vessels and develop an eastern port area, including reclamation for oil refinery site.

(2) Southern Seaboard development plan

The southern seaboard development plan is the second largest comprehensive regional development plan after the eastern seaboard development plan.The construction of a land bridge between Krabi on the Andaman Sea and Kanom on the Gulf of Thailand will reduce the sea route interconnecting the Middle East and the Far East by 835 to 2,780 km, making the international sea transportation of crude oil and containers.Taking recourse to this land bridge construction project, the southern seaboard development plan is aimed at the industrial promotion and regional development in the south of Thailand.

As an integral part of the land bridge construction project, there exist port development projects: the construction at Krabi terminal of an offshore oil terminal for 250,000DWT class vessels and a 14 m deep sea port for container carriers; and the construction at Khanom terminal of an offshore oil terminal and a deep sea port equipped with transshipping and repackaging facilities.Namely, two international deep-sea ports will be constructed as part of the southern seaboard development plan.

10.8 Airport

10.8.1 Present condition of airport facilities

In Thailand the airports providing private air transportation consist of the four international airports -- Bangkok, Chian Mai, Phuket, and Hat Yai -- all operated by the Airports Authority of Thailand (AAT) and the 21 domestic airports operated by the Department of Aviation, Ministry of Transport and Communications (DOA) and the Thai Air Force (Table 10.8-1).

Looking at the length of the runway as an indicator of the scale of the airports, the international airports all have runways of the 3,000m class, allowing service by jumbo jets; of the domestic airports, nine have runways of the 3,000m class, and six airports have runways of the 2,000m class, suitable for service by airbus planes.The remaining airports' runways are 1,000m to 1,500m, and capable of accommodating small aircraft of about 30 passengers.Also, in terms of airport scale, Bangkok Airport can be given special mention.The site occupies 620ha and is provided with runways of 3,700m and 3,000m and equipped with functions that, together with the round-the-clock operability, make the airport a hub for domestic and international air traffic.

Figure 10.8-1 shows location of international and domestic airports.

10.8.2 International airport

The base of Thailand's international airline transportation is Bangkok Airport.Looking at the number of users of international routes at Bangkok Airport (Table 10.8-2 including international and domestic flight passengers), in 1988 there were about 11.4 million passengers, and in 1992 there were about 16.3 million passengers, coming to an average yearly increase rate of about 8%.Examining the amount of airline cargo handled,in 1988 there were about 328,000 tons, and in 1992 there were about 465,000 tons, coming to a yearly increase of about 9%. Of which 98% is occupied by international cargo. Also, 93% of those entering and leaving Thailand use Bangkok Airport, whose service by 66 airline companies puts it well ahead of the other regional international airports.

Table 10.8-1 AIRPORT INFRASTRUCTURE (As of July 1993)

AIRPORT	RUNWAY (m)	OPERATING AUTHORITY	OPERATING HOURS	Remarks
International				
Bangkok	3,700 x 60	AAT	H24	Area:620ha
"	3,000 x 45			66 Airlines
Chiang Mai	3,100 x 45	AAT,RTAF[1)]	23:00-5:00	1 Airline
Phuket	3,000 x 45	AAT	H24	9 Airline
Hat Yai	3,050 x 45	AAT	23:00-7:00	3 Airline
Domestic				
Mae Hong Son	1,630 x 30	DOA		
Chiang Rai	3,000 x 45	DOA	23:00-12:00	
Lampang	1,775 x 30	DOA		
Phrae	1,500 x 30	DOA		
Nan	2,000 x 45	DOA		
Tak	1,500 x 30	DOA		
Mae Sot	1,500 x 30	DOA		
Phitsamulok	2,180 x 45	DOA		
Khon Kaen	2,050 x 45	DOA	23:00-14:30	
Udon Thani	3,048 x 38	DOA	23:00-14:00	
Ubon Ratchathani	3,000 x 45	DOA,RTAF	23:00-17:00	
Loei	1,500 x 30	DOA,RTAF	23:00-14:30	
Sakhon Nakhon	2,600 x 45	DOA		
Nakon Ratchasima	3,000 x 45	DOA,RTA[2)]		
Surat Thani	2,500 x 45	RTAF	H24	
Nakhon Si Thammarat	1,100 x 35	DOA	23:00-14:30	
Trang	1,500 x 30	DOA,RTA	00:00-10:00	
Pattani	1,400 x 40	DOA		
Narathiwat	2,000 x 45	DOA		
Hua Hin	1,200 x 30	DOA		
U-Taphao	3,505 x 60	DOARTN[3)]	22:30-09:30	

Source: TMIS, AAT/ANNUAL REPORT 1992
Notes: [1)] Royal Thai Air Force; [2)] Royal Thai Army; [3)] Royal Thai Navy

Table 10.8–2 INTERNATIONAL AIRPORT TRAFFICE STATISTICS IN 1988 AND 1992

Fiscal Year	Aircraft Movements	Total Traffice (International + Domestic)											
		Passenger ('000)				Freight in Tonnes ('000 tons)				Mail in Tonnes (tons)			
		Embarked	Dis-embarked	Direct Transit	Total	Loaded	Unloaded	Transit	Total	Loaded	Unloaded	Transit	Total
Bangkok													
1988	76,172	4,981	5,028	1,392	11,401	186.8	95.8	45.5	328.1	615	552	795	1,962
1992	126,483	7,248	7,325	1,760	16,333	283.4	141.7	40.3	465.4	672	840	1,432	2,944
Chaiang Mai													
1988	8,943	457	407	–	864	2.6	1.1	–	3.7	39	38	–	77
1992	12,091	657	599	23	1,279	5.0	2.9	0.1	8.0	161	18	–	179
Hat Yai													
1988	5,140	200	175	24	399	2.6	1.3	0.2	4.1	48	12	1	61
1992	9,153	268	246	24	538	1.9	3.3	0.1	5.3	253	71	53	377
Phuket													
1988	8,935	467	458	41	966	1.5	1.3	–	2.8	39	14	–	53
1992	18,408	950	934	86	1,970	1.5	1.3	2.3	5.1	158	92	107	357
Total International Airpor													
1988	99,190	6,105	6,068	1,457	13,630	194	100	46	338.7	741	616	796	2,153
1992	166,135	9,123	9,104	1,893	20,120	292	149	43	483.8	1,244	1,021	1,485	3,750

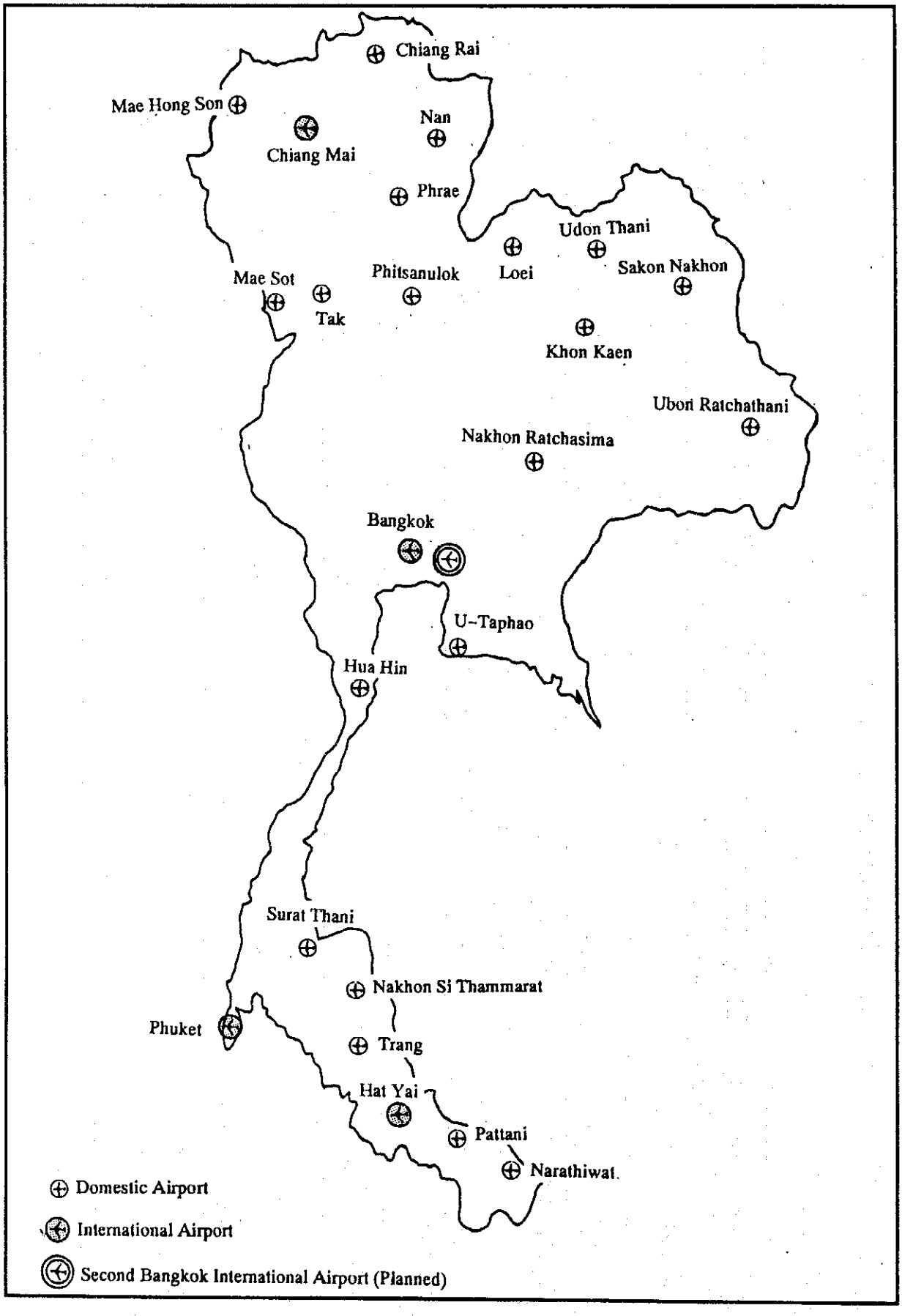


Figure 10.8-1 LOCATION OF AIRPORT

The number of international passengers at Chian Mai, Hat Yai, and Phuket regional international airports combined is only 7% of Bangkok's. However, of these airports, the increase in the number of passengers at Phuket Airport is remarkable, going from about 180,000 passengers in 1988 to about 700,000 in 1992, a yearly increase of 40%. Also, the number of airline companies with international routes serving Phuket Airport is nine, making it the most behind Bangkok Airport.In addition, The Thai Government is currently pursuing a policy of promoting the introduction of international routes to these regional airports.

10.8.3 Domestic airport

The domestic airline transportation network in Thailand consists of Bangkok at the hub joined to regional cities such as Chian Mai, Hat Yai, and Phuket, and in addition, these regional cities and their environs are joined to form a hub-and-spoke airport network.Consequently, regional international airports play a large role in domestic airline transportation.

Examining the transition in the use of the four international airports including Bangkok, over the five years from 1988 to 1992, the yearly rate of increase was about 14% for the number of passengers and aabout 17% for the amount of freight handled, an increase above the rate for international routes.Also, including the total number of passengers from other regional airports, the yearly average increase comes to about 13% and about 7.8 million passengers in 1992 (Table 10.8-3).

Table 10.8-3 DOMESTIC AIR TRAFFIC 1988 to 1992

	1988	1989	1990	1991	1992
Flights	57,638	73,618	91,411	86,377	103,384
Passengers	4,717,791	6,163,980	7,717,198	7,101,030	7,778,554
Freight (ton)	22,855	22,085	27,876	30,331	40,110

Source: TMIS

10.8.4 Airport facilities and future plans

REGIONAL INTERNATIONAL AIRPORT FACILITIES

In response to the continuing increase in demand for airline transportation in Bangkok and the regions, the AAT is pushing forward ith the following projects

to further expand Bangkok International Airport and the regional airports into the ones of sufficient substance in terms of both facilities and services to be called a true international airport.

- Bangkok International Airport: Expansion of the international flight passenger terminal, apron, and freight terminal; new construction of No. 2 cargo terminal (1991–1997).
- Chian Mai International Airport: Expansion of the parallel taxiway, passenger terminal, parking facilities, and the apron for airline use (1993–1998)
- Hat Yai International Airport: Construction of a parking lot and expansion of the freight terminal and passenger terminal (1993–1998)
- Phuket International Airport: Expansion of the parallel taxiway, freight terminal, parking lot, and the passenger terminal

Second Bangkok International Airport

Between 1981–1991, the number of passengers at Bangkok International Airport increased by 15%, freight by 19% annually. The number of airlines showed a remarkable increase from 48 to 63. As a consequence, the Cabinet agreed to let AAT handle the responsibility of developing Bangkok International Airport during 1991–1997 by expanding the building area and other facilities. As a result of feasibility study, it is speculated that air traffic in the next two decades will be heavier, with 37 million passengers in 2000 and 53 million passenger in 2010. The freight transported by air will also increase to 1.35 million tons and 2.46 million otns respectively. There is need to construct the Second Bangkok International Airport to help alleviate air traffic when Bangkok International Airport overflow in 2000 even though continuing expansion of airport facilities.

A construction site for the Second Bangkok International Airport is planned at Nong Ngu Hao area in Samut Prakara province. Total 3,100 ha site was already acquired during 1963~1973. A term of construction will be divided into three phases; the first phase for basic planning for a year, the second phase for designing for two and half year, and the third phase for four years construction so that seven and half years in total. The second airport will have four runawaies with 3,700 m length and a 4,000 m runaway. A new international airport that enhances the efficient operation and will be proper to call hub airport orf Southeast Asia.

10.9 Industrial Pollution

10.9.1 Environment and pollution

Recently, in Thailand rapid economic growth has brought grave environmental and pollution problems.Air pollution is considerable in city regions and industrial zones, and particularly in Bangkok where traffic congestion is severe and the carbon monoxide density from car exhaust gas has been known to exceed the limits in various places. Water pollution is advanced in many major rivers such as the Chao Phraya, Tha Chin, Mae Klong, Chi, and Moon, and Songkhla Lake, where it has brought a tremendous impact on the aquatic life and the coastal residents. Also, problems have arisen including municipal waste continuing to grow beyond the processing capacity, the worsening of the environment from industrial waste products, and the pollution problem from toxic substances such as agricultural chemicals.

10.9.2 Environmental development policy

In the Seventh National Economic and Social Development Plan (1991–1996), as guidelines for environmental development to improve the standard of living, the following were put forth concerning industry.

Measures against water pollution:

- The promotion of the moving of pollution-producing industries from the Bangkok metropolitan area and surrounding districts to specially-selected districts
- Collecting of water user fees for agricultural and industrial activities to bring about an economic use of water.
- Promotion of the use of non-pollution technology such as in the production process.
- Waste water emission sources not served by public wastewater treatment facilities in particular shall be monitored
- Constraining factory building and expansion that would bring about water pollution problems and restraining industry from locating in communities with water sources
- Promotion of the construction of industrial estates.
- In order to improve the efficiency of pollution prevention, in newly

developed communities and industrial districts the sewage water and drainage water will be separated.

- In target districts such as the Bangkok metropolitan area and surrounding areas, local city centers, and sightseeing locations, water treatment facilities for community and industrial use shall be built.
- In other districts also, F/S will be carried out on a priority basis for the construction of water treatment facilities.

Polluter Pays Principle:

- Pollution taxes and fees based on a rate determined by the form of activities and production causing destruction to the environment are collected to be used as fees for pollution measures.This capital forms a fund for investment in environmental control.
- An Environmental Fund shall be established based on the government's initial investment.Initially, Until a proper fund management organization with full corporate power and authority will be established, the already existing public agency will manage the fund. It was established so that the fund would be managed by an independent agency with a legal foundation.

Administrative and legal amendments:

- The granting of public subsidies for local agencies covering some or all of the cost of the construction of water and waste disposal facilities shall be carried out.
- The role of local environmental agencies shall be strengthened and improved by the transferring of control of water treatment facilities.The local agency should flexibly implement the treatment service and should be capable of setting the proper service fee.
- Particularly for city districts, industrial districts, and sightseeing locations, a tripartite association made up of the community, corporations, and the government shall be established for the monitoring and maintenance of the environment.
- Including the establishment of the Environmental Fund to be used for effective environmental control and encompassing all aspects of environmental protection, constraint, and control, the Improvement and Conservation of National Environmental Quality Act was amended.

10.9.3 Environmental pollution administration

The laws and regulations relating to environmental pollution that were amended in 1992 include the following.

- Wildlife Conservation Act (February 1992)
- Hazardous Substances Act (February 1992)
- Improvement and Conservation of National Environmental Quality Act (June 1992)
- Factories Act (June 1992)

The amended Improvement and Conservation of National Environmental Quality Act includes the establishment of an environment fee, designation of areas for environmental protection and conservation, setting up of a pollution regulation committee, introduction of the Polluter Pays Principle (PPP), encouragement of NGO's participation in environmental activities, and the tightening of penalties.Also, the amended Factories Act increased the level of fines, and for factory owners or managers who take these stricter regulations lightly, jail sentences can be dealt out.

Under the Improvement and Conservation of National Environmental Quality Act, the Ministry of Science, Technology, and Environment (MOSTE) forms policy in relation to environmental pollution, sets environmental standards, and is in charge of environmental assessments; under the Factories Act the Ministry of Industry (MOI) carries out the permission, guidance, and supervision of each factory.

10.9.4 Pollution prevention zones

In accordance with the new environment law, the sightseeing locations of Pattaya and Phuket were the first places nationally to be designated as pollution prevention districts, and in each place full-scale pollution measures are being taken up through the forming of a basic plan together with the introduction of the newly-established environmental fund to expand the water treatment facilities. Also, the authorities are now able to exercise the extensive power given to them to strengthen the enforcement of the environmental assessment for each project and to regulate the development connected with environmental deterioration. This will prevent pollution in the these districts

and be instrumental in the promotion of environmental conservation.

10.9.5 Environmental assessment and the location of industry

Based on the Improvement and Conservation of National Environmental Quality Act, the projects which require implementation of the environmental assessment are identified as follows:

(1) Volume of water of at least 100 million m3 or the water surface area of at least 15km2 for a dam or reservoir
(2) Irrigation over a surface area of at least 12,800ha
(3) Private air transportation
(4) Construction of a hotel or resort of over 80 rooms (For environmental reasons, consideration is essential in the location of the site such as near rivers, oceans, or lakes or in the vicinity of national parks.)
(5) Mass transit systems and expressways
(6) Mining regulated by the Mining Act
(7) Industrial estates regulated by the Industrial Estate Authority of Thailand
(8) Commercial ports with a berthing capacity of 500 GT or more
(9) Thermal power plants of 10,000 KV or more
(10) Industries

a. Petrochemical industries whose necessary raw materials for the process of petroleum refining or natural gas separation are 100 tons a day or more
b. Petroleum refining
c. Natural gas separation or processing
d. Chloroalkane industries with production capacities of 100 tons a day or more
e. Steel industries with iron ore or scraps as raw materials whose production is at least 100 tons a day or a capacity of at least 5 tons a day
f. Cement industries
g. Non-ferrous metal refining
h. Pulp industries of 50 tons a day or more

Guidelines regarding the contents of the assessment are made public, so that

employers prepare and submit the environmental impact assessment in advance, and the National Environmental Board (NEB) holds discussions and decides on approval.Basically, the government and local public corporations welcome the development project proposals, but strong opposition of not-in-my-backyard citizens precludes even pre-review adjustments.

Like the industrial parks operated by the Industrial Estate Authority of Thailand (IEAT), those places equipped with environmental conservation measures pose no problem, but outside of industrial parks when individual companies independently acquire and develop sites, there are many cases of disputes with the local residents which often fail to be settled. The IEAT conducts its own environmental assessment, and, for example, is planning to establish an environmentally-acceptable industrial park in which industrial waste water is pretreated to a specified effluent quality level before delivering to the central wastewater treatment plant. Also, the Thai Board of Investment (BOI) has set a policy of project investment stimulation measures for the promotion of the recovery and conservation of the environment and sustaining the investment policy aspect of environmental conservation.

Chapter 11 Conclusions, Recommendations and Proposed Master Plan

The previous chapters reported the results of the Study on the present situations; problems and needs of supporting industries in Thailand.

This chapter summarized these findings, describes the conclusions drawn therefrom, and make recommendations on the future policy of fostering supporting industries in the country. Finally, this chapter proposes a master plan that shows how to implement the recommendations. Hereinafter, the term of "supporting industries" is often referred to as "SIs".

This chapter is composed of the following sections:

1) To clarify differences in the industrial structure between the automotive industry and the electrical/electronic industry of the country and to offer the direction for promoting components and parts industries for each sector. (Section 11.1)

2) To delineate a framework of a master plan presenting basic standpoints for formulating recommendations taking components and parts industries of both sectors as a whole, namely as "supporting industries". (Section 11.2)

3) To clarify major findings involved in SIs of the country, provide conclusions based upon the findings, and propose promotion programs for each of critical factors. (Section 11.3)

4) To formulate a master plan organizing the programs proposed in Section 11.3 showing a time table, priority for implementation, and the expected benefits derived from each program. (Section 11.4)

5) To provide policy recommendations for other important matters not addressed by the programs in the master plan from the viewpoint of strengthening competitiveness of Thai SIs. (Section 11.5)

11.1 Autoparts Industry and Electrical/Electronic Parts Industry in Thailand

11.1.1 Structural difference in upstream industries

Characteristics of parts industry are largely effected by those of upstream industries or assembly industries. Before discussions going to the parts industry, it is needed to clarify the structural difference of the upstream industries; the automotive industry and electrical/electronic industry.

Figure 11.1-1 conceptually illustrates characteristics of two industries. Based on this, main differences between the two sectors are described below.

(1) Export ratio of finished goods and components and parts

Exports of automotives (finished goods) account for less than 1% of domestic automotive production on a value basis. On the other hand, around 70% of electrical/electronic equipment (finished goods) produced in the country are exported. Components and parts seem to reach the similar level if indirect exports (incorporated into finished goods) are included. While the automotive industry limits its activity to the domestic market, the electrical/electronic industry is characterized by many production based specialized in export, both finished goods and components and parts. Thus, market orientation is a major difference between the two industries.

(2) Restriction on import of parts

The automotive industry can import a limited variety of components and parts under the local content regulation. The BBC scheme has been introduced to reduce the undue impacts of the local content regulation on the automotive industry. On the other hand, the electrical/electronic industry, without any local content regulation, can import any components and parts so far as import duties are paid.

Indirect restriction on imports of electrical/electronic components and parts does exist, including CRTs for TVs, compressors for air-conditioners, compressors and evaporators for refrigerators. To encourage and protect local production of these components, tax incentives are granted to designated enterprises. Nevertheless, these measures are not necessarily

aimed at the import ban like the local content regulation for the automotive industry. Thus, the electrical/electronic industry enjoys a higher degree of freedom in import of components and parts than the automotive industry.

(3) International competitiveness

The electrical/electronic industry in Thailand consists of various companies who have invested in the country with a clear intention to establish export bases from the beginning. These export-oriented enterprises have volume production capabilities and international competitiveness. In fact, they have successfully gained international competitiveness as a result of the government policy to give incentives to export industries, with reduced restriction on foreign ownerships.

On the other hand, the automotive industry clearly lacks international competitiveness in both finished cars and components and parts due to 1) production of many models for the limited domestic market prevents them from volume production, 2) the use of heavy equipment and large components, compared to the electrical/electronic industry, require larger amounts of investment in parts production facilities and equipment, and 3) automotives use less common components and parts than the electrical/electronic industry.

(4) Variety of products and requirements for technology

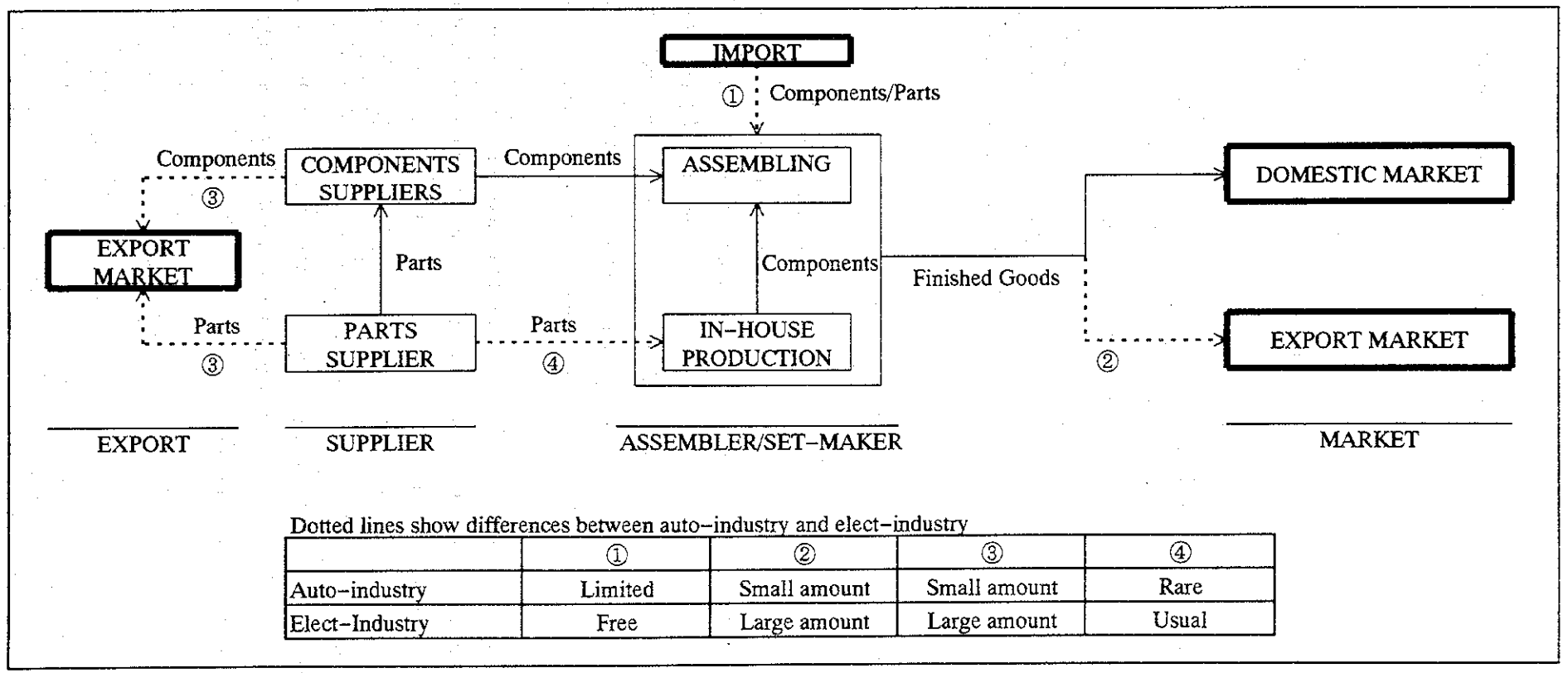
The automotive industry produces a single product, that is a car, while the electrical/electronic industry supplies numerous types of products, which are sometimes regarded as components or finished products, e.g., printers, HDDs, and FDDs. Secondly, automotive production is characterized by high safety requirements that preclude the use of low-cost, low-end components and parts, making it difficult to foster local suppliers.

On the other hand, some of electrical/electronic equipment can be produced by small enterprises with their own technology, while clearing the minimum requirements for function, quality and durability. In fact, many small companies in Thailand manufacture and a variety of consumer products, such as air-conditioners, electric fans, and rice cookers, to the domestic market.

The electrical/electronic industry seems to warrant the ease of penetration for local enterprises due to availability of common components and parts for assembly.

(5) Difference in variety of in-house components and parts

In the automotive industry, components and parts produced by assembly makers at their own facilities are limited to critical ones such as engines, transmissions, large press parts, and plastic products. Since primary responsibility of automakers lies in design and assembly operations, they do not have technical expertise and know how in design and production of individual components and parts. In contrast, electrical/electronic set makers often design and produce most of components, and even small parts. In effect, they serve as components and parts makers. It is a normal practice for set makers to supply their components and parts to other makers.



Dotted lines show differences between auto-industry and elect-industry

	①	②	③	④
Auto-industry	Limited	Small amount	Small amount	Rare
Elect-Industry	Free	Large amount	Large amount	Usual

Figure 11.1-1 COMPARISON OF GOODS-FLOW AND STRUCTURE BETWEEN AUTO-INDUSTRY & ELECT-INDUSTRY

11.1.2 Future outlook for the automotive industry and autoparts industry in Thailand

(1) Growth potential

Today, the automotive industry is one of key industries to form the economic foundation in many countries. At the same time, it undergoes constant and dynamic changes due to various factors, including intense competition driven by market principles and political conflict. Thailand, supported by successful foreign investments under the government's initiatives and robust growth of its domestic demand, has a chance to establish itself as a major automotive production base in the ASEAN region. The interview survey conducted by the Study Team shows all the automakers intend to develop Thailand to their major production base in ASEAN. In fact, 70% of the automakers plan to increase their capacities.

(2) Relations with Foreign automakers

All automotive assembly in Thailand is based on the foreign technology and investment. Nearly 95% of automotive production in Thailand are done by using capital and technology of Japanese automakers. And also in the ASEAN regions as a total, they account for over 90% of total automotive production. Around one half of primary parts suppliers in Thailand (those directly supplying components to automakers on an OEM) are partially owned by foreign capital, 90% of which are invested by Japanese companies.

Many of local companies who have not introduced foreign capital receive technical assistance from foreign companies. As a result, major portions of imported CKD components come from Japan. Under these circumstances, the future of the Thai automotive and autoparts industries is largely affected by economic conditions in Japan, USA and Europe as well as their automaker's investment strategies. Most importantly, the Japanese autoparts industry is losing cost competitiveness due to the strong yen, and high labor and land costs in the domestic.

(3) Imminent international competition

In Asia, especially in ASEAN countries it shows a remarkable industrial development even though in automotive industry. It is a fact that, however, each country has own development problems.

Thailand is ahead of ASEAN countries for the automotive industry and has growth potential, while Malaysia suffers from limited domestic demand because of rather small number of population, Indonesia has cost penalty, because of slow development in the automotive industry under historical protectionism of local industries, and political instability hinders growth of the industry in the Philippines.

As the automotive industry provides durable that are directly supplied to mass consumers, it leads to intense competition among makers in terms of quality and cost. Government intervention is not effective, rather likely to deteriorate international competitiveness, as seen in several countries. Competitiveness represents overall excellence in quality, cost, and delivery time combined. To establish competitiveness of its automotive industry, Thailand is on the turning point to shift its industrial policy from the current protection (high tariff and local content) to free competition in line with the ongoing economic liberalization policy.

(4) Direction of trade liberalization in ASEAN

In the automotive sector, six ASEAN countries has introduced the mutual complementary agreement on parts supply (BBC). Under the agreement, autoparts of the same brand that are in-house produced by automakers are subject to favorable treatment in trade, including a mutual 50% reduction of import duties, and the inclusion of BBC products in local content. (It should be noted, however, that Indonesia has not signed on the BBC yet). The BBC will be maintained in the short run, but will be absorbed into AFTA in the long run. Also, GATT may become a major driving force for free trade within the region, before AFTA does. In addition, recent movement of APEC shall be carefully watched. More importantly, the relation with Japanese automakers and or autoparts makers will become a critical point and

a major concern for the automotive industry and its parts industry, rather than the relations among ASEAN countries. In the near future, exports of autoparts made in Thailand and other Asian countries to Japan will take place and increase.

The irrevocable move toward trade liberalization will lead to lower tariff rates on finished cars as well as parts. Accordingly, the current production system of automotives, where each country produces a variety of models in small quantities, may change into another system where one country specializes in mass production of certain models. If this occurs, ASEAN countries will become to complement finished cars model by model, in place of parts under the BBC. Such specialization will take place in production of autoparts that requires large amounts of investment. The investment will be made intensively in a certain country based on demand forecast for the entire ASEAN region.

It should be pointed out that regional complementation in finished cars may offer more benefits than in parts under the BBC, in terms of costs export packaging, painting, transportation, damages during transportation, and customs clearance.

(5) Direction toward local sourcing of autoparts

Automakers operating in Thailand intend to procure components and parts in Thailand as far as possible, provided that they have competitiveness in quality, cost, and delivery. The biggest reason why the Japanese automakers in Thailand intend to expand local sourcing is that the imported parts and components from Japan are losing cost competitiveness due to yen appreciation. Considering that the yen appreciation will continue, each automaker has started diversification of production bases for assembly as well as parts procurement based on their own globalization.

Most of all automakers in Thailand are willing to develop the country as the biggest production base in the Asia region. To cope with this trategy, the domestic production of autoparts will grow. As a result, it is expected that the local procurement of autoparts will naturally increase in the country which has also high potential to become the biggest exporter of autoparts in

Asian countries.

11.1.3 Autoparts identified for import substitution

As shown in ATTACHMENT 4-1 in Chapter 4, currently imported components and parts marked by ○ and components and parts in the process of localization (marked by △) will be encouraged for future investment by local and foreign companies. Components and parts marked by × are mostly localized (including in-house production) and will require improvement of competitiveness as the next step.

Note that localization of components and parts marked by ○ or △ has not progressed by the reasons of the small domestic market, high technologies requirements and huge investment requirements. Therefore, the localization shall be promoted by development of the local parts industry and attraction of foreign investment instead of regulations. In long term view, the localization will naturally progress subject to the appearance of the following conditions:

1) Production of automotives in Thailand reaches 800 thousands to 1 million units, and nearly 60% of which are passenger cars.

2) Import duties on finished cars and autoparts are reduced, while the current imbalance in tariff system is corrected.

3) The local content regulation is lifted or significantly flexed.

Possible approaches to accelerate local production are described below for components and parts marked by ○ and △ that are classified according to the type of production process. Note that some of components and parts under the same name may be produced by using different materials and methods. See ATTACHMENT 4-2 in Chapter 4 for details.

(1) Iron castings

Toyota and a joint venture between Thai and Japanese companies are currently building foundries to produce diesel engine components for pickup trucks, cylinder blocks and heads, cam shafts (sometimes made by forging).

Those many supply them to other automakers. The engine components for passengers cars (mainly gasoline engines) may be locally produced if production volumes reach an economic size in the future. Cast iron valve guides can also be locally produced if existing makers receive technical assistance from foreign vendors.

Water pump bodies and impellers are currently produced using imported CKD parts. The recent investment by a Japanese water pump manufacturer will help improve the localization level. As clutches and housings are partially localized, and local foundry makers are expected to gain market share. On the other hand, cast iron transmission cases will continue to be produced by automakers or imported as part of transmission assembly. As for ductile iron brake disks, efforts are required at existing foundry makers for quality improvement and capacity expansion. Ductile iron front hubs and knuckles are closely related to precision machining, and feasibility of local production needs to be studied in the future.

(2) Aluminum alloy castings

Aluminum alloy castings are made by a variety of methods including sand mold casting, gravity diecast, pressure diecast, and low pressure die casting. At present, the following components and parts are imported in relatively large quantities. Note that some of them are imported as part of CKD production because of the lack of local suppliers.

> Rocker arms, intake manifolds, oil pump cases (assemblies), water pump bodies, steering wheels, steering gar housings, and transmission cases

As for cylinder blocks, some makers use aluminum alloy products and others uses iron casting products. An automaker who consumes a large number of aluminum alloy cylinder blocks plans to import them to Thailand from the existing diecast shop in Indonesia. Metal molds for large die castings are mostly supplied by users, i.e., most of them are imported.

(3) Forgings

Crank shafts and connecting rods for pickup trucks (mainly diesel engines) are required to be locally produced by 1995 under BOI's local content regulations. Cam shafts may also be produced by means of forging. While there is no forging maker to supply these products in Thailand, a foreign maker is said to invest in the near future, so that local production will be started in due course. As for the same components for passenger automotives (mainly gasoline engines), local production will depend upon how far domestic demand grows to reach critical mass. Other forgings such as arms, shafts, hubs, and knuckles are imported as part of CKD components.

Note that some of the above forgings are made by casting or press working too, as shown in ATTACHMENT 4-2 in Chapter 4.

(4) Sintered alloys

Bearings used for pistons are produced by foreign-affiliated makers. There is no local manufacturer of sintered alloys for engines, but a foreign company seems to plan investment. Sintered alloy-made components include valve guides, valve seats, and rotors and gears for oil pumps.

(5) Press products

The subsectors of press work, including die-making, are at the highest level of local production in the country.

Still imported are engine mounts, body outer panels, and exterior parts. Outer panels (skin parts) for pickup trucks are produced by automakers, and those for passenger automotives are imported. Exterior parts include radiator grills, garnish mogol, head lamps, wheel covers, most of which are localized for pickup trucks. Those for passenger automotives have still to be localized due to high quality requirements and an insufficient local market size.

(6) Plastic products

Among plastic components, large components requiring precise forming and those requiring difficult forming techniques, such as instrument panels, console boxes, and fenders for passenger automotives, are imported or partially produced by automakers. Small plastic components are mostly localized, but their quality needs to be further improved.

(7) Rubber and glass products

Rubber products are used for hoses and vibroisolation parts, which are entirely localized. Safety glass is also locally produced. Supply capacity is sufficient, but efforts should be made to reduce cost for small-lot production of a large variety of products.

(8) Raw materials

Steel plates are all imported and satisfy quality requirements. There are several coil centers to ensure stable supply. A plan to build a steel plant seems to be considered, but no detail has been revealed. As for plastic materials, olefin-based general-purpose resins are locally produced by using natural gas, while engineering plastic materials and various chemicals for additives are imported. Note that a detailed survey on the raw material industry will be conducted during Phase II.

(9) Machining and assembly

As shown in ATTACHMENT 4-2 in Chapter 4, machining is needed for many castings, forgings, and round bars and pipes, such as gears, shafts, cylinders, and housings. Mold- and die-making manufacturing is classified as part of machining operation. In addition, the repairing and maintenance of machinery and equipment which are used by component suppliers is considered as part of machining operation, as they are indirectly related to production of components. Among them, the machining of castings and forgings, including heat treatment, is one of key areas related to promotion of the auto parts industry in the future.

11.1.4 Direction of autoparts industry development

(1) Limits of parts focused promotion method

There is a way for development of the parts industry giving priority to certain parts by name or category. However, it is not necessarily feasible to select parts by name or category for development under uniform standards and from short-term perspective. Also, it may hinder market-oriented and healthy growth of the automotive industry and autoparts industry for the following reasons.

1) Investment requirements and economic size

To meet local content requirements imposed in Thailand, automakers have been localizing production of components which have smaller cost penalty, even in small quantity production. Similarly, parts suppliers have been making investment in the area requiring relatively a small amount of investment. This means, future localization will be less and less effective in terms of cost/benefit ratio. For instance, assuming 100 units of money have been invested so far to achieve the local content of 54% for passenger cars, additional 100 units are likely to be spent if the local content has to be raised by 10% to 15% more. This involves a difficult decision making unless volume production is feasible. It is not so easy for the industries to localize currently imported parts disregarding economy.

2) Difference in procurement strategies between automakers

The automakers operating in Thailand have their own procurement strategy designed to balance global relations with a network of local and foreign production, together with procurement under the BBC. Based on the strategy, each company has already invested in some countries and has own future plans. Obviously, it is very difficult to select priority parts that can be applied to all the automakers. For instance, they produce different components in Thailand under the BBC scheme.

3) Relation with development policies of the automotive industry

The automakers are highly sensitive to tariff rate on CBU cars and change in local content regulations. On the other hand, most of parts suppliers complain about the unbalanced import duties; higher tariff on raw materials and parts they use than CKD they produce. This is a highly volatile area for both automakers and autoparts makers. If the import duty system changes, priority parts may change accordingly.

(2) The proposed future direction

In promoting the supporting industries by selecting particular components and parts, the most popular approach is to give incentives for acceleration of local production. In light of the fact that these parts are usually selected for import substitution purposes, and they are so selected because they are not currently produced locally due to a high level of production technology not available in the country. The approach inevitably requires foreign technology and/or investment. In fact, the parts-focused promotion of the supporting industry intrinsically leads to a policy direction that encourages foreign investment.

(Note) Most of ASEAN countries including Thailand took the policy-mix for their parts localization by a combination of tariff protection, tax incentives, approval for monopolized production, and mandatory regulations. Those methods or protectionism, except the tax incentives, resulted in the low competitiveness of local parts in international markets.

Another approach is to strengthen the foundation of the supporting industry by disseminating fundamental technology to local enterprises. This approach emphasizes the fostering of local small and medium scale enterprises in view of "bottom-up" even though foreign technology plays a critical role.

As a conclusion, the direction of the development the autoparts industry is to upgrade quality and quantity of the entire autoparts industry of the country; providing various incentives for both "fostering SMEs" and "investment promotion", not using mandatory regulations; and leaving the priority parts to the market economy.

11.1.5 Future outlook for the electrical/electronic and the related parts industry in Thailand

(1) Growth potential

The electrical/electronic industry in Thailand has high growth potential up to 2000 for the following reasons.

Domestic consumption for electrical/electronic equipment has been growing at an average 10% – 12% annually (on a volume basis) in the recent 3 – 5 years, with consumer equipment (home appliances) as a major driving force. At the same time, production has been growing at more than 45% annually during the same period greatly affected by strong growth of exports, in addition to domestic consumption. Now, set makers in the country predict that domestic consumption will continue to grow at the same pace as seen in the recent few years, or at an even higher pace, up to Year 2000. At the same time, they are convinced that they will be able to maintain competitiveness in the export market. In fact, they plan to boost production capacity or some of them have already added capacity.

There is a correlation between automotive consumption and TV consumption in many countries. In particular, a country where the former reaches one half the latter is considered to become an industrialized country. This means, the rise in personal income to a certain level derives TV consumption, which goes up to a next level of consumption – automotives – as incomes grows further. In Thailand, TV consumption amounted to 1 million units and automotive consumption 450,000 units in 1993. In 2000, the former will grow to 1.8 million – 2 million units and the latter nearly 1 million units.

(2) International competition and borderless economy

In the future, Thailand is expected to minimize protectionist policy that would weaken its international competitiveness, and to provide incentive measures and build infrastructure that help reduce costs of production and distribution. This way, it will be able to develop an economic system which can grow through healthy and fair competition and complementary and interdependent relations with other economies.

In contrast to the automotive industry, Malaysia takes a lead in the electrical /electronics industry over Thailand, in terms of production volume and localization of components and parts. Malaysia seems to have successfully attracted foreign investors because of less restriction on foreign capital participation, favorable tariff rates, and simplified customs clearance procedures.

Today, Malaysia is the world largest exporter of air-conditioners. It has steadily localized production of electrical and electronic components and parts and exports significant quantities to Thailand via Singapore. Also it exports components and parts made in Thailand through export makers. Similarly, Singapore boasts sizable production of audio equipment, ICs, and TVs. Within the ASEAN region, electrical and electronic components are distributed through international procurement offices (IPOs) established in Singapore. This is clearly reflected in the fact that Singapore is the second largest and dominant trade partner of Thailand, next to Japan, in the area of electrical and electronic components and parts. The highly complementary trade relationship among Malaysia, Singapore, and Thailand suggests that economic borders are disappearing between these three countries, and the move will intensify in the future.

(3) Relations with other countries

Today, electrical and electronic products manufactured in Japan and Asian NIEs are losing competitiveness due to the strong yen, and the high labor and land costs. Smaller companies, mainly components and parts suppliers, are particularly hit hard and intend to survive by relocating their production facilities to countries offering cost advantages. Thailand will continue to attract certain portions of such companies and needs to be ready to accommodate them for its own industrialization.

At present, 66% of electrical and electronic set makers and 54% of components/parts makers are wholly or partially owned by foreign capital. If measured by production volume or exports, foreign-affiliated companies may account for nearly 90% of total. In this context, the future of the electrical and electronics industry in Thailand hinges on continued dynamics

of their counterparts and partners in Japan, Asian NIEs, the EC, and the U.S., who will determine the positioning and role of the Thai industry.

(4) Influence of the inflow of export-oriented makers

Traditionally, like the automotive industry, the country's promotion policy for the electrical/electronic industry has been based on the domestic market until the period of 1970s. This somewhat closed and protected system is breaking up with the rapid inflow of export-oriented set makers as well as components and parts makers since 1980s because the special incentives were set for the export-oriented companies. Thus, the traditional domestic-oriented companies and the new export-oriented companies are intermingled. Since they are allowed to sell a certain parts of their products to the domestic market as well, they have inevitably brought the competitive reality in the international competition. New comers are lifting a boarder between the domestic market and the international market.

(5) Repercussion on the components and parts industry

The components and parts industry is expected to upgrade their products from domestic standards to international levels if they try to supply their products to the export-oriented set makers. At the same time, they have to expand production capacity significantly, since settlement of the export-oriented set makers has created a new market in the country for electrical/electronic components and parts, that is a few times in size of the past domestic market.

BOI's Promotion Project was originally designed to establish self-sufficiency of components and parts supply to meet domestic consumption. However, the influx of the export-oriented industries has necessitated the government to modify its policy objectives. For instance, CRTs for color TVs have been mostly localized under the BOI Promotion Project. Then, world-class manufacturers came in to establish export bases and TV production increased fivefold. Naturally, large amounts of CRTs, 5 times that produced locally, are imported. Other electrical/electronic products are facing the similar situation. All of sudden, it can be happened to create a new but big market. Parts suppliers have to enter the new market not under protection but with

international competitiveness.

The result of the interview survey reveals that set makers want to locally procure components and parts that are currently imported from Malaysia, because of difficulty in controlling delivery time, quality, and cost.

11.1.6 Electrical/electronic parts identified for import substitution

The primary purpose of promotion of the components and parts industry is to improve the country's trade balance through import substitution. In this context, component groups marked by ○ and △ in Table 5.2-14 of Chapter 5 are those promoted for accelerated development with priority.

(1) Parts for electrical home appliances

Air-conditioners, refrigerators, washing machines, electric fans, and rice cookers, on so called white products have developed to healthy subsectors that bring significant valued added to the country's trade balance. Production techniques required for these products, including press work, plastic molding, diecast, and painting, have established their position in the industry. Technically, localization has virtually completed for these subsectors. The future challenges are quality improvement and capacity expansion to boost supply to the export-oriented set makers operating in the country. Components and parts under this category are as follows:

Air-conditioners:	compressors, evaporators, and fan motors
Refrigerators:	evaporators and fan motors
Washing machines:	Nothing in particular
Microwave ovens:	Magnetron, fan motors, sealed doors, glass trays, frame and body assemblies
Electric fans:	Nothing in particular
Rice cookers:	Nothing in particular

(Note) Localization of components and parts for microwave ovens should wait until production grows to critical mass.

(2) Parts for electronic home appliances (audio and visual equipment)

Components and parts for color TVs and VCRs should be directed to overall localization by establishing technical feasibility. The process should start from localization of components and parts meeting domestic specifications. In particular, production technology related to components and parts for color TVs is most advanced and covers a wide range of areas among consumer electrical and electronic equipment. Localization will diffuse and upgrade diverse technologies from mechanical, mechatronics, electronics, chemical, photographing and printing, and coating.

Color TVs:	CRTs, chassis, electronic parts
VTRs:	Magnetic heads, electronic parts

Production of audio equipment, such as radio receivers, tape recorders, and stereos, is remarkably small compared to Malaysia and Singapore. Thus, it is important to foster parts makers for these equipment. In particular, functional parts will mainly consist of electronic parts.

(3) Parts for equipment of communications and office automation

In Thailand, demand for electrical and electronic home appliances is being satisfied, and the center of gravity in consumer consumption will shift to equipment of communications and office automation. There are 7 telephone set makers, 1 facsimile machine maker, 1 printer maker, and 1 copier maker in Thailand. In the future, manufacturers of word processors and personal computers should be attracted to fill the expected gap, and parts makers should also be attracted or fostered. Since these products required high levels of production technology, the fostering of components and parts suppliers should be promoted with high priority in medium and long term views.

Major components and parts are as follows:

Telephones:	connectors and other electronic parts
Facsimile machines:	Thermal heads, cutters, nickel batteries, and electronic parts

11.1.7 Direction of electrical/electronic parts industry development

Localization of components and parts of electrical home appliances for the domestic market has been mostly completed in Thailand. The parts industry in this subsector shall expand their market to the export-oriented assemblers located in the country. In addition, efforts should be directed to localization of functional parts in the field of electronics, particularly audio/visual equipment and office equipment.

Generally speaking, the electronic industry develops in the form of an expanded backward linkage from the highest value added sector to lower ones. The evolution process can be depicted conceptually in Figure 11.1-2.

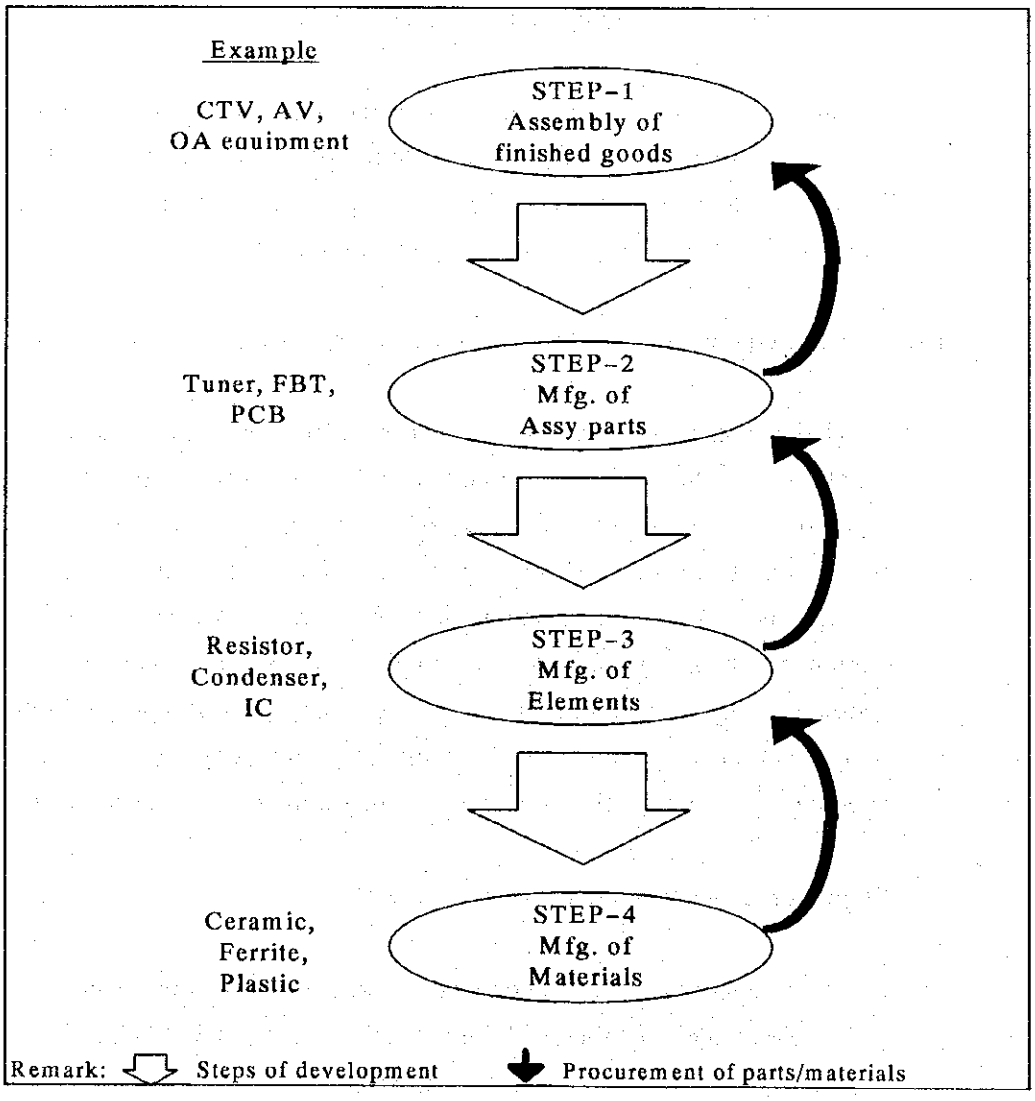


Figure 11.1-2 STEP OF ELECTRONIC PARTS INDUSTRY DEVELOPMENT

In the context of the conceptual diagram above, the Thai industry has mostly localized the "assembly of finished goods," of electronic equipment or Step 1. Now, Step 2 or localization of "manufacturing of assembly parts" is to be promoted as the short-term target. Then, the medium-term target will be production of elements to complete Step 3. At present in the country, foreign-capital manufacturers produce elements, most of which are directly exported. The production of elements calls for massive and repetitive investment due to a rapid pace of technology innovation. In the long-term, the nurturing of the materials industry to support elements production will constitute the final step, or Step 4.

For localization of the manufacturing of assembly parts, which is a short-term target, it is describe to disseminate to supporting industries basic technologies which are applicable to the next step development and other subsectors of industries. Those are called "common processing technology" in this section.

The common processing technologies includes presswork, plastic processing, machining, grinding, and mould- and die-making. Although the processing technologies are used for electrical home appliances, electronics often demand a higher level of precision when compared to those for electrical home appliances. To illustrate the common use of the technologies covering a wide range of products, relationships between major parts and the common processing technologies are plotted in Table 11.1-1. The table indicates that production of an individual component involves a wide range of common processing technologies. It also suggests that one technology can be applied to various components production as a common technology.

Localization of the common processing technologies for the cabinet parts, items 13 to 16 of the table with a low level of precision, has been almost completed in Thailand. The common processing technologies for the assembly parts of items 4 to 12 with a higher level of precision shall be localized as a present target being followed by localization of those for the elemental parts of items 1 to 3 with a highest level of precision as the next step.

Table 11.1-1 TECHNOLOGIES USED FOR ELECTRONIC PARTS MANUFACTURING

Parts Item		Element Parts			Assembly Parts									Cabinet Parts			
No		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
No	Parts Name / Common Technology	Registers	Capacitors	Inductances	Transformers	Remote Controllers	PCBs	Tuners	Speakers	CRTs	Magnetic Heads	Motors	Switches	Panels	Metal Parts	Cabinets	Frames
1	Press			○	○	○	○	○	○	○	○	○	○		○		○
2	Injection	○	○	○	○	○	○	○	○	○	○	○	○	○		○	
3	Lathe Cutting	○			○	○		○	○	○	○	○					
4	Gilding		○			○	○	○	○	○	○		○	○	○	○	○
5	Polishing	○	○							○	○	○	○				
6	Painting	○			○	○	○			○				○		○	○
7	Printing	○	○			○	○			○	○			○		○	
8	Adhesive		○		○	○	○	○	○	○		○		○		○	
9	Die Mold			○	○	○	○	○	○	○	○	○	○	○	○	○	○
10	SMT 1/			○	○	○	○	○	○	○	○	○	○				

(Note) 1/ Surface mounting technology (SMT) is increasingly used to fix semiconductors and other surface mouting devices (SMDs) on printed circuit boards (PCBs). Mounting can be done manually, but surface mouning machines are required for highly integrated devices.

11.1.8 Summary of direction of supporting industries development for both sectors

(1) Autoparts industry in Thailand has been limited to the domestic market so far although there are topics that a Japanese automaker(s) may invest to Thailand for assembly of pick-up trucks for export. All in all, the autoparts industry has growth potential enjoying the expansion of their markets.

(2) Electrical/electronic parts industry of Thailand is bi-polized: one is a group of parts makers subcontracting with those assemblers who sell their products to only the domestic market and the other is a group of export-oriented parts makers who are fully owned by a foreign capital. In addition, there is few parts makers who supply parts to the export-oriented assemblers located in the country. This area is the next target market for supporting industries.

(3) Automotive industry has only one finished product, that is a car. Contrary, electrical/electronic industry has variety of finished products in categories of electrical home appliances, audio/visual equipment, communications equipment and office equipment: Besides, each category has various types of products. Therefore, delineration of development is needed for the electrical/electronic parts industry, especially for parts suppliers owned by Thai capital. This report has concluded that dissemination of precision processing technologies shall be an urgent matter.

(4) Generally, there are two measures for promotion of parts industry or supporting industries. One is the investment attraction from overseas and within the country; the other is fostering of the existing local parts suppliers. Taking into account these two measures, concrete promotion measures will be proposed in the subsequent sections.