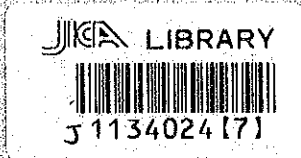


JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
INDUSTRIAL ESTATE AUTHORITY OF THAILAND
MINISTRY OF INDUSTRY

FEASIBILITY STUDY
ON
BANG SAPHAN INDUSTRIAL ESTATE
IN
THE KINGDOM OF THAILAND

FINAL REPORT

January 1997



NIPPON KOEI CO., LTD.
JAPAN INDUSTRIAL LOCATION CENTER

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The 21st century is a time of unprecedented change and challenge. The world is becoming more interconnected, more diverse, and more complex. The challenges we face are both global and local, and they require a new way of thinking and acting. We must embrace change and innovation, and we must work together to build a better world for all.

One of the most significant challenges of the 21st century is climate change. The Earth's climate is warming rapidly, and this is causing a wide range of problems, including sea level rise, extreme weather, and the loss of biodiversity. We must take action now to reduce our greenhouse gas emissions and to adapt to the changes that are already underway. This will require a fundamental shift in the way we produce and consume goods and services, and it will require the cooperation of all nations.

Another major challenge is the growing inequality between rich and poor. In many countries, the gap between the wealthy and the poor is widening, and this is leading to social unrest and instability. We must find ways to create jobs and to provide education and healthcare for all. This will require a commitment to social justice and to the well-being of all people.

Technology is also a double-edged sword. While it has brought us many benefits, it has also created new challenges. For example, the rise of artificial intelligence and automation is raising concerns about job displacement and privacy. We must ensure that technology is used in a way that benefits all people and that it does not erode our values and freedoms.

Finally, we must address the challenge of terrorism and violence. In the past few decades, there has been a significant increase in acts of terrorism and violence, and this has caused a great deal of suffering and loss. We must work to understand the root causes of these problems and to find ways to prevent them. This will require a combination of military, diplomatic, and social measures.

The challenges of the 21st century are daunting, but they are not insurmountable. We have the knowledge and the resources to build a better world, but we must have the will and the courage to do so. We must embrace change and innovation, and we must work together to build a better world for all. The future is in our hands, and it is up to us to make it a better one.

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FINAL REPORT

January 1997

NIPPON KOEI CO., LTD.
JAPAN INDUSTRIAL LOCATION CENTER



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Preface

In response to request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Feasibility Study on Bang Saphan Industrial Estate in the Kingdom of Thailand and the study was implemented by the Japan International Cooperation Agency (JICA).

JICA sent a study team, led by Mr. Hajima Koizumi of Nippon Koei Co., Ltd. and organized by Japan Industrial Location Center, to the Kingdom of Thailand three times from November 1995 to November 1996.

The team held discussion with the officials of the Government of the Kingdom of Thailand, and conducted related field surveys. After returning to Japan, the team conducted further studies and compiled the final results in this report.

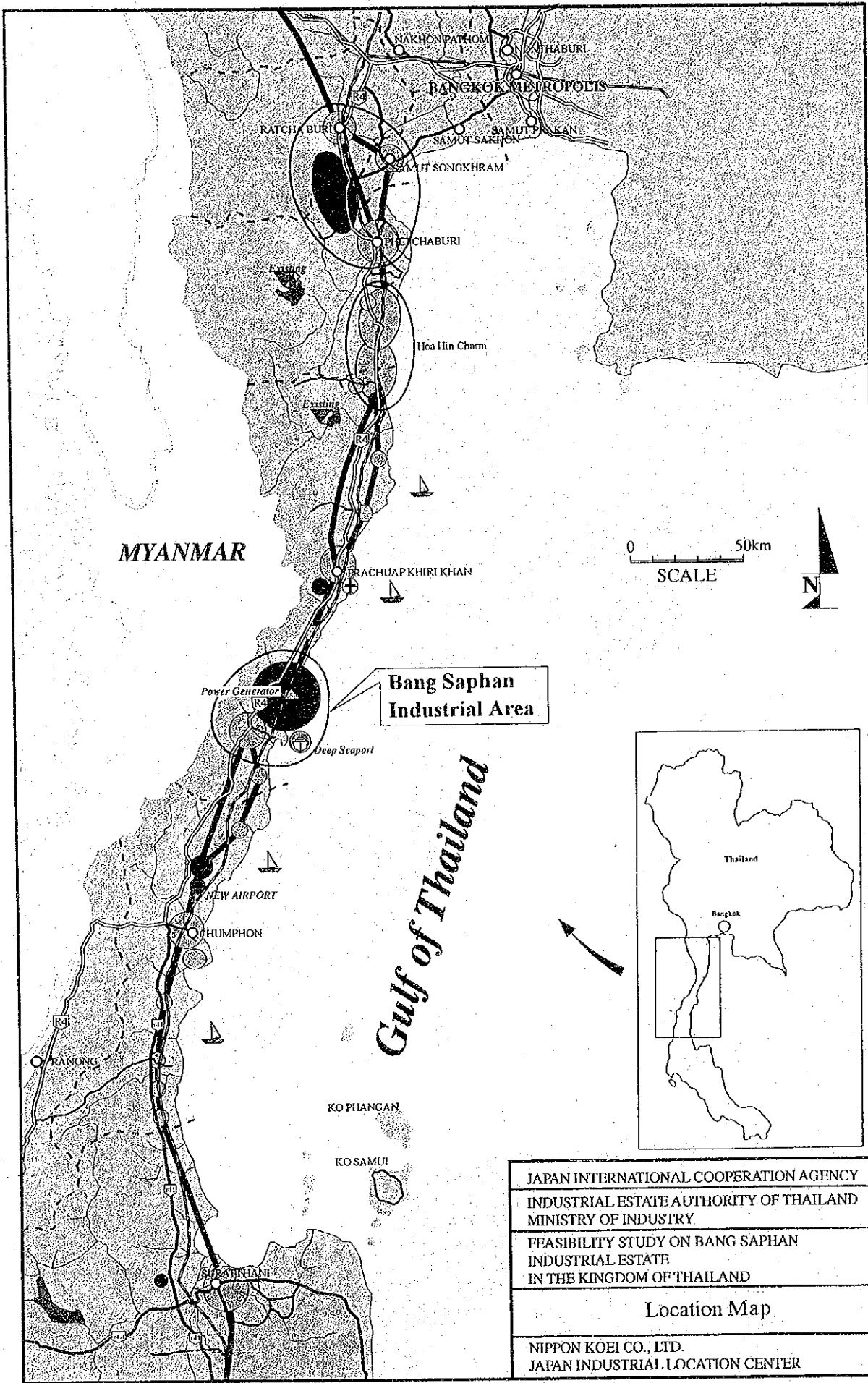
I hope this report will contribute to the promotion of the plan and to the enhancement of friendly relations between our two countries.

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

January, 1997



Kimio Fujita
President
Japan International Cooperation Agency



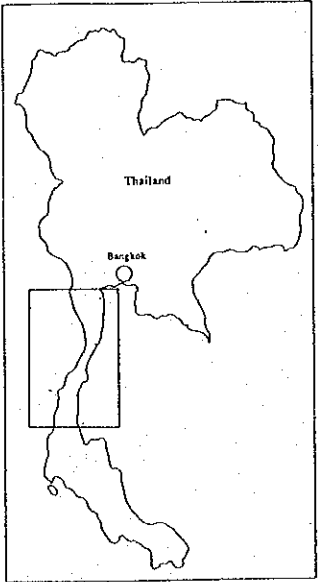
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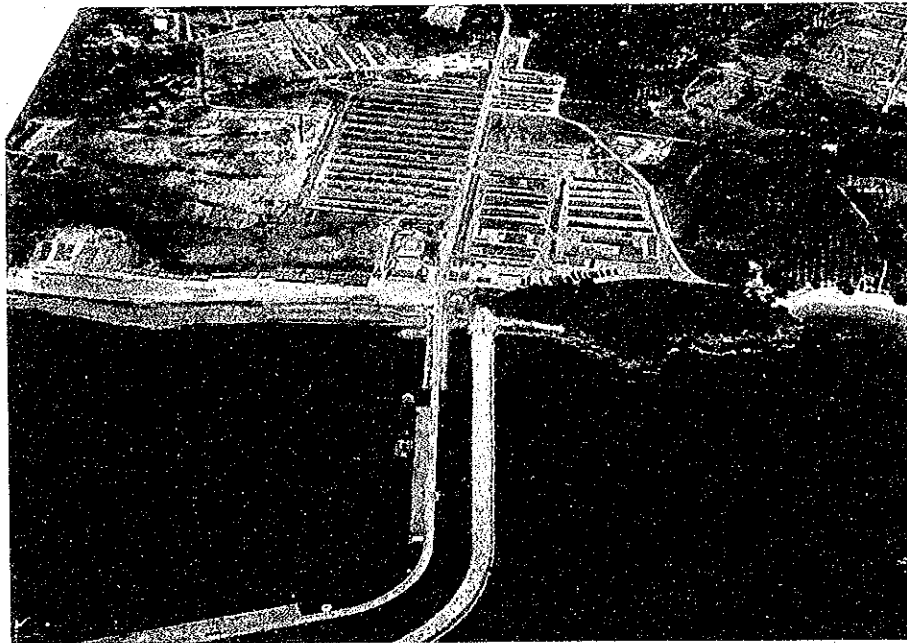
**Bang Saphan
Industrial Area**



JAPAN INTERNATIONAL COOPERATION AGENCY
INDUSTRIAL ESTATE AUTHORITY OF THAILAND MINISTRY OF INDUSTRY
FEASIBILITY STUDY ON BANG SAPHAN INDUSTRIAL ESTATE IN THE KINGDOM OF THAILAND
Location Map
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Aerial View of the Project Area (February 1996)



Prachuap Port (February 1996)

**The Feasibility Study on Bang Saphan Industrial Estate
(Final Report)**

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List of Acronyms

AFTA	ASEAN Free Trade Agreement
BMA	Bangkok Metropolitan Authority/Area
BOI	Board of Investment
BSIE	Bang Saphan Industrial Estate
DOH	Department of Highways
DTCP	Department of Town and Country Planning
EGAT	Electricity Generating Authority of Thailand
EPZ	Export Processing Zone
ESB	Eastern Seaboard
FTA	Free Trade Area
FTZ	Free Trade Zone
GIE	General Industrial Estate
IEAT	Industrial Estate Authority of Thailand
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
MCM	million cubic meter(s)
MOI	Ministry of Industry
NESDB	National Economic and Social Development Board
PCU	passenger car unit
PEA	Provincial Electricity Authority
RID	Royal Irrigation Department
TOT	Telephone Organization of Thailand
WSB	Western Seaboard

Exchange Rate
US\$1 = Baht 25
in July 1996

1. INTRODUCTION

1.1 Background and Objective of the Study

Thailand is enjoying economic expansion and drastically enlarging the manufacturing industry in recent years. However, such industrial production enlargement depends on the growth of processing and assembling industry which imports industrial materials, processes materials and assembles final products. It can be said that upstream industry producing industrial materials, on the other hand, is immature in Thailand. For instance, iron and steel industry, one of major material industries, covers only 17% of the amount of consumption in Thailand and the remainder is imported presently.

Due to the enlargement of processing and assembling industry and the growth of domestic consumption, trade deficit has degraded and enhancement of material industry is being required.

For the purpose improving the trade imbalance and realizing an advanced industrial structure supported by the integrated production process, principles for enhancement of the material industry were adopted by the Government. As for the iron and steel industry, large-scale development has commenced in the Bang Saphan area from 1993 on the private sector initiative.

The Study aims to examine the development possibility of "Bang Saphan industrial estate" which is expected to be contributive to the establishment of a material industry complex in the Bang Saphan area with the cooperation of the iron/steel industry initiated by the private sector. Development viability of the industrial estate was studied paying due attention to the development potential of infrastructure and social and educational facilities which are indispensable for the realization of an industrial estate, to the introduction of a free trade zone to cope with the worldwide free trade trend, and to the creation of an industrial city to reserve the environment and create an integrated support for industrial production.

Against this background, the Government of the Kingdom of Thailand (GOT) requested the Government of Japan to provide technical cooperation. At the request of GOT, the Government of Japan decided to cooperate in executing the Feasibility Study on the Bang Saphan Industrial Estate in Thailand (the Study). The execution of the Study was entrusted to the Japan International Cooperation Agency (JICA), an official agency in charge of the technical cooperation program. On July 25, 1995, the Industrial Estate Authority of Thailand (IEAT) and JICA agreed on the Scope of Work for the Study.

1.2 Scope of the Study

The scope of the studies to be executed by the Consultants under the Terms of Reference (TOR) has been defined to include the following:

- 1) Study of Present Conditions
 - General survey on present conditions of Thailand
 - Survey on economic development and industrial promotion policy
 - Survey on present conditions of Prachuap Khiri Khan province
 - Survey on present conditions of the Bang Saphan area
 - Survey on iron/steel industry
 - Survey on export oriented industry
 - Collection and analysis of environmental data/information
- 2) Questionnaire survey on investment demand in the Bang Saphan industrial estate from Thailand, Japan, USA, Korea, and Taiwan
- 3) Study on target categories of industry
- 4) Formulation of the development scale of the Bang Saphan industrial estate
- 5) Study of development potential (land use concept, development concept of infrastructure, preliminary environmental consideration, etc.)
- 6) Formulation of the development plan of the Bang Saphan industrial estate
- 7) Preliminary design and cost estimate of the Bang Saphan industrial estate
- 8) Preliminary environmental impact assessment
- 9) Financial / economic analysis
- 10) Formulation of the implementation plan

A technical transfer seminar will be held during the explanation and discussion of the Draft Final Report.

1.3 Execution of the Study

The Study has been executed by the consortium of Consultants retained by JICA. The consortium is composed of the following consulting firms:

Nippon Koei Co., Ltd. (Lead firm)

Japan Industrial Location Center

On the Thailand side, a Steering Committee was formed to coordinate, review and supervise the Study. The Committee, headed by Vice-Governor of IEAT, is composed of the representatives from NESDB, MOI, DTCP, BOI, DTEC, RID, DOH, PEA, Office of Environmental Policy and Planning, and Thai Industrial Estate Association. Several meetings between the Committee and the Consultants were held. The Consultants also had meetings for in-depth discussions with the member organization of the Committee. Further, a team of counterpart experts was assigned to jointly work with the Consultants for the execution of the Study in Thailand. Two counterparts were invited by JICA to Japan for training, and they partially took part in the Study at the Consultants' Headquarters. The participants in this Study from the consortium of Consultants, members of the Steering Committee and the counterpart experts, are listed in Table 1.1.

The Study was initiated in November 1995 and the Final Report was submitted in January 1997. In the course of the Study, a total of 103 days were spent in Thailand for field surveys, discussions and exchange of opinions.

1.4 Reports

In the course of the Study, the Consultants has submitted the following reports to IEAT and the Steering Committee:

Inception Report	:	November 1996
Progress Report - 1	:	December 1995
Interim Report	:	April 1996
Progress Report - 2	:	July 1996
Draft Final Report	:	October 1996
Final Report	:	January 1997

This Final Report of the Study consists of two (2) volumes: Volume-1 presents an executive summary of the Study, and Volume-2 contains the main text and appendices describing all the results of the Study and recommendations.

2. BACKGROUND OF THE PROJECT (1)

- OVERVIEW OF NATIONAL/PROVINCIAL ECONOMY AND INDUSTRY -

2.1 Social Conditions

1) Population

The Western Seaboard (WSB) composed of six provinces had a population of 2.9 million in 1994 representing 5.2% of the population of the Kingdom. The region's population increase of approximately 154,000 during 1989 ~ 1992, at an annual growth rate of 1.5%, was a little larger than the national average of 1.1% per annum.

The population of Prachuap Khiri Khan province, located in the center of the Western Seaboard, was 441,930 in 1994 as shown below and increased by approximately 22,000 during the last 5 years at a growth rate of 1.0%. The province's population ratio of 0.75% against the national population is somewhat smaller than the land ratio of 1.24% and the province's population density is a little low compared to the national average.

Population of Prachuap Khiri Khan Province, Western Seaboard and Thailand

	1989	1990	1991	1992	1993	1994	annual increase (%)	ratio
Prachuap Khiri Khan Province	419,945	424,766	430,487	451,155	452,235	441,930	1.0%	0.75%
Western Sea Board	3,269,183	3,305,115	3,336,923	3,423,473	n.a.	n.a.	1.5%	5.9%
All Country	55,900,000	56,300,000	56,900,000	57,800,000	58,300,000	59,100,000	1.1%	100%

Source: Provincial Statistics (Prachuap Khiri Khan Province, 1994),
STATISTICAL REPORT OF REGION (1993)

Prachuap Khiri Khan province is composed of six districts (Amphoe) and one municipality (City). The composition of the population is shown in the table below. The most populated district is Pran Buri with 110,144 inhabitants in 1995, an increase of 7.8% from 1994. Hua Hin, Prachuap Khiri Khan and Bang Saphan had the next largest population of 69,350, 68,404 and 65,115 respectively in 1995.

Bang Saphan Noi district located in the south end of Prachuap Khiri Khan province is the only district which shows a decreasing population.

Population by District in Prachuap Khiri Khan Province

	Amphoe	Area (km ²)	Population		
			1994	1995	1995/1994(%)
1.	Hua Hin	911	68,972	69,350	0.5
2.	Pran Buri	1,540	102,200	110,144	7.8
3.	Kuiburi	750	49,189	49,259	0.1
4.	Prachuap Khiri Khan	1,043	68,154	68,404	0.4
	Municipal area	14	15,354	15,479	0.8
	Non-municipal area	1,209	52,800	52,925	0.2
5.	Thab Sakae	518	51,315	51,483	0.3
6.	Bang Saphan	876	65,115	65,503	0.6
7.	Bang Saphan Noi	720	36,985	36,777	0.6
	Prachuap Khiri Khan Province	6,358	441,930	450,920	2.0

Source: Statistical Report and Investment Plan of Prachuap Khiri Khan Province

2) Labor Force

The labor force of Thailand was 2.63 million in 1980 and 3.28 million in 1994 and increased at an annual rate of 1.6%. Prachuap Khiri Khan has a labor force of approximately 233,000, or 0.76% of the national labor force. This ratio is almost the same as the population configuration of Prachuap Khiri Khan province. The labor force configuration by industry of Prachuap Khiri Khan is shown in the table below: 62% for the agricultural industry, 13% for the manufacturing industry and 25% for the commercial and other industries. From these figures it can be said that the main industry of Prachuap Khiri Khan province is agriculture.

Labor Force of Prachuap Khiri Khan Province (1990)

Workers		Prachuap Khiri Khan		Thailand (1993) (1,000)	
Total		233,077	(100%)	29,207	(100%)
1st Sector	Agriculture, Animal Husbandry, and Forestry	144,657	(62.0%)	14,288	(48.9%)
	Miners, Quarrymen	354	(0.15%)	-	
2nd Sector	Craftsmen, Production Workers	29,272	(12.5%)	5,999	(20.5%)
3rd Sector	Professional, Technical	7,654	(3.3%)	1,328	(4.5%)
	Administrative, Executive, etc.	9,369	(4.0%)	640	(2.2%)
	Clerical, etc.	4,742	(2.0%)	1,093	(3.7%)
	Sales Workers	22,388	(9.6%)	3,414	(11.7%)
	Transport Equipment	6,246	(2.68%)	1,111	(3.8%)
	Service Workers	8,012	(3.4%)	1,319	(4.5%)
	Unknown	377	(0.16%)	17	(0.1%)

Source: Statistical Report of Prachuap Khiri Khan Province and Labor Force Survey (1993)

3) Education

There were 237 primary schools with 43,000 pupils and 69 high schools with 28,700 students in Prachuap Khiri Khan province in 1993 as shown below. The number of graduates per year is estimated at 4,300 assuming that high school graduates account for 15%. Approximately 800 workers can be expected annually from these graduates assuming that 20% will work for the manufacturing sector. Considering that more than 20,000 workers will be demanded by the Bang Saphan industrial development, a large number of migrant workers from other provinces and other industrial sectors such as agriculture and fishery will be required.

Number of Schools, Pupils and Students in Prachuap Khiri Khan Province

Amphoe	No. of Government Schools				No. of Private Schools				Total			
	Primary		Secondary		Primary		Secondary		Primary		Secondary	
	School	Student	School	Student	School	Student	School	Student	School	Student	School	Student
Whole country (1992)	-	6,067,000	-	2,297,000	-	691,000	-	420,000	-	6,758,000	-	2,717,000
1. Prachuap Khiri Khan	43	7,856	3	3,077	1	157	5	1,299	44	8,013	8	4,376
2. Hua-Hin	31	5,426	7	2,694	2	1,252	5	3,669	33	6,678	12	6,363
3. Pranburi	41	7,331	9	3,976	1	570	8	3,860	42	7,901	17	7,836
4. Kutuburi	36	5,384	4	1,376	-	-	2	188	36	5,384	6	1,564
5. Tab Sakae	26	4,306	6	1,790	1	390	2	1,227	27	4,696	8	3,017
6. Bang Saphan	35	7,052	12	4,051	-	-	1	677	35	7,052	10	4,728
7. Bang Saphan Noi	20	3,293	5	833	-	-	-	-	20	3,293	5	833
Total	232	40,648	46	17,797	5	2,369	23	10,920	237	43,017	69	28,717

2.2 Export and Investment

1) National Economy

Thanks to foreign direct investment after the Plaza Accord in 1985, together with the world economic expansion, Thai industries began to take off and the economy achieved rapid economic growth from 1987 to 1995. Especially in the three years, 1988 - 1990, there was a remarkably high growth, registering in double digits. In 1991 the growth rate slowed slightly, falling to 8.4%, however, it was evaluated as still high. Sustainable growth of 8% and more has continued during the early 1990s.

Total GDP (constant price in 1988) is estimated at 2,684.4 billion Baht in 1994, which is around 1.4 times that in 1990, and the average annual growth rate during this period reached 8.27%. The largest sector of GDP is the manufacturing industry; with a 31.3% share to the total, followed by wholesale and retail trade, with 16.1% of the total. On the other hand, the share of the agricultural sector, which had been a main player of Thai economy during the period from the 1960s to the early 1980s, declined and was 11.3% in 1994. The increment of the share of the manufacturing industry to GDP during this period marked 3.6 points.

GDP industrial Origins at Constant Price in 1988

	1990		1994*		Unit: Mill. Baht
	Value	(%)	Value	(%)	Growth Rate 94/90(%)
Agriculture	266,227	13.63	304,200	11.33	3.39
Mining and quarrying	31,051	1.59	44,200	1.65	9.23
Manufacturing	542,669	27.78	841,400	31.34	11.59
Construction	116,606	5.97	163,100	6.08	8.75
Electricity and water supply	46,867	2.40	70,500	2.63	10.75
Transportation and communication	146,753	7.51	206,800	7.70	8.95
Wholesale and retail trade	341,137	17.46	433,500	16.15	6.17
Banking, insurance, and real estate	108,111	5.53	204,400	7.61	17.26
Ownership of dwellings	60,756	3.11	69,400	2.59	3.38
Public administration and defense	61,366	3.14	70,900	2.64	3.68
Services	231,839	11.87	276,000	10.28	4.46
GDP	1,953,382	100.00	2,684,400	100.00	8.27
Per Capita GDP**; Baht	39,069	-	60,258	-	11.44
Population; 000 person	56,083	-	59,300	-	1.40

*: Estimate, **: Current Price

Source: NESDB

2) Export

Foreign trade increased strongly during the last decade. For example, in the period of 1990 - 1994 exports were around 1.92 times and imports around 1.62 time (on Baht

basis). But the trade deficit remained during the period; furthermore, in recent years it has tended to expand.

The major export goods by sector in recent years were manufactured goods, with a 81.0 % share of total exports in 1994, followed by agricultural goods, 11.4% (In 1980 the share of manufactured goods to total exports was 35.1% and it took over that of agricultural products in 1985).

	Unit: Mill.Baht					
	1990	1991	1992	1993	1994	1995*
Manufactured Products	440,395	553,188	634,386	752,557	922,791	530,434
Agricultural Products	100,003	109,278	123,810	110,695	129,559	85,087
Fishery Products	32,507	43,704	48,793	55,689	67,903	33,984
Others	16,908	19,459	17,655	16,921	17,347	10,311
Total export	589,813	725,629	824,644	935,862	1,137,600	659,816

*: Sum of 1st & 2nd Quarter(Prospect)

Source: Quarterly Bulletin, Bank of Thailand

Major export goods in the manufacturing sector are textile products, machinery and mechanical appliances, electrical apparatuses and electrical appliances (2-digit code base); those four industries accounted for 47.9% of total manufacturing exports in 1994 as shown in Table 2.1. In commodities base (3-digit) garments (10.9%), computers & parts (10.0%), IC & parts (4.9%), and televisions (2.4%) accounted for the largest share of total exports.

In order to identify the target industries to be introduced to Bang Saphan, not only the volume but growth of exports should be focused on, so in the same period of 1990-1994 the top 10 export industries of growth are identified in Table 2.1. Both in value and growth, 4 industries are identified: Vehicle parts & accessories, plastic products, electrical apparatuses, and electrical appliances (2-digit code base). In commodities base (3-digit) the following 6 goods have higher growth: Motorcycle parts, air conditioners, passenger cars & parts, refrigerators & equipment, brassieres, and televisions.

3) Investment

One of the prime motors to promote rapid economic growth has been investment, especially foreign direct investment (FDI). In the late 1980s foreign investors (mainly Japanese) rushed to invest in Thailand, and the number of approved projects peaked in 1988. In 1989 FDI slowed slightly and continued to decrease during the first half of the 1990s.

As for FDI by industry, the manufacturing sector has been the main player during the 1980s and the first half of the 1990s. In the manufacturing sector the machinery and electrical & electronics subsectors are major (BOI approved list showed that the total number of projects invested by major countries (Japan, USA, Taiwan, Hong Kong, Singapore)

between 1987 and 1993 was around 3,000 and the share of machinery and electrical & electronics to the total was 31.5%).

As for FDI by region (operation status), investment was concentrated in Bangkok and its vicinity followed by the Eastern Region. In the Western Region including Bang Saphan the share was 3% of the total number of projects, 4% of investment, and 2% of employees as shown in Figure 2.1. In approval status, however, FDI tends to go to Zone 3, however the directions are to the north, east, and northeast. In 1989, the number of approved projects in Zones 1&2 (excluding Ratchaburi, Kanchanaburi, Samut Songkhram) was 823 or 69.9% of the 1,178 approved projects in total. In 1994, the number of total approved projects was similar to 1989, 1,173 projects, however, in Zones 1&2 the share of approved projects to the total declined to 33.9%. The main players of this trend, namely Zone 3, are the Central & Eastern regions and the Northeastern region.

Number of Approved Projects by Region

	1989	1990	1991	1992	1993	1994
Whole Kingdom	1,178	912	606	371	851	1,173
Zone 1	541	386	193	138	192	233
Zone 2	282	225	141	77	143	165
Western Seaboard	70	38	36	18	40	57
Northern Region	74	69	55	36	135	121
Northeastern Region	56	51	64	28	114	165
Central & Eastern Region*	75	68	62	60	137	303

Source: BOI * : Except Provinces included in Zones 1&2, **: Chumpon is in Western Seaboard.

2.3 Industrial Structure

1) National Structure

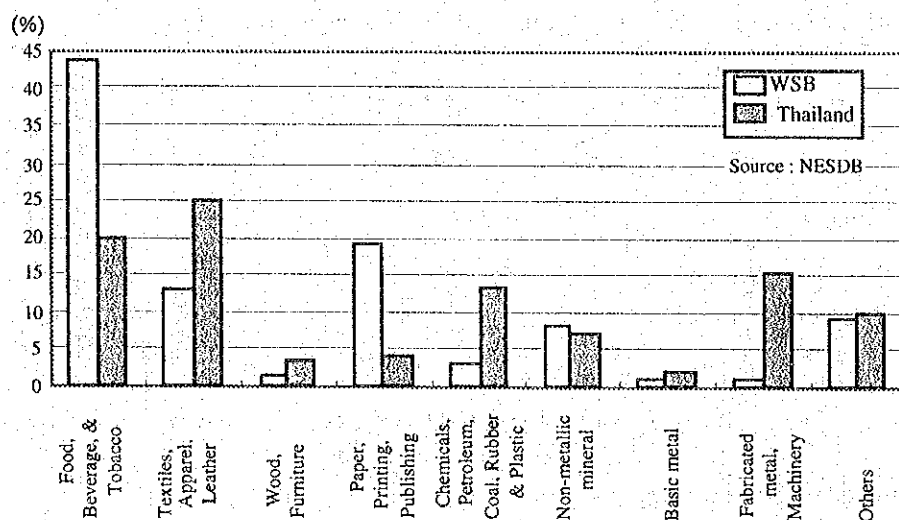
In 1980, major manufacturing subsectors were food, beverages, textiles, garments, and chemicals and the sum of these subsectors' share was 56.4% to total value added of manufacture (GDP base). Until the late 1980s, these subsectors, except chemicals, were prime motors of the Thai economy. During the early 1990s, the share of both food and beverages declined and were taken over by electrical equipment, transportation equipment, and miscellaneous products. As for the growth rate (current price) between 1988 and 1993, electrical equipment marked 30.54%, followed by miscellaneous products (24.52%) and machinery (27.74%).

The industrial structure of Thailand as a whole has been diversified and has become a high-value-added-based structure. Growing subsectors such as machinery, electrical equipment, and transportation equipment are high-value-added industries.

The structure of manufacturing industry is characterized as follows (Industrial Survey 1994).

- Textile and apparel, and their related industries are the biggest subsector
- Fabricated metal products, machinery, and equipment industry follow the textile, wearing apparel, and their related industries
- Basic metals industry has a small share

Manufacturing industry in WSB is characterized by the large configuration of the food and related industry as shown below. The fabricated metal and machinery industry as well as chemical industry, on the other hand produce smaller component.



Industrial Structure by GDP in 1944

2) Provincial Structure

The major industry in Prachuap Khiri Khan Province has been agriculture as stated before. As for the manufacturing industry, a total number of 458 registered establishments were in operation and employed 13,332 workers in 1994. The Total amount of investment in the same year was 18,550.61 million Baht.

Major manufacturing subsectors are food manufacturing (113 establishments and 8,986 employees; canning and preserving of fruit and vegetables factories are large both in investment and number of employees) followed by transportation equipment (70 establishments and 1,165 employees).

Like in the Kingdom in general, the great majority of establishments in Purachuap Khiri Khan are small and medium scale enterprises. Average employment and investment per establishment are 29.1 people and 40.5 million Baht (investment per establishment, except one iron & steel factory, declines to 12.6 million Baht. Furthermore the largest investments by subsectors are canning & preserving of fruit and vegetables with 1,724.8 million Baht or 82.1 million Baht per factory, therefore per factory investment of the remaining industries is 9.2 million Baht).

Establishments Operating in Purachuap Khiri Khan

Industry	No. of Factories	Investment Mil. Baht	No. of Workers (Person)		
			Male	Female	Total
Food, Beverages & Tobacco	152	2,563	2,171	7,469	9,640
Textile, Apparel, Leather & Leather Products	27	98	284	379	663
Wood & Wood Products, inc. Furniture	45	58	464	66	530
Paper & Paper Products, Printing & Publishing	5	55	50	20	70
Chemicals & Chemical Products, Petroleum, Coal, Rubber & Plastic Products	12	10	27	2	29
Non-metallic Mineral Products except Petroleum & Coal Products	66	145	363	55	418
Basic Metal Industries	1	12,811	269	40	309
Fabricated Metal Products, Machinery & Equipment	130	2,682	1,439	59	1,498
Other Manufacturing Industries	21	128	245	239	484
Total	459	18,550	5,312	8,329	13,641

Source: MOI

2.4 Natural Resources and Energy

1) Mineral Resources in Prachuap Khiri Khan Province

Tin, granite and limestone are produced in Hua Hin District and Tab Sakae District as shown below. Tin and limestone worth approximately 30 million Baht and 9 million Baht, respectively, were produced in 1993.

(1993)

Location	Mineral	Quantity (ton)	Products Value (million Baht)
Hua Hin	Limestone	16,000	9.4
	Granite	2,000	2.0
Pran Buri	Granite	180	0.5
Tab Sakae	Tin		29.9
Note:	Products of Kingdom.....	Granite.....	235 million Baht
	(1992)	Tin	671 million Baht
		Limestone.....	2,162 million Baht

Source: Investment Plan of Prachuap Khiri Khan Province

2) Energy Resources

Energy consumption in Thailand has been increasing at an annual rate of 10.8 % to cope with the rapid expansion of the economy. Total energy consumption in 1995 was approximately 1.0 million barrels of crude oil equivalent per day as shown below.

Energy Consumption in Thailand

	(million barrels per day: crude oil equivalent)					
	1990	1991	1992	1993	1994	1995
Consumption	0.60	0.67	0.72	0.81	0.90	1.01 ^{1/}
Stock	0.01	-	-0.02	0.03	0.01	0.04
Total	0.61	0.67	0.74	0.84	0.91	1.05

Source: Energy Policy News, National Energy Planning Office (NEPO)

Note: ^{1/} Seven-month data

Energy production, on the other hand, was limited to 0.40 million barrels of crude oil equivalent per day in 1994 and the balance of 0.65 million barrel or 60 % of consumption was imported from outside as shown below.

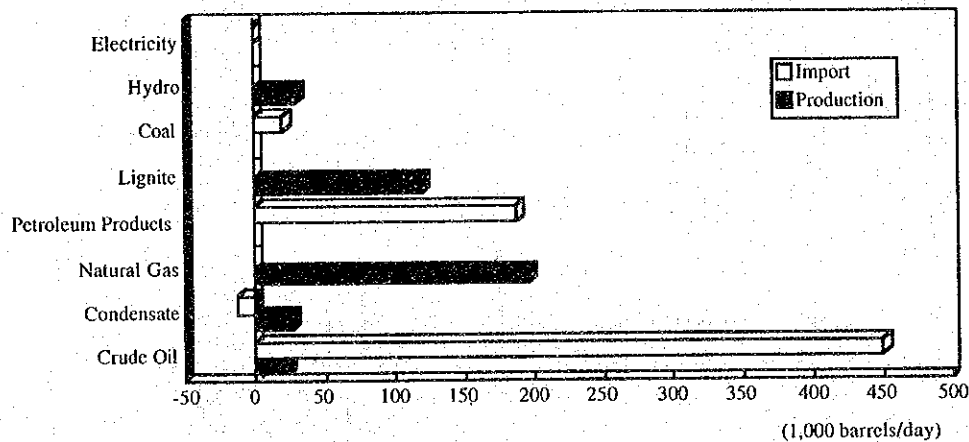
Energy Production in Thailand

	(million barrels per day: crude oil equivalent)					
	1990	1991	1992	1993	1994	1995
Domestic Production	0.25	0.29	0.31	0.34	0.37	0.40 ^{1/}
Import	0.36	0.38	0.43	0.50	0.54	0.65
Total	0.61	0.67	0.74	0.84	0.91	1.05

Source, Note: ditto

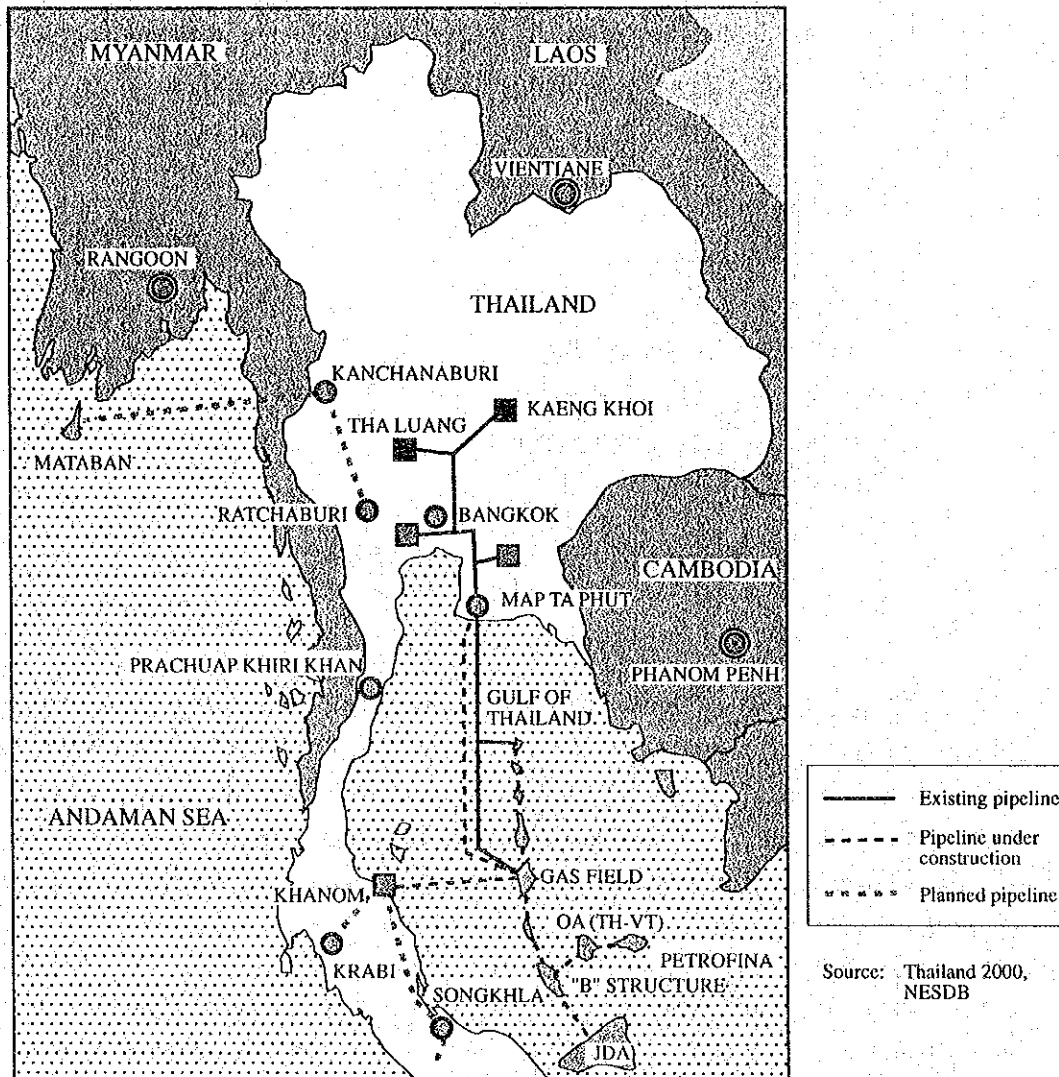
The natural gas and lignite are the dominant energy resources in Thailand, while crude oil and petroleum products are imported in large quantities as shown in the chart below.

Despite the increase in natural gas and lignite production, oil and petroleum product imports have increased sharply due to the rapid growth of energy consumption.



99% of lignite is produced in the north of Thailand and consumed as fuel for power plants and factory boilers and material for cement production. The consumption of lignite as fuel is anticipated to be reduced in the light of air pollution problem, i.e. high contents of SO_x and strict standards for stationary emission to be introduced in 1996. The import tax on coal, lowered from 25 % to 1 % in 1994, will accelerate coal imports to meet the energy demand.

The production of natural gas, rather clean energy, increased at annual rate of 10 % in 1994 and 1995 and is conveyed to the Eastern Seaboard and Bangkok Metropolis by a submarine pipeline from the Gulf of Thailand. The Khanom power plant, located in the eastern coast of the Southern Seaboard, is also connected by a submarine gas pipeline with the Erawan gas field. Import of Myanmar natural gas is scheduled to commence from 1998 to supplement the demand increase. The development of a pipeline between Ratchaburi on the Western Seaboard of Thailand and Mataban gas field located offshore of Myanmar will soon start supplying gas to the Ratchaburi thermal plant.



Natural Gas Pipeline of Thailand

2.5 Industrial Estate

1) Present Situation

The Government of Thailand recognized the important role of industrial estates in industrial promotion and embarked on a program of creating industrial estates from the 1970s. IEAT developed the Bang Plee industrial estate, Lat Krabang industrial estate in the Bangkok suburb, and Laem Chabang industrial complex and Map Tha Phut industrial complex on the Eastern Seaboard to cope with the drastically increasing investment demand of foreign entrepreneurs. In the 1990s, private development of industrial estates was started, encouraged and supported by the government, and many joint-venture developments by IEAT and private companies have since been made.

The numbers of developed and planned industrial estates in Thailand are listed below. Regional locations of industrial estates with the axes of industrial development in Thailand are illustrated in Figure 2.2. The list of industrial estates is tabulated in Table 2.2.

Industrial Estates by Region in Thailand

Region	No. of I.E.	Total		Vacant Area		Area Occupied	
		ha	rai	ha	rai	ha	rai
Central	32	6,518	40,738	1,759	10,994	4,766	29,789
Eastern	25	7,794	48,715	3,296	20,601	4,498	28,114
Northern	13	1,091	6,818	566	3,536	525	3,282
North Eastern	12	2,613	16,329	1,268	7,924	1,345	8,405
Western	3	557	3,481	557	3,481	0	0
Southern	11	138	864	129	804	10	60
Total	96	18,711	116,945	7,575	47,340	11,144	69,650

- (1) 96 industrial estates with an area of 113,464 rai (18,154 ha) in total have been developed during the 23 years from 1972 to 1995 in Thailand. About 46 industrial estates have already been developed and the remaining 50 estates are under construction or planning.
- (2) The total land area sold for industrial development is 69,650 rai (11,144 ha) accounting for 60% of the total area of industrial estates, and the remaining 40% or 47,340 rai (7,575 ha) is undeveloped.
- (3) 18 industrial estates with an estimated area of 60,700 rai (9,712 ha) are planned to be developed in addition to the above.
- (4) 32 industrial estates are concentrated in the central region in which the Bangkok metropolis and neighboring provinces are included. 33% of total industrial estates are developed in the central region and 73% of the estates developed in the central region have already been occupied by investors.

In the eastern region including the Eastern Seaboard, 25 industrial estates with an area of 48,715 rai (7,794 ha) have been developed. The extent per one industrial estate developed in the Eastern Region is the largest. More than 80% of industrial estates are concentrated in these central and eastern regions.

- (5) On the Western Seaboard, three IEs are planned in the WSB, namely Kanchanaburi IE (681 rai/109 ha), Mahachay IE (1,300 rai/208 ha) in Ratchaburi, and Khao Yoi IE (final 1,500 rai/240 ha) in Petchaburi. Kanchanaburi IE and Mahachay IE are under construction. The developers of these IEs are private companies.

- (6) On the Southern Seaboard, 11 small industrial estates in Song Khla and other major cities have been proposed. 4 estates out of 11 have detailed development plans and 864 rai (134 ha) of industrial area will be developed. The Songkhla industrial estate has already been developed and 60 rai (10 ha) out of 319 rai (50 ha) have already been occupied by investors.

2) Demand and Supply of Industrial Estates in Thailand

The Government of Thailand has initiated the development of industrial estates to supply sufficient infrastructure for industrial production activities. However, development of industrial estates has not always kept pace with the investment demand of investors.

The present stock of industrial estates is analysed in comparison with investment demand as shown below.

Demand-Supply Balance of Industrial Estates in Thailand

(1) Annual demand (1989-1995 average)	18,179 rai	2,909 ha
(2) Stock of industrial estates	47,340 rai	7,580 ha
(3) Expected years to be sold out	2.6 years ($47,340/18,179=2.6$)	
(4) Industrial estates under planning	60,000 rai	9,600 ha
(5) Expected years to be sold out (Stock+planned IE)	5.9 years ($(47,340+60,000)/18,179=5.9$)	

The present stock of industrial estates in Thailand is estimated at 47,340 rai (7,575 ha) in 1995 and 18,179 rai (2,909 ha) have been sold annually during the last 6 years. If the stock of industrial estates will be sold at the same rate of annual demand, only a period of 2.6 years is necessary to complete the sale.

Even if the 18 planned industrial estates with an estimated area of 60,000 rai (9,600 ha) are developed on schedule, all industrial estates will be occupied by investors after only 5.9 years.

In case the investment demand shrinks to a half of the present figure, the annual demand is predicted to be 9,000 rai (1,500 ha) and approximately 10 years are necessary for the existing and planned industrial estates to be fully occupied. It means that all industrial estates including planned estates will be filled by the year 2005.

The demand and supply balance of industrial estates in Thailand is still tight even though the investment demand will decrease.

Considering the situation of industrial estates supply, development of the Bang Saphan industrial estate and other planned estates is recommended to be promoted urgently.

2.6 Role of the Western Seaboard and Prachuap Khiri Khan

1) Development Axes

Thailand has established an industrial infrastructure in the Bangkok metropolis and its vicinity to cope with the high economic growth of the 1980s. Nowadays, development of industrial infrastructure in rural areas is required to support the growth of the local economy and upgrade the living conditions of local people.

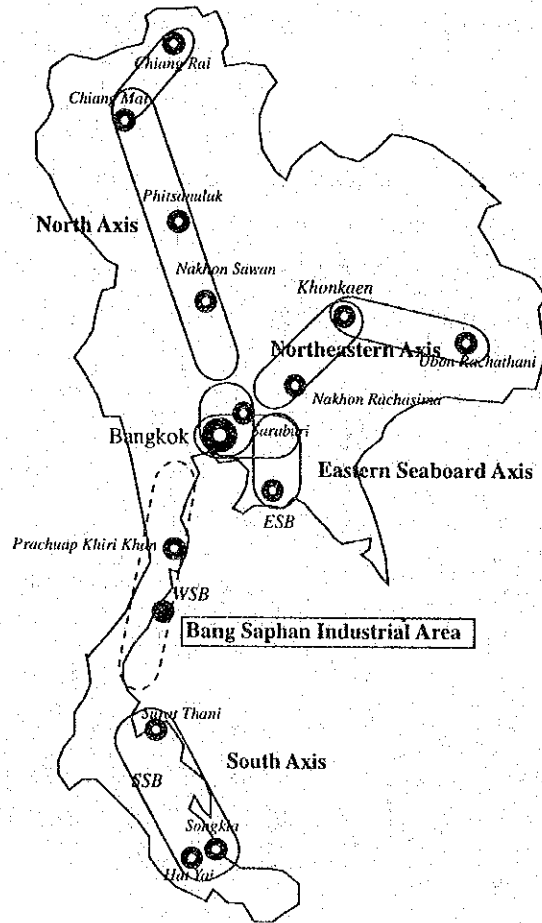
As shown in Figure 2.2, industrial development axes can be conceived as follows judging from the development situation of industrial estates:

- | | | | |
|----|--|---|---|
| a. | Relocated axes from Bangkok Metropolis | : | Eastern Seaboard, Saraburi |
| b. | Northeastern axes | : | Khon Kaen, Nakohn Ratchasima, Ubon Ratchathani |
| c. | Northern axes | : | Nakhon Sawan, Phitsanulok, Chiang Mai, Chiang Rai |
| d. | Southern axes | : | Surat Tani, Song Khla, Hat Yai |

Four industrial development axes, in the east, northeast, north and south, will be encouraged to promote well-balanced national development. However, nonindustrialized areas will stagnate as a result of development of these axes. Especially for the south axes, there is a long undeveloped coastal area in the Western Seaboard.

In order to develop industrial areas, enclave development is not proper due to the lack of regional coordination and cooperation, and development of continuous cores linked by means of transportation and communication networks is needed to realize new industrial areas. It is important that the industrial area of the Western Seaboard be developed in order to link the Bangkok Metropolis and the Southern Seaboard and an axis from Bangkok to the border with Malaysia will be realized.

Industrialization of the Western Seaboard which is located next to the Central Area will be contributive to the decentralization of the over-populated capital area. Further, the development of industrial area in the hinterland of the deep sea port in Bang Saphan will be important for the effective utilization of deep shore which is finite in the Gulf of Thailand.

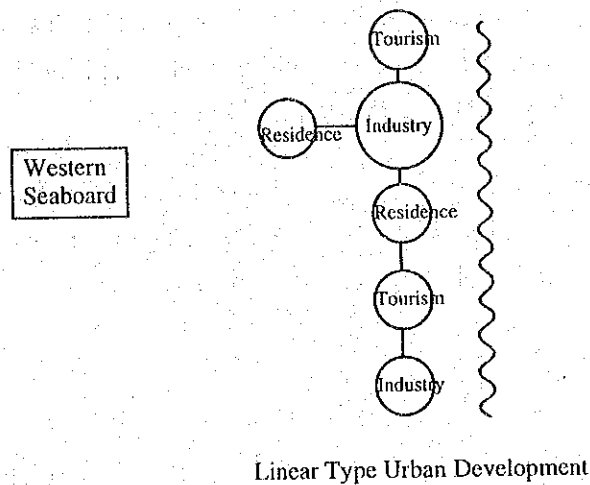
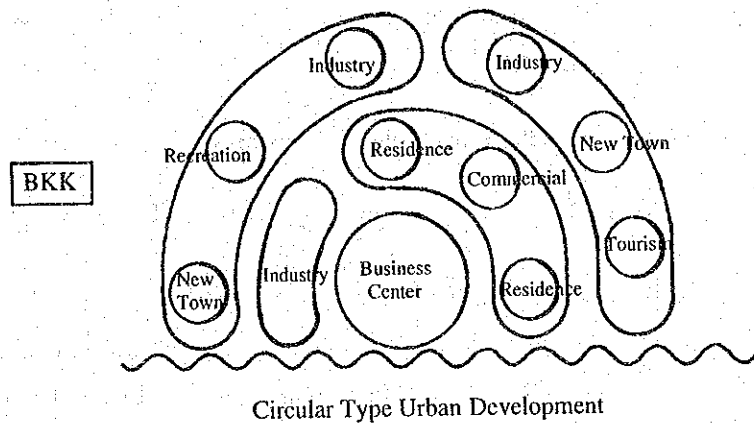


Industrial Development Axes of Thailand

2) Characteristics of Urban Development in the Western Seaboard

Urban development in the Western Seaboard is characterized as follows:

- a. Urban functions such as central business function, residential function, industrial function, etc. are distributed in a circular fusion and form the metropolis of Bangkok. In the Western Seaboard, such a circular distribution of urban functions is difficult due to topographical constraints.
- b. Small cities and towns have been nurtured by diverse histories on the long slender peninsula in the Western Seaboard.
- c. Therefore, urban functions in the Western Seaboard will be developed in a linear fashion as illustrated below.



3) Development Image of Prachuap Khiri Khan Province

Future features of the Western Seaboard are conceived as follows and Figure 2.3 presents the schematic design of Western Seaboard development.

- (1) As mentioned above, a circular distribution of urban functions is impossible and only linear distribution is possible for the Western Seaboard. Cores of urban functions such as business, industry, tourism and residence will be linked by transportation and telecommunication networks to form a Western Seaboard corridor.

The following figure explains the concept specifically.

- Ratcha Buri and Petcha Buri form the northern core of the industrial city.
- The tourism core is promoted in north Prachuap Khiri Khan

- A big scale industrial core will be developed in Bang Saphan, south of Prachuap Khiri Khan.
 - A tourism core will be promoted in Chumporn.
 - Transportation, telecommunications and energy networks will link each core.
- (2) Prachuap Khiri Khan province located in the center of the Western Seaboard will sustain steady growth supported by the agricultural industry and tourism industry. In addition, Bang Saphan industrial development will dramatically expand the manufacturing industry of the province.
- (3) In Bang Saphan, a large industrial area with iron/steel industry and relevant downstream and supporting industries will be established, utilizing a deep sea port which is the only one in the Western Seaboard.
- (4) To enhance the industrial development of Bang Saphan, a concept of industrial city composed of an industrial estate, a new town, a resort area, and business and commercial areas should be taken into consideration.

3. BACKGROUND OF THE PROJECT (2)

- DEVELOPMENT DIRECTION OF STEEL INDUSTRY IN BANG SAPHAN -

3.1 Present Status of Steel Industry in Thailand

The Thai steel industry has experienced constant growth in terms of both consumption and production, underpinned by steady economic growth. This is in accordance with the general trend in Asia, where most countries have enjoyed constant growth in finished steel consumption, as shown below.

Apparent Consumption of Finished Steel in Asia (1990-1994)

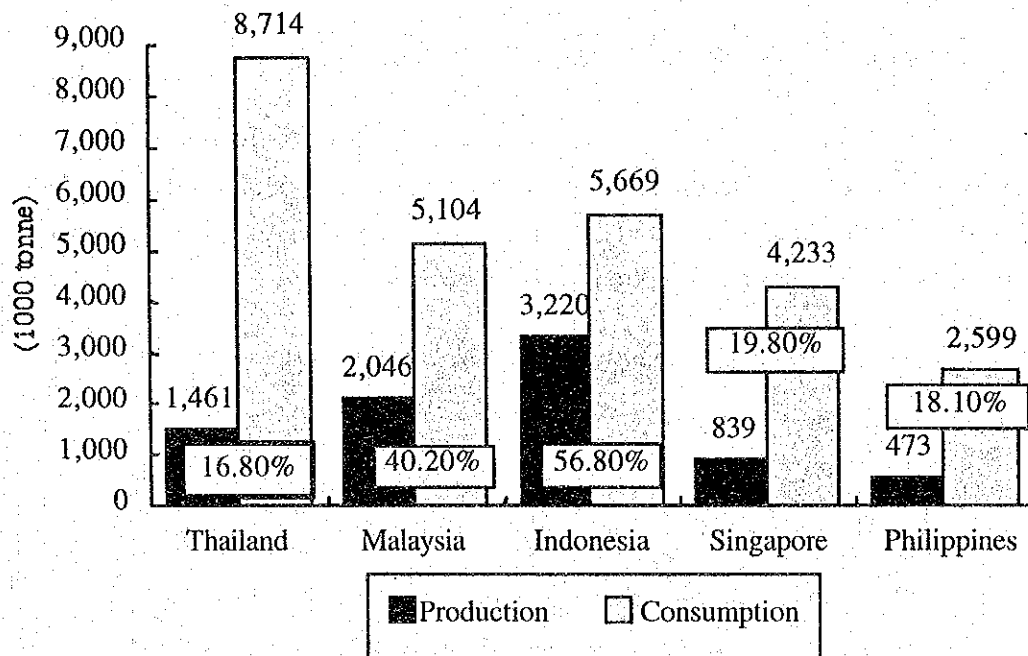
	1990	1991	1992	1993	1994	94/90*
ASEANS	17,700	17,984	20,408	22,473	23,694	7.6
Thailand	6,434	6,081	7,456	7,619	7,849	5.1
Malaysia	3,159	3,521	3,876	4,809	4,594	9.8
Indonesia	3,944	4,076	4,581	4,484	5,102	6.6
Singapore	2,471	2,513	2,575	3,185	3,810	11.4
Philippines	1,692	1,793	1,920	2,376	2,339	8.4
Korea, R.O.	19,960	24,470	21,090	24,760	30,020	10.7
Taiwan	12,713	15,567	17,640	20,830	18,692	10.1
China, P.R.	49,216	52,410	66,311	99,095	90,000	17.9
Total Listed	99,589	110,431	125,449	167,158	162,406	13.0

Source: Southeast Asia Iron & Steel Institute, "Steel Statistics Yearbook 1994" and other national statistics.

*: Annual percentage change from 1990 to 1994.

However, one of the characteristics of the Thai steel industry is that along with Singapore, it is one of the two countries among the five ASEAN countries with lowest self-sufficiency in steel products. Particularly, it is notable that Thailand has the lowest self-sufficiency rate in terms of crude steel, as shown below, while it has a relatively large economy and is in an advanced stage of economic development among the ASEAN countries. This is a result of the underdevelopment of upstream steel industry, namely iron and steel making. Establishment of iron and steel making facilities requires a large amount of capital, and the fact that Thailand has no state-owned integrated steel mills is largely responsible for this low rate of self-sufficiency in crude steel, while other ASEAN countries such as Indonesia and Malaysia have.

Production and Consumption of Crude Steel in ASEAN5 (1994)



*: Percentage is self-sufficiency rate (Production/Consumption).

Source: Southeast Asia Iron & Steel Institute, "Steel Statistics Yearbook 1994" and estimation by the JICA Study Team.

In Thailand, almost all steel producers are medium and small scale companies with less than 500,000 tonnes capacity, while some have an electric arc furnacing process. All producers are located in the southeastern part of the country except for one new steel complex in Bang Saphan. In 1993 almost 70 per cent of finished steel production was of long products which are mainly used by the construction sector. This has resulted in a much lower self-sufficiency rate of flat products at 13 per cent in 1993, while the rate of long products was 60%. Due to the start-up of the first hot strip mill in the country in Bang Saphan, production of flat products jumped from 576 thousand tonnes in 1993 to 1.27 million tonnes in 1994, but the self-sufficiency rate stayed at around 25%. Because flat products are mainly used for higher-value-added manufacturing such as automobiles and electrical appliances as well as for construction, an increase in self-sufficiency of flat products through the establishment of production facilities is a central issue for Thailand from the viewpoint of balanced industrial development. At the same time, an increase in self-sufficiency in crude steel through the development of the upstream steel industry is another important issue for the future of the Thai steel industry. With a view of improving the trade imbalance and ensuring a stable supply of steel products as a basic material, these factors will be central for consideration.

3.2 Comparison Study of Promoting Measures for Steel Industries in Asia

In many Asian countries governments have played an important role in promoting the growth of the steel industry of their country by establishing state-owned companies or giving many incentives and protection, as summarized below. Government ownership of the steel industry is found in Korea, Taiwan, Malaysia and Indonesia, and also at the early stage of the industry's formation in Japan. In those countries, there were direct or indirect financial supports by the government, because the steel industry requires a huge amount of capital. There have also been various tax benefits, support for infrastructure and protection from imports. On the other hand, in Thailand the scale of measures taken was relatively small, especially with no direct injection of capital to core steel producers. In the meantime, on a worldwide basis, government control and promoting measures have been gradually diminishing under a general trend of deregulation and trade liberalization. Moreover, tariff rates for steel products have been declining and will be reduced in Asia along with the efforts to conclude "Multilateral Steel Agreement (MSA)" under the WTO scheme and also efforts for AFTA. There is also a global trend of privatization of state-owned steel firms on a worldwide basis to promote efficiency and to reduce government obligations.

While there is no rationale for introducing subsidies and direct promoting measures under this global environment, introduction of indirect measures including a preparation of basic infrastructure such as port facilities, roads, railways, electricity and water supply, should be considered to nurture a steel industry and to establish a steel-based industrial complex in Thailand, particularly in Bang Saphan. This area is away from the Bangkok Metropolitan area and has to bear a lot of inconveniences due to such isolation, while having a perfect conformity to the government policy of "Decentralization". Therefore, those projects which could lead the way to local development should be given special government support (refer Appendix B.2 for details).

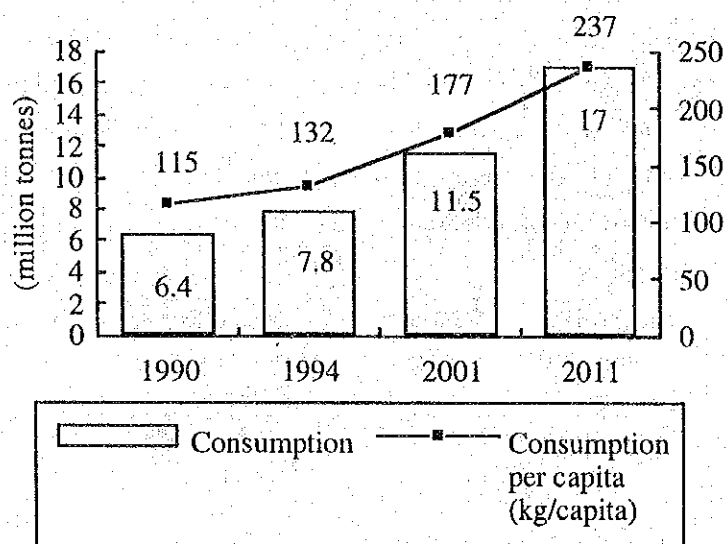
	Government ownership	Financial support	Support for infrastructure development	Tax benefits	Import restriction
Japan	+-	+-	+-	+-	+-
Korea	++	++	++	++	++
Taiwan	++	++	++	++	++
Indonesia	++	++	++	++	++
Malaysia	++	++	++	++	++
Thailand	--	--	--	++	++

++: Exists both in the past and now, +-: Exists only in the past, --: Does not exist

3.3 Future Steel Industry in Thailand

It is generally recognized that Asia will lead world economic growth toward 2011, and Thailand will be one of the chief engines of this growth. Based on the macro economic scenario which assumes an annual 12.6% growth between 1995 and 2001, and an annual 7.9% growth between 2001 and 2011 in terms of nominal GDP, it is forecast that finished steel consumption in Thailand would reach 11.5 million tonnes in 2001 and 17 million tonnes in 2011. Because infrastructure development needs will be high in Thailand, and thus, demand for steel from the construction sector will remain strong. Higher integration of the manufacturing sector whose share to GDP is expected to increase toward 2011, would bring about increased consumption of various flat products. For instance, it is assumed that production of passenger cars in Thailand could increase to more than 1.5 million units against 540 thousands in 1995, and therefore, demand for cold rolled and coated sheet would increase. The Study Team forecasts that steady growth in major steel using industries will bring about an annual 5.6% growth in finished steel consumption between 1994 and 2001, and an annual 4.0% growth between 2001 and 2011. Consumption of 17 million tonnes of finished steel means that every individual in Thailand consumes a 237 kilograms of steel every year, or in other words Thailand consumes a 26 grams of steel to produce one US dollar of GDP, which is a world standard level compared to its assumed per capita GDP of US\$9,000.

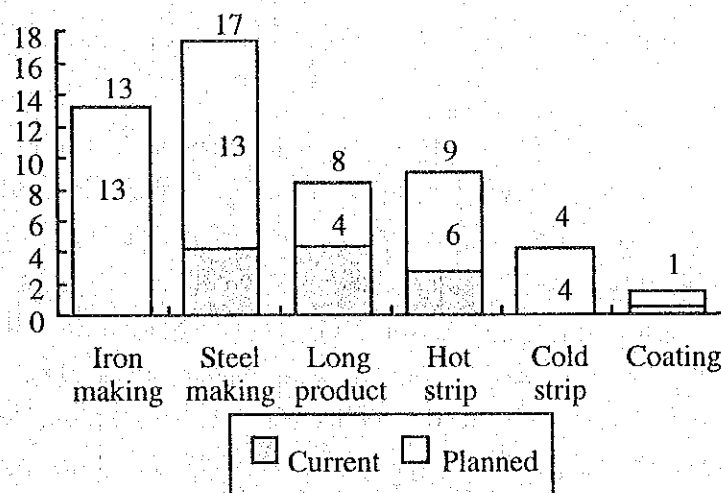
Prospects for Thai Finished Steel Consumption



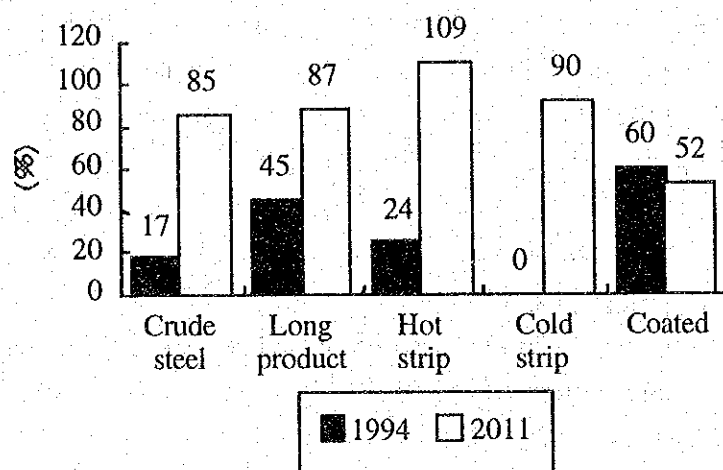
Considering that Thailand has a low self-sufficiency rate of steel products and steel consumption is expected to grow at a steady rate, many are planning to construct steel mills in Thailand. Simple accumulation of reported capacities of these projects suggests that

production capacity increases of 12 to 13 million tonnes of iron and steel making, 3.7 million tonnes of long products, 6.2 million tonnes of hot strip, 4 million tonnes of cold strip, and 840,000 tonnes of coated steel sheet are in consideration. While there is much uncertainty about realization of these projects, some other projects might be realized. It is assumed that production capacities would be increased in a direction to increase the country's self-sufficiency in steel products. The Study Team sees much possibility for Thailand to increase its self-sufficiency rate of finished steel to around 90 per cent by the year 2011. However, it should be noted that most of expanded facilities would concentrate on commodity grade products, and therefore, there would still be a large amount of exchange of products across the border; namely exports and imports. At the same time, it is a fact that many steel mill projects are planned everywhere in Asia. Particularly, the Republic of Korea and Taiwan could dramatically increase their export capabilities in terms of volume, and if China, which could absorb much of the steel produced by new facilities in Asia, fails to follow its anticipated economic growth track, there is a real risk of over-supply of steel products. In that respect, construction of new facilities in Thailand needs a step-by-step approach with a careful assessment of demand-supply balance of steel products in Asia.

Current and Planned Steel Production Capacities in Thailand



Prospects for Self-sufficiency in Steel Products



3 Major Steel Mill Projects in Thailand

Company	(Million tonnes)				
	Ironmaking	Steelmaking	Hot strip	Cold strip	Others
Sahaviriya Group	1.8+Plan	Plan	2.4*+Plan	1.0*	Long/Coating
Nakorn Thai Steel	1.5	1.8	2.4	1.0	Long/Coating
Thai Special Steel	2.8	2.8	Plan	-	Long

Figures are BOI approved ones. * means facilities in operation or under construction.

Among planned steel mill projects in Thailand, several include iron and steel making processes as well as rolling of the flat products which Thailand is most lacking at the moment. The Sahaviriya project and its group in Bang Saphan is positioned as one of the three integrated steel mill projects which include iron making processes as well as those of Nakorn Thai Steel group (Nakorn Thai Strip Mill) and Thai Special Steel Industry, both of which are being pursued or planned along the Eastern Seaboard. While Sahaviriya and Nakorn Thai Strip Mill focus on the flat product market, Thai Special Steel Industry is planning to produce semi-finished and finished long products. Some other projects are planned to produce a direct reduced iron (DRI) to feed electric arc furnaces (EAF), because steel scrap, the main raw material for EAF, is anticipated to be in shortage in the future both in Thailand and overall Asia. However, it is notable that the feasibility of investment for upstream products is still fragile and for all the planned projects it has still not been determined which technology they should adopt. The only project planned by United Iron and Steel would proceed with natural gas-based iron making technology (HYL III or Midrex), given a relatively cheap energy price agreed by PTT, EGAT and MOI, because this is positioned as a kind of national project. Other projects for iron making would take either

a coal-based technology such as Fastmet, Corex and DIOS or a traditional blast furnace route, while many experts are pessimistic about gas-based iron making technology because of its availability and high price in Thailand. Thai Special Steel Industry has recently announced that it will take a conventional blast furnace route, constructing a coke oven battery, a 2,800 m³ blast furnace and basic oxygen converters, while it is seen as a little unusual due to its huge investment cost to produce relatively low added value products, billet and long products.

It is clear that Thailand would benefit from establishing iron making facilities in the future, taking into account that many steel making projects are planned everywhere in Asia, and that there is much concern about a possible shortage of DRI and steel scrap. Under this assumption, it is rational to establish both iron and steel making facilities in the Bang Saphan area, because it has one of the best deep sea ports in Thailand, which is the critical cost factor for transportation of raw materials such as iron ore and coal, and this area will require more semi-products by having a hot rolling capacity of more than 3 million tonnes by 1996.

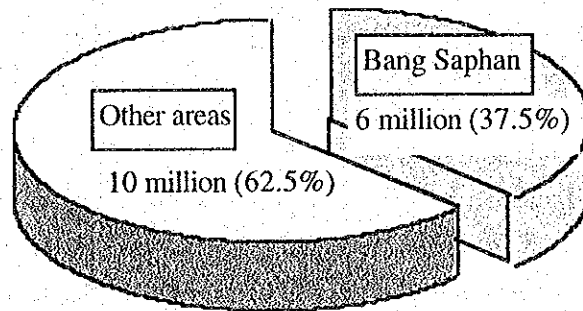
3.4 Prospective Development of Steel Industry in the Bang Saphan Area

3.4.1 Basic Concept on Development

Taking into account the fact that Thailand could expect a constant increase in steel consumption and that the Bang Saphan area has an established base for the steel complex with a deep sea port, it would be quite reasonable to expand its capacity including iron and steel making up to 6 million tonnes by 2011, which is almost one third of estimated crude steel consumption in Thailand.

However, the steel complex in Bang Saphan has been and will be developed by the private sector, and therefore, it is recommended to take very prudent steps such as a) Minimum capital expenditure, b) Stepwise increase of capacity keeping production flexibility, c) Matching between facility plan and utility development.

**Importance of Bang Saphan in Crude Seel Production
in Thailand (2011)**



3.4.2 Current Situation of the Steel Complex

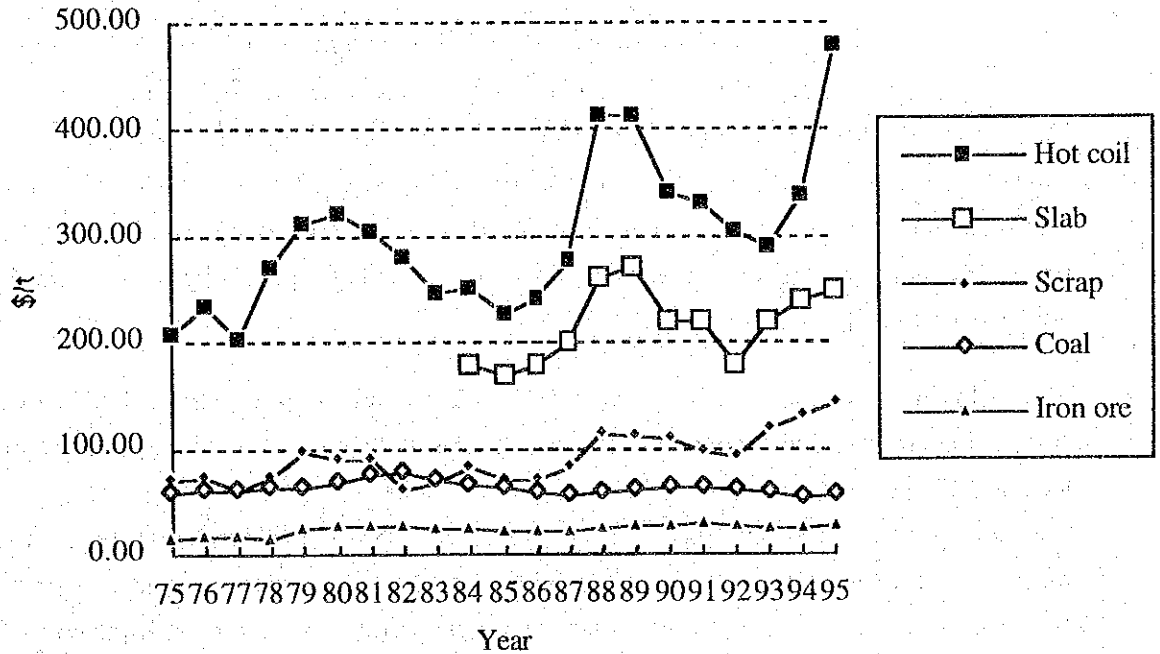
The following facilities have been installed or are under construction in Bang Saphan.

Hot Strip Mill	2.4 million tonnes/y (Mt/y)	in operation
Electroalvanizing	0.135 Mt/y	in operation
Bar Mill	0.72 Mt/y	in operation
Cold Strip Mill	1.0 Mt/y	under construction

At the moment, the complex does not have upstream production facilities which provide semi-products such as slabs for hot strip mill and billets for bar mill. Therefore, these feedstocks have been imported. However, procurement of a big amount of slabs (2.5 million tonnes per annum) is not always easy and will be more difficult.

At the same time, slab prices will fluctuate depending upon the situation of international economy, while iron ore and coal prices will be rather stable compared with semi or finished products, as was the case shown below. Furthermore in the process of steel strip production, the quality and width of final products are basically decided by slabs fed to a hot strip mill, and therefore, too much dependence on purchased slabs from outside will make it difficult to meet these customers' requirements. Therefore, the steel complex will require to have its own capability to produce slabs in order to provide quick and better response to customers' demands. However, it should be again noted that iron and steel making processes require huge capital investment and infrastructure, including water and electricity supply. Because water and electricity are not abundant in the Bang Saphan area, the availability of those utilities is a critical factor to decide the process, capacity and time schedule.

Trends in International Market Prices of Steel Products and Raw Materials



3.4.3 Available Technologies for Iron making

In Thailand the availability of natural gas is limited and the priority of its usage is given to petro-chemical industry and electric power generation. Also the price of natural gas is assumed to be US\$ 2.70 per mm Btu (million British Thermal Unit). Those situations generally prohibit the steel industry from depending upon natural gas.

Among coal-based iron making processes which are alternatives for natural gas-based ones, the blast furnace coupled with basic oxygen furnace (BF/BOF) process is most established and reliable in terms of quality and quantity. The critical shortcomings of BF/BOF process are the larger facility cost including BF, coke battery and BOF as well as the lack of flexibility of operation with regard to stop and go. There are several other processes, but all of them are either in small scale production or in the development stage. At this moment Corex (or coupled with Midrex), Fastmet and DIOS are possible candidates.

Corex process has been applied at ISCOR, South Africa, in the capacity of 0.3 million tonnes per annum. But POSCO, Korea, has started to operate the new model of Corex with an annual capacity of 0.6 million tonnes in November 1995. Fastmet process development will be completed in the fall this year. The first commercial plant will start its

operation in the latter half of 1998 in the U.S., while some further improvement is going to be studied parallelly.

Another strong candidate will be DIOS, whose pilot plant test was completed successfully in February 1996 as a national project in Japan. Based on the test results, conceptual designing for a commercial plant (1 million tonnes annual capacity per unit) was completed in July 1996 which showed manufacturing cost reduction by 19% and facility cost reduction by 35% compared with BF/BOF process with coke oven and sinter as well as many advantages in operational flexibility. The operability and reliability of those three new processes still remain to be seen.

In this report, a direct reduced iron and electric arc furnace process (DRI/EAF) is assumed as an example case of an iron and steel making process. As explained above, technical development in the next several years would enable us to make a decision in selecting the most favorable process and if process selection is made by 1999, the first iron making facilities will be able to start by 2003 in Bang Saphan when the necessary electricity could be supplied by a new 500 kV transmission line and water could be supplied by the enhancement of the Bang Saphan River pumping station. If everything is successful, facilities could be gradually added up to reach the annual capacity of 6 million tonnes or more in concert with the enhancement of infrastructure including EGAT power stations, IPP power stations, Tha Sae Dam and other water resources (refer Appendix B.4 for details).

3.4.4 Recommended Facility Plan

Stepwise expansion of facilities is recommended, as shown below, together with necessary utility development. Although an early installation of 2 million tonnes of iron and steel making capacity is preferable, utility supply does not allow it until 2002. Therefore, in the meantime it is recommended to install electric arc furnace(s) and a continuous caster to produce 1 million tonnes of slabs annually as the first step. A 500 kV EGAT transmission line from the BMA grid is scheduled to be laid by the end of 2001, which will be able to support this EAF installation. This amount is only a half of slab consumption, but will strengthen the bargaining power in the procurement of slabs. As for billets it is generally understood that procurement of ordinary quality billets is much easier in both domestic and international markets, and therefore, production facilities for billets could be left until the third step. Production of one million tonnes of crude steel through EAF will require an enhancement of the existing water pumping station and water reservoir in the steel complex as well as some modification of power transmission lines and installation of a voltage stabilizer to reduce the voltage fluctuation induced by EAFs.

Recommended Facilities for the Bang Saphan Steel Complex

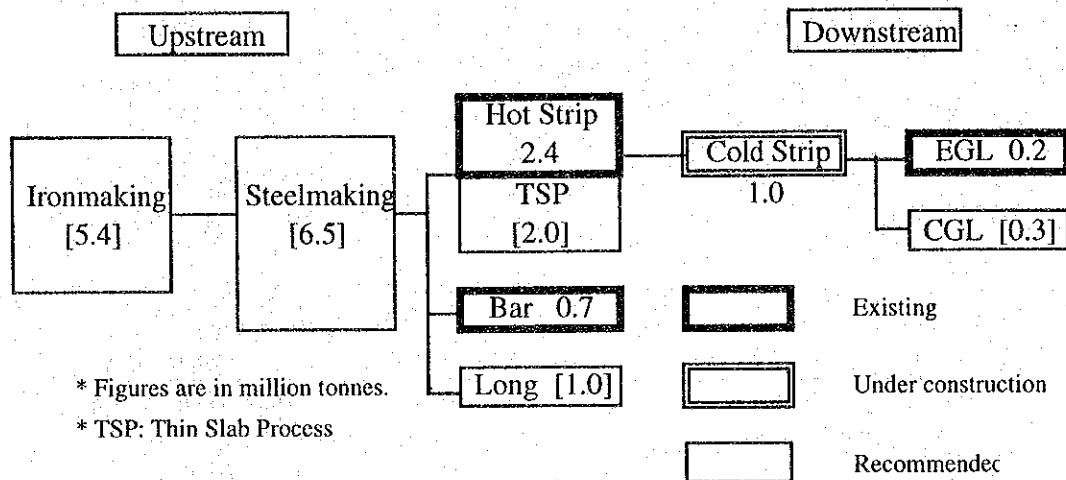
(million tonnes)

Step	Completion Year	Iron Making	Steel Making	Hot Rolling	Cold Rolling	Coating	Remarks
	Current			3.1		0.15	No more facilities possible because of electricity limitation
1	2001		1.0		1.0	0.1	Water pump enhancement necessary, Electricity: 500 kV transmission line
2	2002	1.8	1.5			0.2	Iron making process decision before 1999
3	2004	1.8	2.0	1.0			Tha Sae Dam water 15 Mcm/y (1400 MW IPP)
4	2006	1.8	2.0	2.0			Tha Sae Dam water 15 Mcm/y
	Total	5.4	6.5	6.1	1.0	0.5	* Bang Saphan river basin reservoir development

Alternatives: Earlier installation of one DRI unit to assure its operability and reliability.

In the second step in 2002, 2.5 million tonnes of iron and steel making capacity would be recommended adding 1.5 million tonnes to EAF capacity and 1.8 million tonnes to DRI capacity. Then in 2004 when water supply from the Tha Sae Dam will be secured and electricity supply will be enhanced through EGAT new power stations and IPP plants, a 2 million-tonne long product complex could be completed, and in 2006 flat rolled product capacity could be expanded through the construction of a 2 million-tonne iron and steel making plant followed by a thin slab caster and hot strip mill. Recommended facilities for hot rolling and finishing processes are figured out in relation to the steel market analysis by product category. But those finishing facilities plans may be modified from time to time depending upon the market situation and the entrepreneur's strategy. A production flow image in 2011 is shown below.

Recommended Facilities for the Bang Saphan Steel Complex in 2011



3.4.5 Other Possibilities for Iron Making

In this Study construction of iron-making plants in Bang Saphan is recommended. But there are two other possibilities for procuring iron to feed electric arc furnaces, and these options should be carefully considered in the selection of an iron making technology.

a) Re-utilization of unused capacity of iron and steel making in Japan

Due to restructuring moves in Japan, there is a significant volume * of unused iron and steel making facilities which were substantially modernized enough in production efficiency and environmental protection. Some of those facilities could be economically reutilized through a joint venture or a long-term purchasing or tolling contract. This would be worthwhile to consider from the viewpoints of economy and environment.

b) Construction of DRI plant in foreign countries

Among DRI processes, the Midrex process will be the most established and reliable, if natural gas is available and cheap. Investment in the Midrex process in such country as Venezuela where natural gas costs only a fifth of the cost in Thailand and is abundant in iron ore, would be another possibility.

*Note: As of December 1995, it was reported that 13 blast furnaces were not in operation in Japan, whose total volume was 32,602 m³, equivalent to an annual iron making capacity of about 20 million tonnes.

4. INVESTMENT DEMAND IN THE BANG SAPHAN INDUSTRIAL ESTATE

4.1 Results of Investment Demand Survey

1) Questionnaire Survey Results

The Study Team conducted the questionnaire survey on the enterprises in Thailand, Japan, U.S.A, Taiwan and South Korea.

The number of questioned enterprises in each country is shown below.

Thailand	Japan	U.S.A	Taiwan	South Korea	Total
2,880	2,383	1,000	1,000	500	7,763

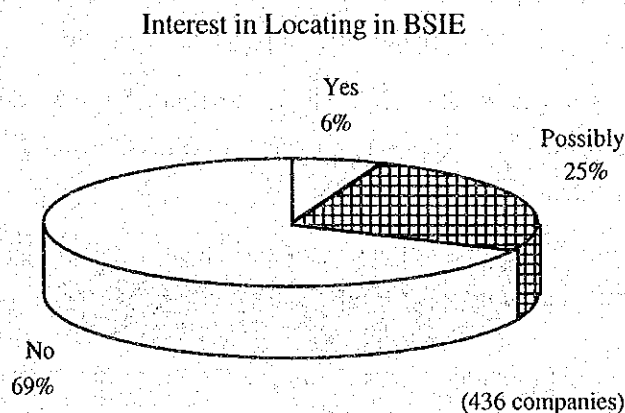
The major questions are the possibility to invest in Bang Saphan industrial estate as well as the required supporting facilities in the vicinity of the industrial estate. The questionnaire survey was conducted by interview in Thailand and by mail in the other counties (refer Appendix A.1 for details).

Rate of Response

Of a total of 7,763 enterprises approached, 901 firms replied, with a response rate of 11.6%.

The possibility to locate in the Bang Saphan Industrial Estate

Concerning the possibility of investment in the Bang Saphan industrial estate, 27 companies answered 'yes', a rate of 6% against 436 effective answers. 111 or 25% companies answered "possibly". Therefore 138 enterprises (31%) showed some interest in investment in the Bang Saphan industrial estate.



Of the total of 27 firms which replied "yes", 12 are Thai and 7 Japanese. If "yes" and "possibly" replies are combined, 43 Korean and 39 U.S. companies showed interest in investment in the Bang Saphan industrial estate.

By type of industry, 5 machinery firms and 4 rubber & plastic firms showed interest. Combined "yes" with "possibly", the industries showing keen interest in investment were machine industries such as machinery, electric machinery and transportation equipment and iron and steel industries such as basic metal and fabricated metal.

Outline of the investment

The dominant answer concerning expected land area for investment in Bang Saphan industrial estate was 10 - 19 rai followed by 5 - 9 rai, and 25 rai (40,000m²) was the average of 138 companies.

As for land price, 1.2 million Baht / rai - 1.6 million Baht / rai was the dominant answer. The average of 55 companies was about 1,684,000 Baht / rai (1,050 Baht / m²).

The expected number of employees of a new factory in Bang Saphan was assumed to be 100 - 299 by 34.8% of investors, followed by 30 - 99, by 24.6%. 4 companies, including 2 Thai companies answered "More than 1,000 employees". The average of 122 companies was 270 workers.

2) Interview Survey Results

Possibility to locate in the Bang Saphan Industrial Estate

To confirm the possibility of investment in the Bang Saphan industrial estate, the Study Team conducted interview surveys on the following three groups of companies.

- the companies which show interest in the Bang Saphan industrial estate in the questionnaire survey in Thailand (Group A : 23 companies)
- the companies which show interest in the Bang Saphan industrial estate in the questionnaire survey in Japan and have an affiliated company in Thailand (Group B : 3 companies)
- the companies belonging to the groups of industrial categories selected by the theoretical approach in 4.2 (Group C : 38 companies)

The interview form includes items to verify the intention of investment in the Bang Saphan industrial estate as well as to know the more concrete requirements for the industrial estate.

10 companies, or 38%, showed strong interest out of 26 enterprises (Group A and B).

Requirements for the Bang Saphan Industrial Estate

- A majority of enterprises wanted the appointment of free zones such as EPZ or FTZ which is useful for import and export. It takes a long time to receive the refund of the import tax and idle money of the tax is a heavy load to the running of the company.
- Sea access means to Eastern Seaboard is required by enterprises. The Eastern Seaboard is the center of manufacturing now and the relation with it is indispensable.
- There should be necessary facilities to encourage engineers to live in Bang Saphan. Engineers are likely to live in Bangkok because of lack of entertainment, high quality school, hospital, etc.

4.2 Promising Industrial Categories for Bang Saphan Industrial Estate

1) Procedure of Theoretical Selection of Industrial Categories

The Study Team selected the target industries to be invited to the Bang Saphan industrial estate from the viewpoint of industrial location theory by matching two factors; one is the location condition in Bang Saphan district, and the other is the location factors of industrial categories.

The major advantage of location condition in the Bang Saphan industrial estate is the availability of a deep sea port. Therefore the industries which use large vessels to carry in raw materials and/or out products should be suitable for this condition. For example, for iron & steel industries which depend on the import of raw materials such as coal, iron ore, etc., the proximity to a deep sea port is one of the crucial conditions for site selection. Export industries also prefer to locate in the vicinity of the sea port. In the near future automobile makers in Thailand should start exporting cars and expanding their factories. In this case some of them will have to scrap and build (S&B) of existing lots and some will have to relocate. The latter should select the area in the hinterland of the sea port. The Study Team identified those industries based on preference of the seashore location condition.

The next approach is examination of the industrial categories based on the Government Industrial Promotion Program. The selection of industries was conducted

based on the List of Activities Eligible for Investment Promotion by BOI (the BOI List). As mentioned above, the trend of FDI (Foreign Direct Investment) expanded to Zone 3, however enterprises tend to select the sites in the vicinity of Zones 1 and 2. Bang Saphan was felt 'far' from both markets and materials by business men operating near Bangkok. So the Study Team omitted the industries which are provided with incentives to locate in Zones 1 and 2, and selected industries which 'Must be located in Zone 3' from the BOI List. Industries selected by this screen corresponded to the location conditions such as seashore location, market oriented location, etc. in order to eliminate the unsuitable industries.

The final one is the selection based on the available local materials. In Prachuap Khiri Khan, the major industries are in the agriculture and fishery sectors, so industries based on raw materials from these sectors have possibility to locate. Some downstream industries related to the iron and steel industries prefer to locate in the vicinity of their material supplier.

The promising industrial categories were selected by the integration of the above three methods (refer to Appendix A.2 for details).

2) Selection of Port-Oriented Industries

The Study Team considered the industrial categories which enjoy the advantage of the seashore area as 'Port-oriented industrial categories'.

The port-oriented industries are characterized into the following 3 categories:

- Industries which need exclusive berths (narrow sense);
- Industries which enjoy the advantage of locating in the proximity of the port (broader sense);
- Industries which take advantage of forming 'Complex'.

165 types of industry are selected from the three categories mentioned above.

The Study Team assessed the amount of raw materials and products to be carried in and out by ship cargo. 14 industries are using ship cargo more than 50% for both carrying in and out and 52 industries depend on ship cargo more than 50% for carrying in or out. Thus, 66 industries are selected.

The Study Team selected prospective industrial categories from the results of the above approaches by using the following criteria.

- To mark the high rate both in reclamation area and in carrying in and out by ship

- The industrial categories which use ship cargo more than 50 % of the total

As a result, 70 types of industry were selected as the first prospective industrial categories.

3) Selection by Characteristics of the Bang Saphan Area

The Study Team selected the industries by matching location factors with the characteristics of the Bang Saphan area.

The major advantage of location condition in Bang Saphan is the existence of a deep sea port. However, Bang Saphan is located about 400 km (remotes point) far from the Bangkok Metropolitan Area.

The Study Team had to exclude or omit industrial categories which enjoy the location in a large city or its outskirts. As a result, 10 categories out of 70 are eliminated and 60 prospective industrial categories are selected.

4) Policy-Oriented Industries

Policy-oriented industries consist of two types; one is in the BOI List and the other is export-oriented industries. The industrialization policy adopted by the Government was to promote export-oriented industries until the early 1990s. The Government continues this policy and adds the policy of nurturing or promoting supporting industries. These industries aim at the domestic market.

The 1st step of selection stalled from eliminating industries which correspond to the following conditions:

- Industries provided with BOI incentives without condition in location
- Industries provided with BOI incentives in Zone '2 or 3'.

After elimination by the above criteria, the industries are screened by the location conditions in Bang Saphan area. Comparing the selected industries with export oriented industries, almost all the industries were found in both lists.

5) Selection of Resource-Oriented Industries.

One of the major industries in Prachuap Khiri Khan province is food processing as mentioned in the previous section. Industries using agricultural products as raw material are thought to be prospective industries: Canning of fruit and seafood, coir fiber, coconut furniture.

These resource-oriented industries are included in the previous selection of port-oriented and policy-oriented industries.

Iron and steel industries have already been located in Bang Saphan. These industries will expand and form a complex of iron & steel industries in the future.

6) Promising Industrial Categories

The target industries or the promising industrial categories are selected through the above approach and the result of the selection, which is the fundamental input for the planning of the Bang Saphan industrial estate, is shown in Table 4.1.

4.3 Industrial Development Demand in Bang Saphan

1) Macroeconomic Point of View

In the Western Seaboard Area (WSB region) including Bang Saphan District, NESDB conducted the projection of the regional economy in cooperation with the JICA Study Team (WSB Team) for the year 2001, 2006, and 2011. In this projection the GRP (Gross Regional Product) is estimated for three cases. The WSB estimates of the industrial sectors including mining, construction, electricity, and water supply are summarized in the following table.

GRP of Industrial Sectors in WSB in 2001, 2006, and 2011

	unit: million Baht, %						
	1994	2001	2006	2011	Annual Growth Rate		
					95-01	02-06	07-11
Low Case	48,985	88,403	134,776	205,474	8.8	8.8	8.8
Middle Case	48,985	122,575	197,408	296,833	14.0	10.0	8.5
High Case	48,985	122,575	246,541	434,490	14.0	15.0	12.0

Note: These figures are still under consideration, therefore subject to change.

Source: Working Paper of Macroeconomic Development Scenarios for WSB Region.

Based on these estimates, the Study Team projects GPP (Gross Provincial Product) of industrial origin in Prachuap Khiri Khan in 2001, 2006, and 2011.

The Low Case in the WSB estimates is assumed as the trend case, therefore, the development of the Bang Saphan Industrial Estate as well as that of other industrial estates in the WSB Region is excluded explicitly. Thus the Study Team adopted the Middle Case and High Case in the WSB estimates for the projection of GPP in Prachuap Khiri Khan. The assumptions of the projection are the following:

- i) The manufacturing industry ratio in GPP is assumed to be 80% (in 1994 this ratio was 70%).
- ii) During the period from 1995 to 2001 the other provinces included in the WSB Region will have a slightly more rapid growth compared with the Prachuap Khiri Khan.
- iii) During the period from 2002 to 2006 the growth of industries in Prachuap Khiri Khan will be more rapid compared with other provinces because of the development of the Bang Saphan Industrial Estate and iron & steel industries.
- iv) During the period from 2007 to 2011 the manufacturing sector in the Bang Saphan New Industrial City will be in full operation.

Based on the above assumptions and the WSB estimates, the Study Team conducted the projection of GPP of manufacturing sectors in the target years as shown in the following table.

GPP Manufacturing Sector in Prachuap Khiri Khan in 2001, 2006, and 2011

	1994a	2001	2006	2011	unit: million Baht, %		
					Annual Growth Rate		
					95-01	02-06	07-11
Scenario 1(Low)	6,661	18,162	37,400	67,314	18.2	15.5	12.5
Scenario 2(High)	6,661	18,162	42,485	87,182	18.2	18.5	15.5

Note: 1994a is an actual figure. In 2001, the estimates of both High and Low cases are same.

Source: The Study Team estimates.

Assuming that manufactured products in Bang Saphan will increase drastically and account for 60 - 90% of GPP as shown in the table below, the value-added derived from the Bang Saphan area (including the manufacturers in the Bang Saphan Industrial Estate and Iron and Steel Complex) was estimated. In the estimate, the configuration of the manufacturing sub-sectors identified in the preceding section is considered.

Percentage of GPP in Bang Saphan Area against Total GPP

	unit: %		
	2001	2006	2011
Scenario 1	60	75	80
Scenario 2	60	80	90

The value-added and development area for industrial use in the Bang Saphan area are set as follows.

(Scenario 1 ~ Scenario 2)

Year	Value-added (mill Baht)	Area (ha.)
2001	10,973	150.0
2006	27,519 ~ 33,169	352.8 ~ 445.4
2011	53,394 ~ 75,469	617.9 ~ 808.2

Source: The Study Team estimates.

2) Results of Questionnaire Survey and Interview Survey

a. Demand for Land Area in 2001

The Study Team identified that 10 of 63 companies might invest in the Bang Saphan Industrial Estate by 2001, according to the interview survey. The types of industry are as follows: Chemical 3; iron & steel 3; furniture 1; machinery 1; auto parts 1; and electrical machinery 1.

The average site demand per company is around 36 rai. The total area demand by 2001 is 360 rai or 57.6 hectares as shown below.

Type of industry	Need of Land area	Major product	The reason of interest							The requirement to I/E					
			1	2	3	4	5	6	7	1	2	3	4	5	
Chemical	60 rai	Pharmaceutical bulk	○		○	○	○			○	○		○		(1 million Baht/rai)
Chemical	150 rai	PX, PTA	○		○					○	○				
Chemical	5 rai	PVC, PP, ABS, PE			○			○					○		(2 million Baht/rai)
Furniture	5 rai	Wooden furniture	○					○		○					
Machinery	30 rai	Pump	○	○						○	○	○			
Auto Parts	20 rai	Bearings	○							○	○	○			
Electrical Machinery	10 rai	Electrical equipment	○	○		○				○	○	○			
Machinery	20 rai	Hoist	○	○	○					○		○			
Iron & Steel	20 rai	Steel Service	○	○										○	
Fabricated metal	40 rai	Steel Structure	○	○	○					○	○				
Total	360 rai	(57.6ha)	-	-	-	-	-	-	-	-	-	-	-	-	

1= Beside Deep seaport
 2= Near iron & steel industry
 3= In FTA
 4= In Zone 3
 5= In industrial estate
 6= Raw materials can be got from near area
 7= Sufficient land space

1= Good city life
 2= Easy access Eastern Seaboard
 3= Stable supply of raw materials
 4= Land price
 5= Nearby customers

The major reasons for companies' interest in locating in BSIE are i) to enjoy the advantage of the deep sea port, ii) to benefit from the FTA, and iii) to take advantage from the iron & steel industries. The main requirements for the industrial estate are to be equipped with urban facilities, to have easy access to the Eastern Seaboard, and to be supplied with qualified raw materials from the iron & steel complex on time.

b. Demand for Land Area in 2011

Based on the results of questionnaire survey and the expansion coefficient, equivalent to the reciprocal of the sampling ratio, total numbers of 'Yes' and 'Possibly' investors are estimated at 177 and 829 respectively as shown in the table below:

	No of Samples	Total Number	Expansion Coefficient	Replied Number		Expanded Number	
	a)	b) *	1/a)/b)	Yes	Possibly	Yes	Possibly
Taiwan	1,000	12,242	12.24	1	11	12	135
South Korea	500	3,926	7.85	4	39	31	306
USA	1,000	5,205	5.21	3	36	16	188
Japan	2,389	29,047	12.16	7	14	85	170
Subtotal	4,889	50,420		15	100	144	799
Thailand	2,888	7,999	2.77	12	11	33	30
Total	7,777	58,419		27	111	177	829

Source: * Taiwan: 1991 Taiwan-Fukien Census Report of Commerce and Service Industry, Republic of China
 Korea: Korea Business Consultancy
 USA: Dun & Bradstreet Directory
 Japan: 1991 Establishment Census of Japan
 Thailand: 1992 Industrial Survey

The confirmation rate of Thailand was acquired from the result of interview survey conducted in Thailand. The reason why the confirmation rate of "yes" is lower than that of "possibly" is thought to be that not a few companies saying "yes" had already determined the location for a new facility. The confirmation rate of four countries except for Thailand was estimated on the basis of the result of survey conducted in Japan.

	Thailand	Other Countries
Yes	25.0 %	34.3 %
Possibly	36.4 %	5.5 %

Source: The Study Team estimates

The Study Team estimated two cases; one is the High case of total companies with 'yes' and 'possibly', the other is the Low case of the number of companies belonging to 'yes'. Thai 'possibly' companies are also added to the Low case in consideration of the certainty for investment demand identified in the interview survey.

Seventy to 115 companies are expected to locate in the Bang Saphan industrial estate by 2011 as shown in the following table.

	Thailand	Other Countries	Total
Low Case	20 companies	50 companies	70 companies
High Case	20 companies	95 companies	115 companies

The average land demand per company is assumed to be 50,000m² from the results of questionnaire survey and interview survey. As a result, the demand of land area by 2011 is from 350 ha (2,188 rai) to 575 ha (3,594 rai).

	Companies	Land Area
Low Case	70 companies	350 ha (2,188 rai)
High Case	115 companies	575 ha (3,594 rai)

Source: The Study Team estimates.

3) Industrial Development Demand in the Bang Saphan Industrial Estate

In the estimates by the macroscopic approach, the land area includes that of existing and future expanding iron & steel industries. On the other hand, the estimates by the microscopic approach, or using questionnaire and interview survey approach, exclude the land area of iron and steel industries. The difference of estimates between the macro and micro approaches is caused by the treatment of the iron & steel industries. The land area derived from the macroscopic approach, not including iron and steel industries by 2001 and 2011 is projected to be 48 ha and 348 ~ 538 ha respectively. The land area calculated by the microscopic approach is 58 ha by 2001 and 350 ~ 575 ha by 2011. The difference between the two approaches is 10 ha in 2001 and 2 ~ 37 ha in 2011 and it can be said that the results of macro estimate and micro estimate almost coincide. Therefore, estimates of macroscopic approach is adopted as the industrial development demand in Bang Saphan industrial area.