4. STRATEGIES AND PROJECTS

4.1 PETROLEUM SUPPLY

After 1991, the country will increasingly suffer from imports of refined oil even with the planned expansion of oil refinery in Bangkok. According to PTT, the gross total oil demand will increase from 237,840 to 367,240 barrels per day during the period from 1983 to 2000. Out of this the net demand will be 211,510 in 1983 and 27,580 barrels per day in 1995, after deducting the oil demand planned to be replaced by other sources of energy including natural gas and lignite. The present capacity of oil refinery is 175,000 barrels per day of which 155,400 barrels are actually supplied in 1983. This supply is planned to increase up to as much as 197,950 barrels per day in 1995 with the plan to expand the existing refinery, with a result that oil product import will increase steadily from 56,070 to 73,630 barrels per day during the priod 1983 to 1995. As natural gas or lignite can replace mainly heavy oil, demand for light petroleum products should increase more rapidly.

The options are to expand the existing oil refineary in Bangkok further or to set up another oil refinery. We would like to take the latter option for several reasons, in addition to the reason that the Fifth National Enconomic and Social Department Plan proposes to expand and/or construct local oil refineries in accordance with the planned targets in order to increase refining capacity to satisfy local requirments. First, construction of an oil refinery outside the Bangkok Metropolitan Area helps decentralization of industries. Second, decentralized supply of energy is desirable from the security point of view. Third, natural gas is desired to be used in Bangkok Metropolitan Area and Eastern Seaboard. It is suitable for large scale and concentrated consumption because natural gas is rather difficult to transport and distribute to scattered and limited consumption market which local refinery could better meet with. Fourth, minimum capacity of an refinery is about 50,000 barrels per day and expected oil deficit at the national level in the 1990's sufficiently meets with this capacity as well as petroleum demand projected for the South.

Among other regions, the South, its west coast in particular, seems to be a candidate area for local refinery development. The South has been far and isolated from Bangkok. In 1981, oil accounted for 25 percent of the goods transported to the South or 82 percent of those by ships. As the South will be more developed and industrialized, oil transportation from Bangkok to the South will further increase. On the other hand, the western coast of the South has direct access to the Middle East capable of supplying the light crude oil which will be of more in need than heavy oil in Thailand.

Another consideration is that off-shore oil exploration has been envisaged in the Andaman Sea. As projected earlier, the oil demand will be more or less 60,000 barrels per day in the South and this amount is sufficient enough to justify an oil refinery.

Krabi seems to be a candidate site to set up an oil refinery because of its easy access to both the Middle East and various parts in the South, including Lower and the Upper South. It is also possible to consider the use of a part of heavy oil for thermal power generation. Phuket is another candidate for its deep seaport, but oil refinery there will certainly damage the natural environment for tourism. The timing of commissioning refinery is considered in 1995 at best in view of projected demand.

There exists a shadow on this proposal in view of international environment for oil productin and refinery capacity. In 1981 total world oil demand/production was 55.5 million barrels per day and the world refinery capacity was 81.4 million barrels per day. For Far East Region, the regional oil demand was 7.2 million barrels per day and refinery capacity was 8.4 million barrels per day in 1983. Therefore excess capacity in world refinery is apparent. In addition the movement of refinery from at consumer-end to producer-end is generally observed in view of retaining more value-added in oil producing countries.

Even though recognizing this international petroleum refinery market trend, with respect to the above merits we still recommend a grass roots refinery of 60,000 barrels capacity in 1995 with hydrocracker. In addition, the following points should be noticed.

- Less influence from the world trend; Currently crude oil demand in Thailand shares only 0.4 percent of the total world crude oil demand so that minimum impact on the world trend is expected.

- Needs for foreign exchange saving; If Thailand goes along the world trend of petroleum products imports, more burden on her balance of payments is envisaged in terms of increasing international transportation cost for diversified petroleum products logistics.

- Possiblity of early recovery of the refinery investment; Benefits derived from locating the refinery in the Upper South is measured in terms of decreased transportation cost for the South. In this regard, the pay-back period of this project is estimated at six years in a preliminary analysis, which also indicates pay back period of six years for usual econmic benefits (i.e., in terms of regional import substitution). Thus long-term trend of the world refinery market can be overcome by short-term strategy of refinery to be set up.

- This region will provide indigenous less expensive petroleum. The project is possible to supply stable and less expensive petroleum products which is a must for regional development. This project can also put the seed for broadening the econmic base for the Upper South.

In implementation of this project, the following salient issues gather due attention. There exists a problem of the marketing of petroleum products. Refined products are sold to the retailers, who have already established market shares currently, are under direct influence of international oil companies. The difficulty in penetrating into this distribution channelings requires assistance in the form of administrative guidances and petroleum policies on marketing and on refining. Further there is a possibility that the international oil companies behave so as to attain maximum utilization of their facilities. This may result in squeezing small capacity refinery. It is beyond the scope of the team to analyze this aspect of international oil companies behavior and world oil market with respect to production and distribution. Thus these are only raised here as exogenous issues.

With regard to LPG, there is an ongoing project to set up LPG depot in Surat Thani in view of ensuring availability of LPG by PTT. This project described in Section 3.3 should be completed as planned so as to ease the pressure of energy transformation from the traditional to commercial energy.

4.2 POWER DEVELOPMENT

In comparing the projection based on the our scenario with the current EGAT Power Development Program, due attention has to be given to the following points:

- Earlier implementation of Kaeng Krung Dam Project: This project is commissioned in June 1990, however, commissioning it in 1989, brings the firm supply to meet with the Upper South's demand as well as irrigation needs.

- An additional capacity of 100 MW to the existing program for the Upper South by the year 2000: In considering the power demand and energy demand in the year 2000, an additional power development project of 100 MW capacity is necessary to satisfy the demand in the Upper South at around 1997. Availability of natural gas at this stage will decide the type of power plant for this project.

- An additional capacity of 171 MW for Region 3 demand by the year 2000: EGAT plans New Krabi No. 3 Lignite Fired Plant of 75 MW capacity in 1992 and a coal fired plant of 150 MW capacity in 1993. However, assuming continued growth of the power energy demand at 5.7 percent per annum (the growth rate projected for 1991 to 96 period by EGAT for the Region 3) in the Region 3, an additional power demand generating capacity of 171 MW to the above two projects has to be recognized. Thus, with the Upper South demand of 100 MW, the generating capacity of 272 MW in the Region 3 in excess of the planned power development by EGAT (South as a whole) is required.

- Strengthening the grid system: Since Krabi is planned to be electricity supply center with the total capacity of 225 MW with three lignite fired plants, the existing transmission line of 115 KV should be changed to 230 KV. Another recommedation is a tie line of 115 KV double circuit line between Krabi and Thung Song foreseeing the electricity transmission to Surat Thani.

In the field of power generation, as seen on the Figure 4.1 the the Upper South holds 82 percent of the planned total generating capacity of the Region 3 (the whole South). Therefore, as one of development strategies, it is recommended to make the Upper South as an electric power center by locating the 272 MW generating capacity to satisfy the projected power requirement in excess of EGAT Plan.

As has been planned by EGAT, the reliance on imported coal as primary energy source for generation is envisaged to increase in view of depletion of lignite resources in Krabi. Although a careful investigation of hydro potential and of natural gas availability in the entire Region 3 contrives the capacity of coal fired plant, the need for coal as primary energy for power in the late 1990s does exist. Thus, we recommend the plan to set up coal center in Krabi, utilizing abandoned open pit of lignite and technologies accumlated in handling lignite.

We also recommends to add the scope of imported coal utilization to the Krabi No. 2 and No. 3 Projects.

Our latest meeting with EGAT adds little adjustment on this recommendation. EGAT has made a revision on its Region 3 electricity demand forecast, which is almost same as our projection. We recommended 272 MW power development over the EGAT's 1982 forecast. Under the new forecast of EGAT, this additional power requirement has been covered (see Table 3.16). In power development, EGAT's latest plan will satisfy additional electricity demend derived from the Upper South develop-

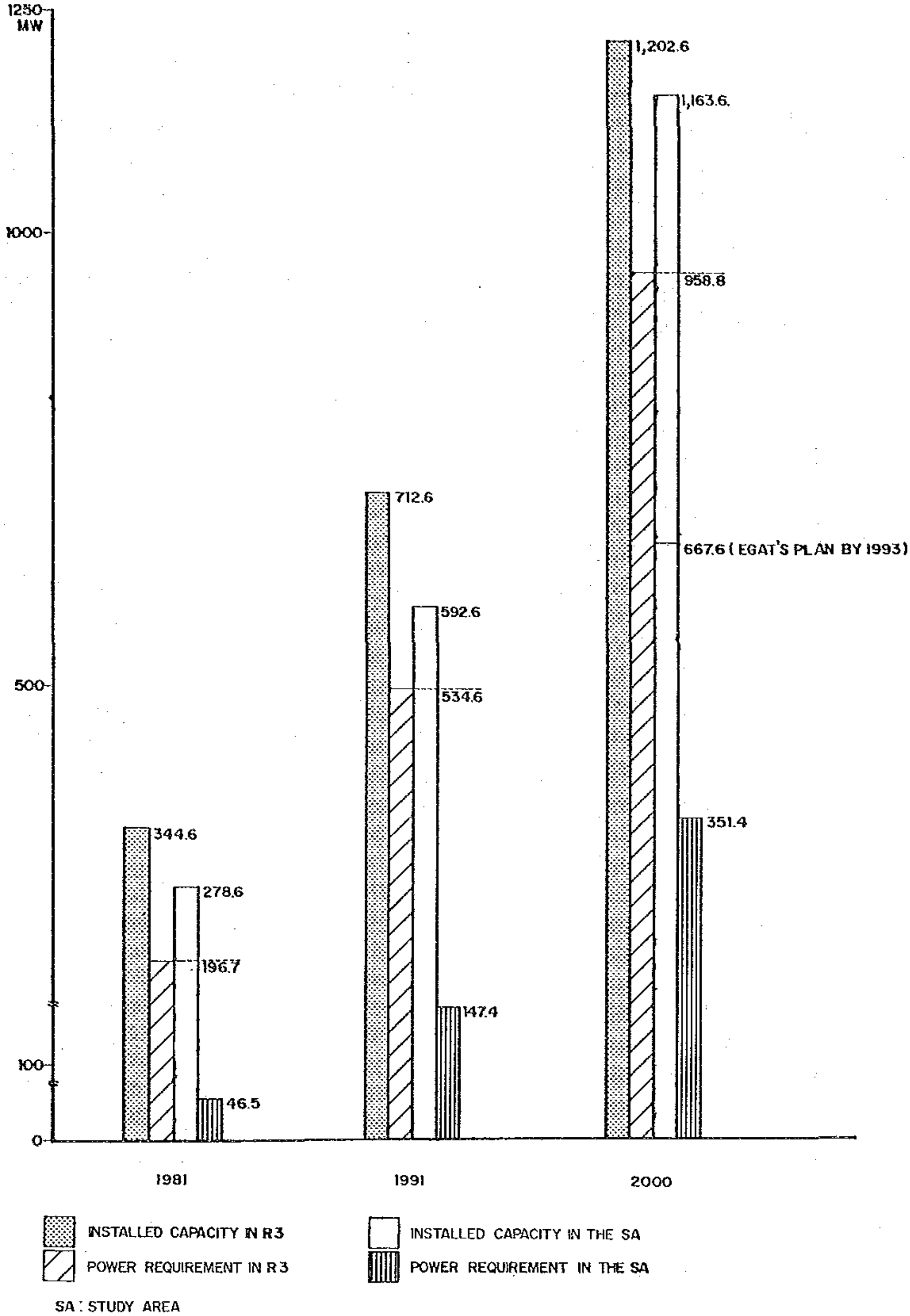


Fig. 4.1 INSTALLED CAPACITY AND PEAK POWER REQUIREMENTS OF UPPER SOUTH AND REGION 3 (SOUTH)

ment programs. Thus it is recommended to implement the plan as scheduled. The main power development plan under the new forecast is imported coal fired power plant of 300 MW capacity from previous 150 MW due to the increased demand and results of re-appraisal of Krabi lignite reserve. In this instance, envisaging 800 thousands ton of coal required annually for this power development plan, a study on imported coal center is strongly recommended in relation to imported coal requirement for Eastern Seaboard Power Projects as well as best thermal power plant option to meet with additional power demand presuming the availability of natural gas.

There exist several major projects related to electricity power development in the Upper South as follows:

1) Intertransfer of Electricity with Malaysia

Foreseeing the possibility of electric power shortage, EGAT plans to practice the agreement on intertransfer of electricity with National Electric Board of Malaysia. This agreement has been in practice since 1971 and in last year the net import of electric power from NEB was 31 GWh (three percent of Region 3 energy generation). A problem associated with this intertransfer of electric power is a large swing of voltage in Malaysian side. Thus EGAT, considering the shortfall of power in the period of 1984 to 1987, may have to carry on the project to set up a voltage stabilization substation. This recommendation has been started.

2) Khanom Expansion Plan

Currently the planned expansion of Khanom Barge Plant (3 x 300 MW) is put aside due to the ambiguity of natural gas reserve in Erawan and slow pace of negotiation of natural gas development plan between Petroleum Authority of Thailand (PTT) and Texas Pacific Oil Co.. Originally the plan called for the natural gas pipeline from Union field to Khanom envisaging the pipeline extension to Bangkok. This on-shore pipeline scheme holds the following constraints.

- The unsettled contract with Texas Pacific
  Due to the current oil market glut, Texas Pacific adopts the attitude of waiting till oil price rises again so as to sell their natural gas with premium.

- 1,000 kilometers long on-shore pipeline to Bangkok: Present pipeline goes through 425 kilometers off-shore and 150 kilometers on-shore. EGAT's view is that another off-shore pipeline in parallel to the existing one might be much easier in terms of investment and land clearance.

- Slow natural gas utilization plan actualization:
  Original projected natural gas demand and supply of 600 MMSCFD by 1986, and 1,000 MMSCFD by 1991, by PTT, with the unsatisfactory Union oil gas supply (150 MMSCFD against the supply contract of 250 MMSCFD in 1983), and slow pace of downstream plants construction postpone the need for another gas pipeline. However the most updated development tends to favour the Khanom Expansion Plan. For our stance on this project, please see Section 2.3.

- Current pipeline has a capacity of 750 MMSCFD and is able to be boosted up to 1,000 MMSCFD.

Considering the possibility of new natural gas discovery in on-shore, the world oil market in which oil glut may disappear in latter part of the 1980s and the domestic fuel demand along with Eastern Seaboard project progress, we feel that the pipeline to Khanom will not be in real discussion for the time being. (see Section.2.3)

3) Krabi Lignite Project

Current capacity of lignite-fired power plant in Krabi is 60 MW (20 MW x 3 units). Proven lignite reserve at Krabi was estimated at seven million tons but by the result of recently carried out exploration survey (1982/83), the proven reserve increased to 30 million tons. EGAT estimates that this reserve provides fuel source for 225 MW capacity power plant for 25 years. EGAT plans to set up three units of 75 MW capacity lignite-fired power plant at Krabi. Again by EGAT the latest conclusion on economically recoverable reserves is reached at 12 million tons. Thus the new scheme is changed to construct two units of 150 MW capacity imported coal fired plant and 75 MW lignite fired plant instead.

4) Chiew Larn Hydro Project

This dam is located at Khao Pang, Amphoe Ban Ta Khun, with the feature of 95 meter height, 700 meter crest length, 100 meter crest elevation and 95 meters of normal water elevation. This dam holds five associated dams. The reservoir capacity is 5,640 million cubic meters with average water utilization volume of 97 cubic meters per second. The generation capacity is 240 MW (80 MW x 3 = 240 MW) and also this dam envisages to benefit irrigation of 100,000 rai.

With these power development programs the current power generation capacity of 374.6 MW will increase to 569 MW by 1993 when annual average electricity demand growth rate of 10 percent per year is assumed.

Besides the above, the rural electrification programs are ongoing under the responsibility of PEA. They are:

1) Accelerated Rural Eelectrification Projects Second Stage (ARE II)

Succeeding to ARE I which electrified 5,213 villages in 27 provinces in Northeast of Thailand, ARE II accelerates electrification of 7,878 villages in South Thailand. An average of 320 villages of electrification for each project province is to be implemented by connecting PEA's 33 KV and 22 KV main distribution line to EGAT's supply substations and at the customer ends, connecting to the 400V and 230V service distribution lines. In total this ARE II is expected to benefit five million people living in rural area of Thailand.

2) Normal Rural Electrification Project (NREP)

NREP differs from ARE II in contribution-in-aid character for electrification. The village requesting electrification sooner than PEA's several ongoning village electrification projects, has to contribute about 25 to 30 percent of the total investment cost such as electric poles, cross arms and half of labour. This NREP covers 5,800 villages.

3) Tambon Electrification Program (TEP)

This project started in 1979 and has been scheduled to electrify 4,692 villages of which 2,243 are tambons and 2,449 are adjacent villages, by 1984.

4) The Power Distribution System Reinforcement Project Third Stage (PSR III)

Objective of this PSR III is to replenish more electricity and to improve quality of services for the present and potential consumers (especially in the industrial and commercial sectors in the project area). Thus, the system reliability in terms of share loads among adjacent substations and remedying excessive voltage drop and losses are put main focus.

PSR III's scope of work seizes construction and/or reinforcement of distribution systems connected to 56 substations of EGAT in the areas where energy consumption has grown faster than existing distribution system capacity.

The Upper South is located in Southern Region 2, a PEA's service region and PSR III covers the substation distribution systems in the Upper South, namely, Phuket 1, Phuket 2 which will be constructed by EGAT, Phun Phin and Krabi.

Although the progress of ARE II is enormous, the completion date for the ARE II program is expected to be delayed till 1987 due to the extensive scale of the project.

Taking into account these existing and ongoing projects/programs, the followings are recommended in terms of electricity development strategy.

- The electricity supply in quantity and quality is so crucial for supporting the expected industrialization so that these projects should be implemented on scheduled time as much as possible so as to cope with the consumption demand of about 1,500 Gwh or the peak demand of 250 MW in the Upper South in 2000.

- In this context, the rural electrification should be simultaneously accelerated with great effort by PEA. At least 90 percent of whole households is recommended to be served with electric power in 2000. For the achievement of this target, the Power Distribution System Reinforcement Project Third Stage (PSR III) and the Tambon Electrification Programme (TEP) should be aggressively promoted and coordinated.

4.3 TRADITIONAL ENERGY

The Upper South is endowed with rich agricultural resources. In order to maximize this advantage in view of easing energy transformation from traditional fuel to commercial energy, we have already recommended several programs as seen earlier in Section 3.3.

In respect to restructuring economic structure as energy efficient one, palm oil project provides bright future because of its energy self-recycling system, which just fits to the goal of agricultural development being "sustaining land capability".

The current agricultural practice heavily depends on energy use. The production cycle is formed in the manner of plant breeding - petrochemical fertilizer - petrochemical pesticide - irrigation - mechanization, and lack of any part of this chain fails to move the system. Thus the project recommended in agriculture is also pursued strongly in view of self-recycling energy system.

Industrial program has also incorporated the shortage of traditional energy resources so that required value-added in manufacturing sector will be produced in a manner of bringing up the value-added in resource-oriented manufacturing and setting up other manufacturing utilizing strategic advantage of the Upper South to serve regional domestic and international market.

Direct recommendation for traditional energy development is as has been proposed already in land use section, primary and secondary forestry management programs. Another recommendation is to carry out survey on mangrove forest with reference to its endowments and annual production volume to attain sustainable yields of the forests so as to attain mangrove forest utilization in view of easing the energy transition from traditional to commercial energy.

Besides the above projects, the strategy described in Sec. 3.3.4 i.e. charcoal for export in envisaging higher prices and its unique use, should be explored further in agencies concerned .

5. OIL REFINERY DEVELOPMENT

5.1 STUDY BACKGROUND

The effort poured forth in the course of the study was to seize the energy supply/demand pattern in the Upper South, in view of formation of energy projects which would bring economic efficiencies to the development. However, in the field of petroleum, the projected pertroleum demand of about 24,000 BPD in the year 2000 in the Upper South alone, does not lead to any able solutions in the above regard.

While carrying out the energy study, it has pointed out that the high petroleum product prices relative to the prices in Bangkok prevail in the Upper South and also in the whole of the South, portending stress on the promotion of industrialization. Currently on average, the prices in the South are set 40 satang higher than those in Bangkok in every type of petroleum product reflecting product replenishment costs. In addition, the previous study has estimated the petroleum demand in the whole of the South at 65,000 BPD in the year 2000.

These two points together open up a new path for an energy oriented development scheme in the Upper South in line with the issues at the national level as to how to cope with the increasing petroleum product demand and the problem of petroleum products imbalance (i.e., strong trend of petroleum product imports over domestic supply). The scheme of a new refinery for the South thus necessarily has direct link with the national policy on new refinery capacity in this country. To answer the viability of the refinery in the South in this perspective is far from the scope of this study, since key assumptions necessary to carry out such a study are subject to large alternations, when envisaging introduction of national guidelines on firstly the ramification in petroleum product pricing policy to remedy product imbalances in the near future, secondly unclear national gas production schedule (however, this aspect has been extensively discussed in Section 2.3 "Utilization of Natural Gas in the South"), thirdly the still uncertain expansion and modification plan for the existing domestic refinery capacity. Nevertheless these national issues are disscussed here to the extent of providing fundamental reasons for setting up a new refinery in the South.

In these instances in addition to the long term nature of timing of the project implementation, the study here directs the attention to viability of the project in terms of locational advantage of the Upper South so as to provide judgemental criteria in formulation of national policy on the additional refinery capacity in the country as well as appraising one of the core projects for the Upper South regional master plan, rather than to seek feasibility of the project in commonly practiced way.

5.2 PETROLEUM PRDUCTS BALANCES AND REGIONAL PRICE DISPARITY

5.2.1 Petroleum Products Balances

With the current capacity of the refineries, or even with their expansion plans, Thailand will suffer from the increasing burden of importing petroleum products.

The total petroleum product demand for the year 1990 is estimated by SIAM II at 233 Thousand Barrles Per Day (KBPD) assuming natural gas supply of 985 Million Standard Cubic Feet Per Day (MMSCFD), by PTT total petroleum product demand at 242 KBPD with 500 MMSCFD natural availability, and by our team at 286 KBPD with 500 MMSCFD of natural gas supply.

The total petroleum product yielding capacity of Thailand would be 220 KBPD (256 KBPD of design capacity) in 1990 assuming completion of debottle-necking program of ESSO and Bangkok and expansion plan of Thai Oil Refining Corporation (TORC).

Thus a demand-supply difference in the petroleum product shall fall in the range of 13 to 56 KBPD in 1990 depending on the assumption of natural gas availability. In the year 2000, the difference will be widened and reach to the range of 77 to 95 KBPD assuming the natural gas supply of 1,200 to 1,660 MMSCFD (see Table 5.1).

As long as Thai economy grows at six percent per annum until 1990 and thereafter at 4.8 percent toward the year 2000 as SIAM II study suggests, it is certain that the petroleum product demand will increase, unless some drastic changes would be introduced in pricing structure for petroleum products.

1) Forcussing individual petroleum product further, provided particularly with continuation of the current pricing structure with completion of planned expansion and modification plan as well as increased domestic production of LPG from the advent of the gas separation plant, the future petroleum products imbalances are apparent and they are summarized as follows :

- The biggest persistent deficit exists in diesel and this deficit dominates the import structure of total petroleum products;

Table 5.1 HYDROCARBON ENERGY DEMAND ESTIMATES BY THAI AGENCIES

Unit: 1000 barrels/day of crude oil equipment

	1990			1995		2000	
	TUSP	PTT	SIAM II	NEA	PTT	TUSP	SIAM II
Total Hydrocarbon Demand	373	329	403	304	393	522	582
Petroleum Demand	286	242	233	180	272	315	297
Domestic Crude 1/	(40) 1/		(40) 1/			(60)	(60) 2/
Natural Gas in KBPD	87	87	170	124	121	207	285
NG Demand in MMSCFD	(500)	(500)	(985)	(720)	(720)	(1200)	(1658)
Total Energy Demand			551	470			857

1/ Total of condensate from NG fields plus Shirikit crude. 20,000 BPD is assumed currently for domestic crude production however, maximum production of Shell field may go up to 40,000 BPD for 5 to 6 years.

2/ If the supply of domestic crude is limitted to 40 KBPD, then Siam II's NG Demand increases accordingly and the amount would be 232 MMSCFD

Source: The Team

- For fuel oil the current deficit continues steadily. However after 1990 the deficit will be reduced due to expected natural gas peak production of 1,000 to 1,200 MMSCFD during 1990 to 2000 period. (see Section 2.3 on the Natural Gas Production Scenario);

- Kerosene demand including aviation gas continues to exceed over domestic supply but by least margin in comparison to the other petroleum product balances of deficits;

- The gas separation plant eases the LPG balance in the mid 1980s, however domestic demand surpasses the LPG supply toward the year 2000 even assuming the Second Phase of Eastern Seaboard Development of doubling the separation plant capacity; and

- Projected gasoline demand shows a wide variation among available forecasts. In contrast to the other projections, our projection gasoline shows second largest product imbalances during 1990 to 2000 period.

2) As background data for reaching petroleum products imbalances and for seizing the impact of the imbalance, Tables 5.2 through Table 5.5 are prepared.

Table 5.2 shows the records of petroleum product consumption, refinery production and imports in Thailand, and Table 5.3 illustrates the impact of crude and petroleum products imports over national trade. The main points to be noted from these tables are:

- Diesel oil import dominates the petroleum product imports and accounted nearly 50 percent in 1982;

- The volume of diesel import climbed up latter part of the 1970s and exceeded the output of all the refineries in Thailand in 1982; and

- Petroleum import both products and crude oil accounted over 20 percent of the total commodity imports for last five years and occupied 30 to 44 percent of total commodity exports. Thus this has been giving burden on the balance of payment.

Table 5.4 illustrates the planned average charge rate of the capacity and the product slate for refineries in Thailand in 1989, when all the expansion and modification plans would be completed. These modification and added capacities indicate the probable increase of 45 percent in average charge rate (feed capacity) and 47 percent in product outputs during 1983 to 1989 period with the average crude stream factor of 0.91 and refinery fuel loss of 3.3 percent in volume of the charge rate, while design capacity increases 37 percent from 187 KBPSD(on per stream day basis) in 1982 to 256 KBPSD. Thus the high operation efficiences and lower fuel loss are assumed to be achieved at all refineries with completion of their plans, which are targeted to meet the future petroleum product demand pattern.

Table 5.5 presents petroleum products demand in Thailand, the South and the Upper South estimated by the team. Current consumption pattern dominated by diesel and fuel oil is expected to continue under assumptions to be described succeedingly. The table does not show natural gas substitution, however, in preparation of Figure 5.1 through Figure 5.5 the subsitution by natural gas in LPG production and in fuel oil consumption by total amount equivalent to 127.5 KBPCD (on per calendar day basis) in 1991 and 140.2 KBPCD in 2000 is assumed based on Our scenario of the natural gas substitution discussed in Section 2.3 of this chapter.

Table 5.2 PETROLEUM PRODUCTS CONSUMPTION, REFINERY PRODUCTION AND IMPORTS

Unit: million liters

		1974	1975	1976	1977	1978	1979	1980	1981	1982
LPG	Consumption	161	194	223	244	277	327	367	475	620
	Production	189	197	223	240	218	251	232	244	194
	Imports	0	1	0	4	59	76	135	231	426
Gasoline	Consumption	1,606	1,763	1,963	2,183	2,307	2,323	2,290	2,101	2,002
	Production	1,623	1,734	1,903	2,118	2,058	2,117	1,828	1,822	1,982
	Imports	42	65	60	64	249	205	462	279	20
Diesel Oil	Consumption	2,955	2,867	3,357	3,730	3,926	4,411	4,374	3,927	4,010
	Production	2,033	2,171	2,547	2,799	2,576	2,772	2,794	2,751	2,845
	Imports	953	702	810	930	1,350	1,639	1,580	1,176	1,165
Kerosene	Consumption	241	206	294	285	266	340	300	391	428
	Production	285	245	293	281	262	319	293	353	361
	Imports	1	1	2	4	4	21	7	38	67
Jet Fuel	Consumption	714	835	855	763	786	869	959	1,008	1,054
	Production	672	815	840	752	755	782	777	925	949
	Imports	46	22	15	11	11	87	182	83	105
Fuel Oil	Consumption	2,536	2,648	2,924	3,529	3,977	3,972	4,714	3,939	3,001
	Production	2,537	2,630	2,588	2,839	3,125	3,488	2,514	2,626	2,369
	Imports	0	19	336	690	853	484	2,200	1,313	632
Total	Consumption	8,212	8,513	9,616	10,734	11,539	12,242	13,005	12,842	11,113
	Production	7,338	7,792	8,394	9,031	8,995	9,729	8,438	8,722	8,698
	Imports	1,042	810	1,223	1,703	2,545	2,513	4,567	3,120	2,415
						22%	20.5%	35.1%	24.3%	21.7%

Note : Actural data furnished from NEA show statisitcal discrepancies from 1980 to 1982. These are mainly due to stock figures and the data collection method where production data are gathered from Excise Department, Import data from Customs Department and Consumption data from oil companies.

For 1974 and 1975 figures, there were exports of petroleum products. The export amounts of each petroleum product can be obtain as a difference between Production plus Imports minus Consumption. After 1975 there was no record of petroleum product exports.

Source : NEA

Table 5.3 CIF VALUE OF PETROLEUM PRODUCTS AND CRUDE OIL IMPORTS

Unit: million baht

	Petroleum Products	Crude Oil	Total	Impact of Oil import (1)	(2)
1978	4,989.7 (23.5)	16,221.9 (76.5)	21,211.6	19.84	26.0
1979	7,844.4 (24.7)	23,855.3 (75.3)	31,699.7	22.0	30.0
1980	18,434.7 (31.8)	39,598.5 (68.2)	58,033.2	30.0	44.0
1981	15,584.0 (24.8)	47,256.1 (75.2)	62,840.1	29.0	41.3
1982	13,232.9 (22.7)	44,972.9 (77.3)	58,205.8	30.0	37.6

Note : Figures in ( ) are percentage to the total value of petroleum imports.
(1) Net Oil Imports/total Commodities Import
(2) Net Oil Imports/total Commodities Export

Source : NEA

Table 5.4 FEED CAPACITY AND PETROLEUM PRODUCT SLATE FOR OIL REFINERIES IN THAILAND IN 1989

Unit: 1000 barrels/day

Refinery / Product Slate	FANG	BANG CHAK[1]	ESSO[2]	TORC[3]	TOTAL[4]	1982 Actual[9] Production	1982 Actual[9] Consumption	1982 Actual[9] Imports
LPG	-	1.5 (2.3)	2.7 (4.3)	1.7 (1.7)	5.9 (2.6)	3.3 (1.9)	10.4 (5.5)	7.3 (17.5)
Gasoline Regular								
Premium	.04	13.4 (20.6)	11.4 (18.2)	22.0 (21.5)	46.8 (20.3)	34.2 (19.4)	34.7 (18.3)	.3 (0.7)
Kerosene Jet Fuel	-							
Kerosene	-	6.5 (10.0)	7.9 (12.6)	18.6 (18.1)	33.0 (14.3)	22.6 (12.8)	25.3 (13.3)	3.0 (7.2)
High Speed Diesel[8]	.15	18.3 (28.2)	19.0 (30.3)	41.4 (40.4)	78.7 (34.2)	49.0 (27.8)	67.7 (35.7)	20.1 (48.3)
Fuel Oil	.31	22.7[5] (34.9)	18.4[6] (29.4)	14.7 (14.3)	30.8[7] [55.8] (13.4)	40.8 (23.2)	51.6 (27.2)	10.9 (26.2)
Bitumen	-	-	1.9 (3.0)	0.8 (0.8)	2.7 (1.2)	2.1 (1.2)	-	-
Product Total	.50	62.4 (96.0)	61.3 (97.9)	99.2 (96.8)	197.9[7] [222.9] (96.9)	152.0 (86.4)	189.7	41.6
Feed Capacity	1.00	65.0	62.6	102.5	230.1	176.0[10] [159.0]	-	-
Design Capicity	112	78.0	67.0	112.0	256.0	187.0	-	-

Note :
1/ Assume its completion of Debottlenecking/rehabilitation program by W/B by 1987
2/ Assuming expansion/renovation program is completed by 1985
3/ Assume completion of its two phases' expansion plan by 1989
4/ Total exclude marginal FANG capacity
5/ This entire amount is fed to TORC
6/ The 2.3 KBPD out of 18.4 KBPD is fed to TORC
7/ Exclude the fuel oil feed from BANG CHAK & ESSO. If it is included, the total fuel oil production would be 55.8 KBPD and product total would be 222.9 KBPD
8/ Low speed diesel occupies only 1.3% of the total diesel consumption
9/ Production figures from Excise Department for consumption from oil companies, and for Import from Customs Department. Thus the statistical discrepancies exist, however, most of them are related to stock levels.
10/ Total feed in 1982
11/ KBPD-1,000 barrels per calendar day
12/ Figures in parenthesis are percentages.

Source : PTT

Table 5.5 PETROLUEM PRODUCTS DEMAND IN THAILAND AND UPPER SOUTH BEFORE REPLACEMENT BY NATURAL GAS

Unit: KBPD

	1980	1991	2000	Growth Rate(%) 80/1991	80/2000
Gasoline					
National	36.21 (17.4%)	73.60 (19.7%)	99.90 (19.1%)	6.6	5.2
South	3.87 (23.7%)	7.83 (20.2%)	12.94 (19.6%)	6.6	6.2
Upper South	1.20 (17.0%)	2.55 (19.8%)	4.76 (19.1%)	7.1	7.1
Diesel					
National	75.37 (36.1%)	122.69 (32.9%)	165.78 (31.7%)	4.5	4.0
South	10.15 (62.3%)	18.30 (47.1%)	27.14 (41.2%)	5.5	5.0
Upper South	4.60 (65.2%)	7.68 (59.7%)	12.69 (50.9%)	4.8	5.2
Kerosene	(5.17)	(8.17)	(1.17)		
National	21.69 (10.4%)	37.29 (10.0%)	43.08 (8.3%)	4.2	3.9
South	0.71 (4.4%)	0.94 (2.4%)	1.72 (2.6%)	2.6	4.8
Upper South	0.045(0.6%)	0.096(0.8%)	0.130(0.5%)	7.1	5.4
Fuel Oil					
National	69.00 (33.1%)	114.71 (30.8%)	162.21 (31.1%)	4.7	4.4
South	1.05 (6.4%)	9.29 (23.9%)	16.38 (24.9%)	-	6.5
Upper South	1.11 (15.7%)	3.01 (16.6%)	5.89 (23.6%)	6.1	8.3
LPG					
National	6.32 (3.0%)	24.40 (6.5%)	51.38 (9.8%)	13.1	11.3
South	0.52 (3.2%)	2.47 (6.4%)	7.74 (11.7%)	15.1	14.4
Upper South	0.10 (1.4%)	0.42 (3.3%)	1.45 (5.8%)	13.5	14.0
Total					
National	208.59	372.69	522.35	5.4	4.6
South	16.3	38.83	65.92	8.2	6.3
Upper South	7.05	13.75	24.92	5.6	6.5

Source: The Team

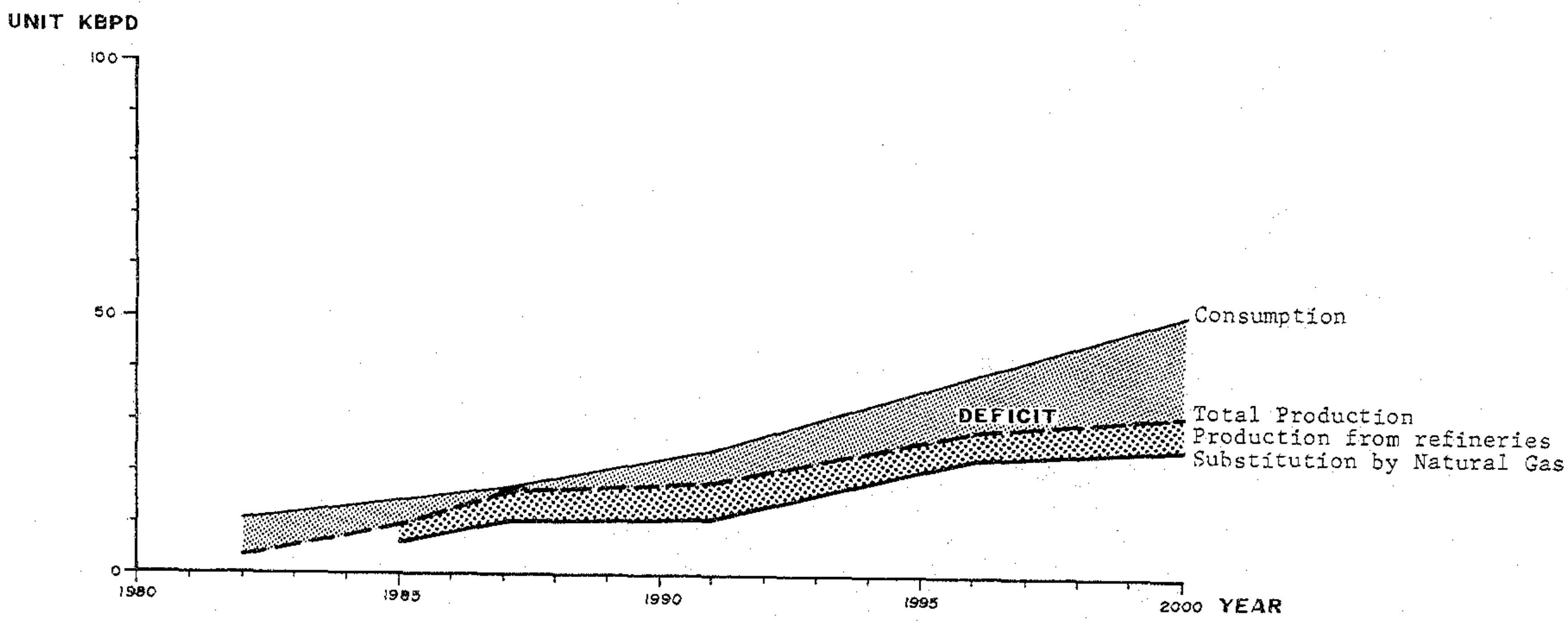


Fig. 5.1 LPG BALANCE

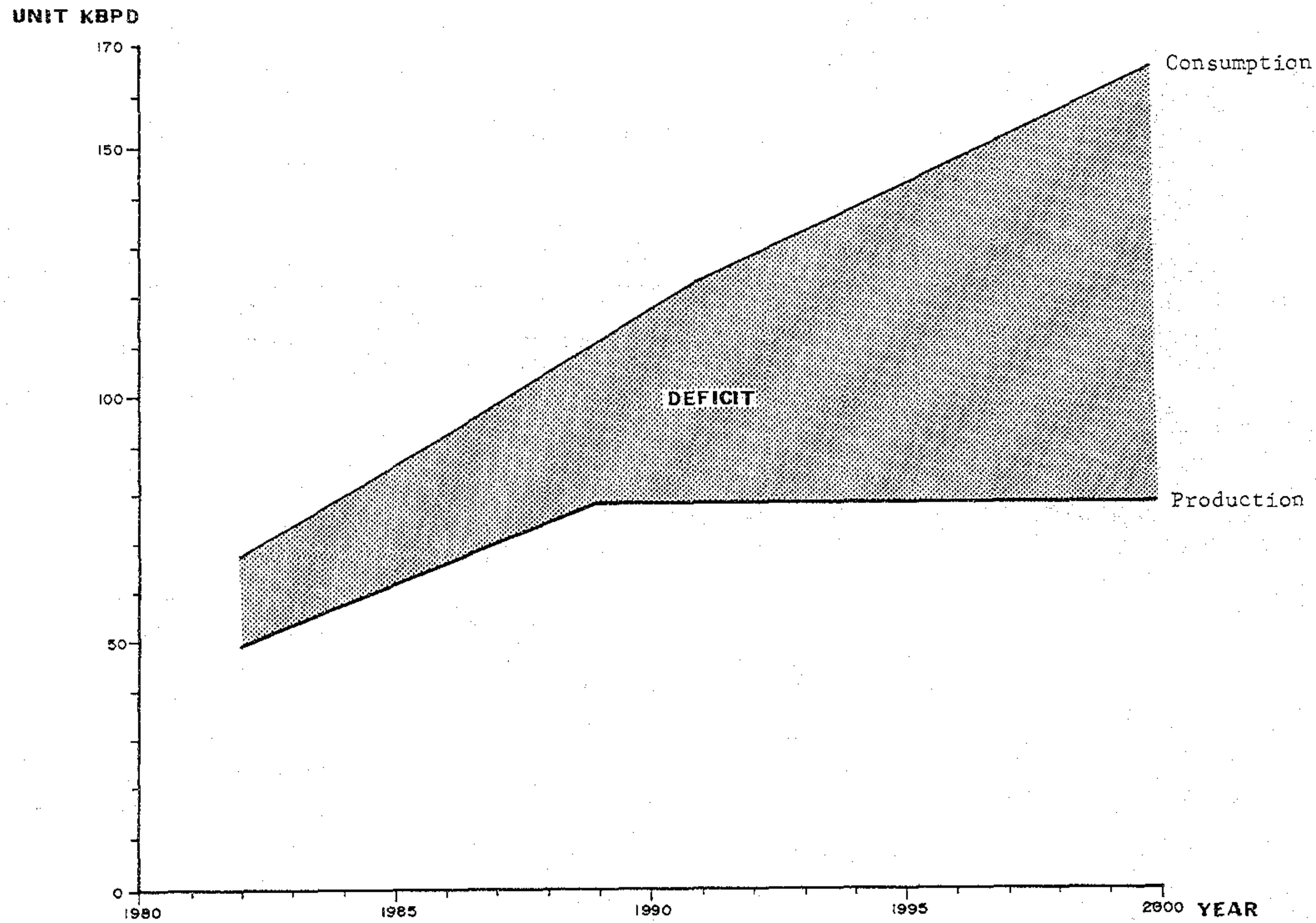


Fig. 5.2 DIESEL BALANCE

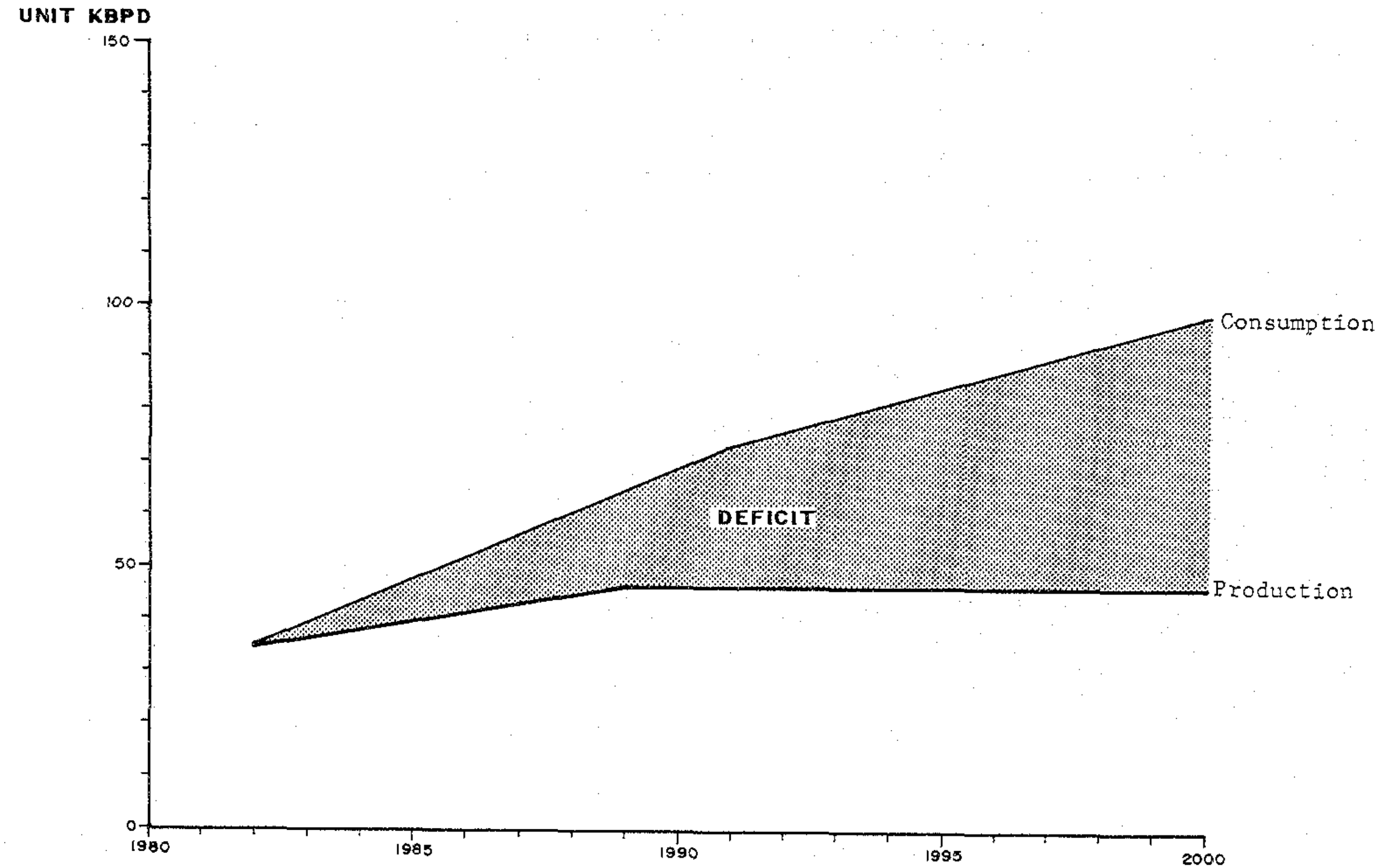


Fig. 5.3 GASOLINE BALANCE

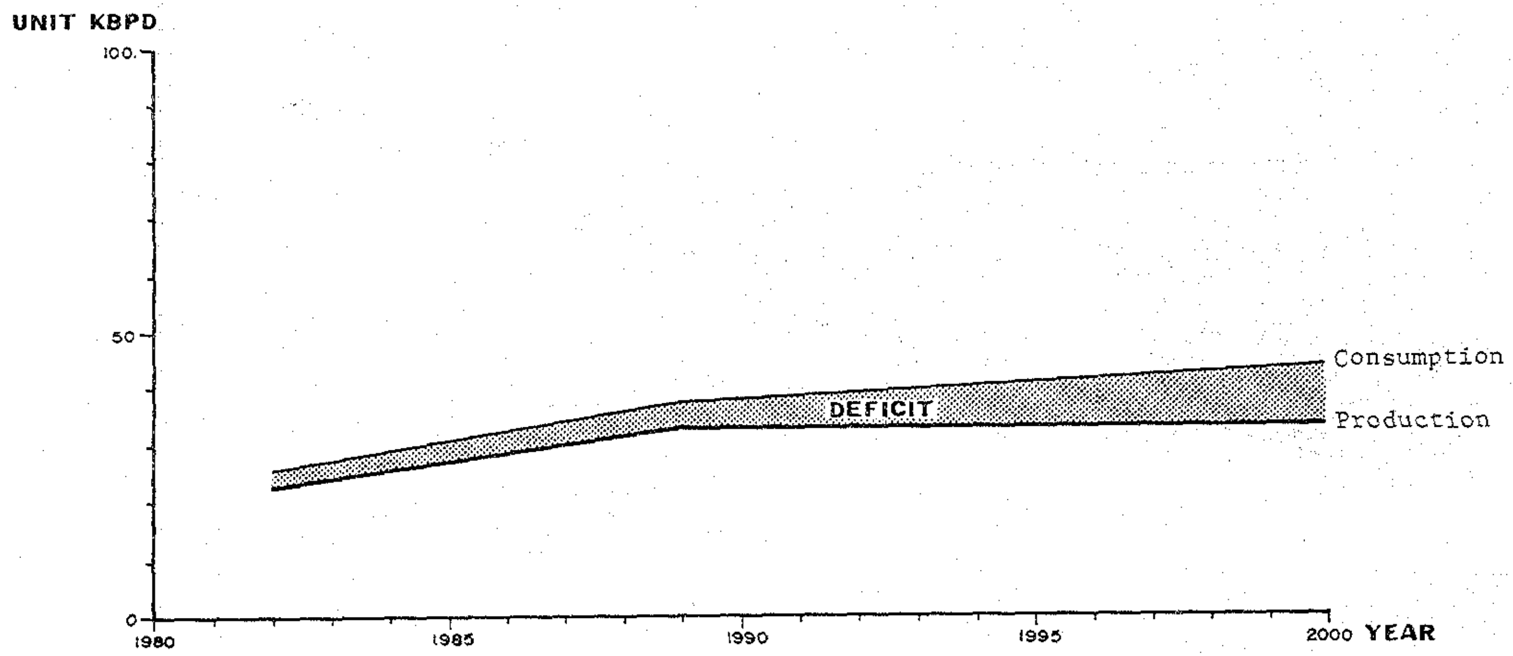


Fig. 5.4 KEROSENE AND JET FUEL BALANCE

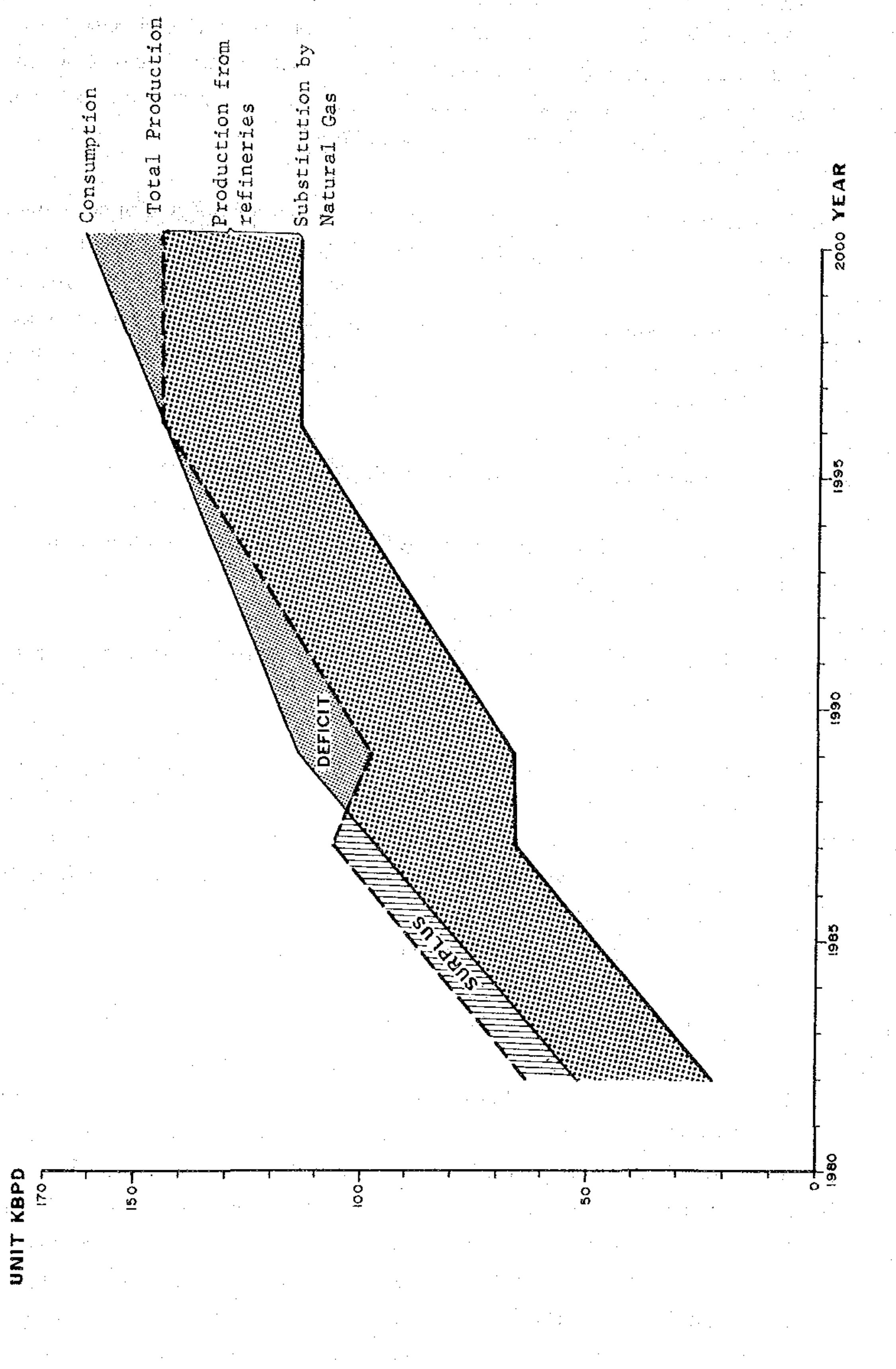


Fig.5.5 FUEL OIL BALANCE

3) The presumptive basic condition for deriving the product balance is that oil demand will grow in this country toward the year 2000 at a rate of four to five percent per annum even assuming ambitious annual natural gas replacement of 14.5 percent, and that the current price difference between petroleum products and crude oil is not going to narrow down to the extent to benefit only the petroleum product import option toward the year 2000 as analized by the World Bank.

While the growth of world petroleum demand is estimated at 1.3 percent per annum toward the year 2000, in actualizing the smooth world petroleum market development toward the year 2000 as well as, in turn, achieving the development of alternative energy resources, the curde oil price is assumed to be raised from the latter part of the 1980s at two to three percent per annum and it is believed that petroleum product price will follow accordingly.

The assumptions particularly for product balances are essentially as follows :

- Natural gas supply scenario assuming 1,000 to 1,200 MMSCFD production during 1991-2000 period (See Section 2.3)

- Condensate from natural gas production and domestic crude oil is used as feeds to the existing refineries.

- Current system of pricing is continued to be maintained toward year 2000. Crude oil price is assumed to be 37.65 US dolalrs per barrel in 1991 and 46.6 US dollars per barrel in 2000 in 1983 price level. The annual average crude price escalation rate of 1.7 percent is assumed during 1980 to 1991 and 2.4 percent for the period of 1991 to 2000. The petroleum product price has been projected with this crude oil escalation rate and with forcasted product/crude ratio by the World Bank (see Section 5.2.3)

5.2.2 Petroleum Product Procurement in South

The South has been restrained by high petroleum product prices. As petroleum product demand in the South grows toward the year 2000, the South striving for regional development in view of decentralization of Bangkok economic activities has to bear increasing burden of such economic cost. In 1982 every petroleum product price in the South is set by Petroleum Pricing Committee at 40 satang higher per liter on average than the price in Bangkok taking into account the product transportation costs from Siracha/Bangkok to the South. (see Table 3.5). Due to the softening of governmental guidance on petroleum product imports, this price difference between

Bankgkok and the South is reduced to 32 satang per liter on average now i.e., Aug. 1984.

It is fortunate that the South holds a limited number of consumers of heavy oil now, for which price is set 10 percent higher than in Bangkok. If this disparity continues, it will certainly give undue stress on the promotion of industrialization.

This higher price of every petroleum product stems from concentration of refineries in Bangkok (Bangkak/Sri racha). The current crude oil procurement and product replenishment practice of double trip have a large room for cost minimization. (The interregional flows of oil are shown on previous Figure 3.2)

Some petroleum companies are taking advantage of this situation in view of fuller utilization of their refineries in Singapore. They ship gasoline to the depots in Phuket, while on the way back, they fill the taker with diesel at Singapore and supply diesel to Songkhla, Surat Thani or Bangkok.

Currently five private oil companies replenish petroleum products to the South by tanker and by truck. Their total oil depots capacity is 92.3 million liters or 580,500 barrels. These oil depots' stock capacity is 31 days in the Upper South and 24 days in the South. The previous Table 3.6 shows location and capacity of oil depot in the South.

Concentration of refinery facilities in Bangkok Region would give rise to the undue sea traffic problems in the Gulf of Thailnd together with increasing fleets along with the Eastern Seaboard Development, as well as the undue risks on security in any event of unpassable situation in Malacca Strait and around the Singapore.

In 2000, assuming the current crude oil receiving practice to continues i.e., the use of 85,000 tonnage tanker, the total annual number of round trips required by refineries in the Eastern Seaboard would reach around 145 times a year. While in Krabi the proposed site for receiving crude oil can accommodate up to 200,000 tonnage tanker without any sizable investments for crude oil receiving facilities.

5.3 INTERNATIONAL PETROLEUM ENVIRONMENT FOR THE PROJECT

5.3.1 World Oil Outlook

The world oil balance for the year 2000 as shown in Table 5.6 provides rather pessimistic outlook especially for the forecast by International Energy Authority (IEA). Forecasting methodology adopted by both IEA and World Bank are based on income and price elasticities which are adjusted by judgemental criteria such as energy intensity trend, production constraints and the possibility of political changes in capital surplus oil producing countries.

With the provided assumption, current oil demand in 1980 of 50 million BPCD grows 58 to 74 million BPCD in the year 2000. IEA's forecast suggests nine to 13 million BPCD shortage of oil while World Bank's projection provides even supply and demand of oil. The important facts of these projections are that; (1) the OPEC still plays the major role in the world oil market, (2) the LDC'c oil demand is growing rapidly while OECD countries demand remains stagnant and (3) non-oil producing developing countries will be vulnerable to the international oil market changes.

Table 5.7 shows the world energy demand and supply forecast up to the year 2000 made by major oil companies. Although all majors anticipate that the oil will steadily be substituted by other energy sources, except for CFP's forecast, share of oil is forecasted to be still dominant and its production to be continuously sustained at moderate speed. OPEC's share in oil production is projected to remain dominant except for CFP's figures. The differnce between CFP's and other majors' forecast figures seems to lie in how they see the prospect of OPEC's future production capacity. Thus, these majors' forecasts also reinforces the important facts stated in the previous paragraph.

Forecasts of future oil prices were made by DOE/EIA and CMB in 1983. As shown in Tables 5.8 and 5.9, they anticipate that the oil prices will begin to increase from the year around 1985 onward.

5.3.2 Excess Capacity of Refineries in the World

In 1982 the world refinery capacity was estimated at 81 Million Barrels Per Day (MMBPD) and the world petroleum consumption was 58 MMBPD. In the free market world the capacity was 65 MMBPD and the consumption was 46 MMBPD. (See Tables 5.10 and ll)

Table 5.6 WORLD OIL OUTLOOK

Unit: million barrels/day

	1980		1985		1990		2000	
	IEA	WB	IEA	WB	IEA	WB	IEA	WB
International Oil price (1981 US$)	(34.2)	29.4	28.9 28.0[1]	32.0	33.5 28.0	37.0	45.0 28.0	41.0
Economic growth rate (world: %)	2.5	2.2	2.4 2.6	3.9	2.7 3.2	3.8	2.7 3.2	3.8
World oil Demand	49.5	50.2	48 50	50.5	50 56	53.9	58 74	57.6
(OECD	38.7	35.5(33.9)[2]	35 36	34.5(34.3)[2]	34 37	34.3(32.3)[2]	33 43	34.0(31.4)[2]
(OPEC	2.9	)14.7(2.3)[3]	4	)16(2.9)[3]	5 6	)19.6(3.9)[3]	8 9	)23.6(5.1)[3]
(NON OPEC LDCs	7.9	) (11.2)	9 10	)	11 13	)	17 22	) (17.0)[3]
World oil Supply	49.5	50.2	48 50	50.5	50 52	53.9	49 53	57.6
(OECD	14.8	14.0	15	14.6	14 13	13.8	15 13	13.5
(OPEC	27.5	27.4	23 26	25.4	27 29	27.8	24 28	30.8
(Others	5.3	7.8	8 9	10.5	8 11	12.0	9 13	13.8
(Processing gain)	(0.6)		(0.6)		(0.6)		(0.6)	
CPE Net Exports[4] (IMPORT)	1.3	1.0	1.0 (1.0)	(0.7)	(0.2)	0.3	(0.2)	(0.4)

SOURCES: OECD/IEA "World Energy Outlook", Aug., 1982
WB "Price Prospects for Major Primary Commodities", July 1982, No 814/82.

Note 1 : IEA's figure of rightside and left represents low case and high case scenarios respectively.
2 : Parences figure are excluding banker
3 : Bunder oil
4 : Centraly Planned Economies

Table 5.7 WORLD ENERGY DEMAND AND OIL SUPPLY FORECAST BY MAJOR COMPANIES

Year	1980	1985			1990						1995	2000			
Forecasting Co.	GULF	GULF	EXXCH	CFP	GULF	EXXCH	TEXACO	MOBIL	SOCAL	CFP	CFP	GULF	TEXACO	SOCAL	CFP
GNP (%)		80/85	82/85		85/90	85/90	82/90	82/90	80/90			90/2000	90/2000	90/2000	
USA	----	1.3	----	----	2.5	----	3.5	3.0	3.0	----	----	2.1	2.4	2.5	----
CANADA	----	1.6	----	----	3.3	----	----	----	3.0	----	----	3.3	----	2.5	----
JAPAN	----	3.5	----	----	3.5	----	4.0	4.0	4.0	----	----	3.0	3.5	4.5	----
EC	----	1.7	----	----	2.3	----	2.2	2.0	2.5	----	----	2.6	2.2	3.0	----
	----	1.8	3.1	----	2.6	2.9	----	----	----	----	----	2.5	----	----	----
OEDS	----	----	5.9	----	----	4.6	----	----	----	----	----	----	----	----	----
OIDS	----	----	4.3	----	----	4.5	----	----	----	----	----	----	----	----	----
	----	4.0	----	----	4.5	----	DCs>ICs	----	4.5	----	----	4.6	----	5.5	----
Sub-total	----	2.3	----	----	3.0	----	----	3.0	----	----	----	3.0	----	----	----
Planed economies countries	----	----	2.6	----	----	3.1	----	----	3.5	----	----	----	----	3.0	----
World Total	----	----	3.3	----	----	3.2	----	----	3.5	----	----	----	----	3.5	----
Primary energy Demand (MMBDOE)* Oil	49.5	47.1	world62 48	44	49.8	world65 50	49.6	47	49.6	44	43	53.7	55.4	54.9	41
N. GAS															
Coal	16.8	18.4	----	18	19.5	34	20.9	22	22.2	19	21	21.9	23.4	26.7	21
Nuclear	16.8	18.6	----	23	20.8	48	26.9	24	24.5	29	35	25.8	36.4	34.7	42
Hydro & other	3.0	5.3	----	5	7.7	10	7.4	7	8.4	7	8	12.5	9.9	12.0	10
	7.6	8.0	----	7	9.4	13	8.6	9	10.0	9	11	12.3	10.2	13.7	13
Total	93.7	97.4	----	97	107.2	170	113.3	109	114.7	108	118	126.2	135.3	142.0	127
Growth rate	----	80/85 0.8	----	80/85 0.7	85/90 1.9	82/90 2.5	82/90 2.3	82/90 2.3	83/90 2.6	85/90 2.2	85/90 1.7	90/2000 1.6	90/2000 1.8	90/2000 2.2	95/2000 1.5
Oil supply USA	10.2	9.1	10	10.0	8.1	9	6.6	----	8.1	9.4	8.5	6.0	5.3	6.7	7.3
Canada	1.7	1.3	----	1.5	1.6	----	1.4	----	----	1.4	1.2	1.7	1.5	----	1.0
E C	2.4	3.0	3	3.3	2.8	3	2.7	----	----	3.1	3.0	2.5	1.8	----	2.8
Mexico	2.1	3.5	----	----	4.5	----	4.0	----	----	----	----	6.0	4.5	----	----
others	4.4	5.3	10	8.4	5.7	13	6.5	----	----	10.2	10.8	7.7	5.0	----	11.5
Synthetic	----	----	1	----	----	1	0.5	----	----	----	----	----	1.0	----	----
Fuel	----	----	----	----	----	----	3.1	----	----	----	----	----	2.9	----	----
Total	20.8	22.2	24	23.2	22.7	26	24.8	----	----	24.1	23.5	23.9	22.0	----	22.6
OPEC Production	27.8	23.7	24	19.4	25.7	25	24.3	----	----	18.8	18.5	29.6	33.4	27	18.1
Total Production	48.6	45.9	48	42.6	48.4	51	49.1	----	----	42.9	42.0	53.5	55.4	----	40.7
Net Imports from planned economy	1.5	1.2	0	1.5	1.2	-1	0.5	----	----	1.0	0.8	----	----	----	0.6
Process gain	-0.6	----	----	----	10.2	----	----	----	----	----	----	10.2	----	----	----
Total supply	19.5	47.1	48	44.1	49.8	50	49.6	----	49.6	43.9	42.8	53.7	55.4	54.9	41.3

*MMBDOE 10^6 Barrel per day Oil Equivalent Source: Compiled by the Institute of Energy Economics for IDCJ/IEE joint discussion.

Table 5.8 WORLD OIL PRICE OUTLOOK (1)

	Unit: 1982 price US/bbl		Unit: Current price $/bbl	
1979	27	–	22	–
1980	39	–	34	–
1981	39	–	37	–
1982	34	–	34	–
1983	30	28–32	31	29–33
1984	26	23–30	29	25–33
1985	25	21–34	29	24–40
1986	28	21–38	34	26–47
1987	32	22–41	42	29–54
1988	34	24–43	48	34–60
1989	36	26–45	54	39–67
1990	37	28–48	59	45–77
2000	59	42–85	–	–

Source: DOE/EIA Apr. 1983

Table 5.9 WORLD OIL PRICE OUTLOOK (2)

Unit: US$/bbl

		Current price	1981 price
Low Case	1982	33.00	31.22
	1983	27.40	25.12
	1985	28.45	24.09
	1990	40.40	27.45
Medium Case	1983	29.50	26.80
	1985	32.70	27.17
	1990	43.80	31.76
High Case	1983	29.75	26.95
	1985	38.00	30.87
	1990	60.35	36.50

Source: Chase Manhattan Bank May 1983

Table 5.10 (1) CURRENT WORLD OIL MARKET OUTLOOK

Unit: 1000 barrels/day

	World Refinery Capacity 1/	Production 2/	Consumption 3/
N. America	20,900	9,875	16,485
L. America	8,664	6,017	4,900
Europe	19,741	2,555	12,455
M. East	3,302	15,694	1,720
Asia Pacific	10,985	2,234	8,495
Africa	1,773	4,360	1,635
Sub-Total	65,365	40,735	45,690
USSR/E.Europe/China	16,031	14,610	12,820
Grand Total	81,396	55,345	58,510

Sources:
1/ International Petroleum Encyclopedia 1982

2/ Same as the above but 1981 figure

3/ BP statistical Review of World Energy 1982

Table 5.10 (2) CURRENT WORLD OIL MARKET OUTLOOK

	Refinary 1) capacity in Jan. 1984	Crude 2) production in 1982	Product 3) consumption in 1982
OPEC	4,654.0	18,497.8	2,200
LDC's	14,181.4	70,340.0	9,715
LDC total	18,835.4	25,531.8	11,915
OECD	39,722.7	14,831.8	33,775
Free world	58,558.1	40,363.6	45,690
CPE	16,531.0	14,803.5	12,820
	75,089.1	55,167.1	58,510

Sources: 1) "OGJ Report" Oil & Gas Journal, Dec. 26, 1983

2) Petroleum Economist April, 1982

3) BP statistical Review of World Energy 1982

Table 5.11 REFINERIES IN ASEAN 1982

Unit: barrels/day

	Capacity	Demand
Singapore	1,130,000	170,000
Malaysia	166,000 (166,200)	155,000
Thailand	176,000	200,000
Indonesia	498,000 (403,500)	380,000
Philippines	286,000 (246,300)	220,000
Taiwan	515,000	511,000
S. Korea	755,000	584,000
Japan	5,601,000	4,380,000

Source : "Energy Development Planning in ASEAN Countries" IDCJ, 1982
Japan Petroleum Association 1982.

Note : Figures in parentheses include the modification/ expansion plans to be completed by 1985

We are well aware of this current excess refinery capacity in the world however, we point out that the problem of excess capacity exists in the industrialized countries and in crude import/product export countries.

The excess capacity was resulted from a fundamental misinterpretation of post-1970 events in the international oil market. Now toward middle of the 1980s, the problem of excess capacity has led to large-scale closures and scrapping of refineries in the world.

As of January 1984, the world total refinery capacity stands at 75 MMBPD reduced by six since 1982 as seen on Table 5.10(2). Thus currently in 1984 the rate of refinery utilization is assumed at 78 percent.

The trend of setting up new refineries in oil producing countries especially in Saudi Arabia, Indonesia and Mexico should be taken care of by major petroleum consuming nations such as the U.S., the EC countries and Japan. Japan has already started rearranging local oil industry to cope with this trend.

In this trend, it is estimated that newly 6.6 MMBPD refinery capacity is planned to be constructed over the world according to F. Fesharki and D. Isaak "OPEC, the Gulf, and the World Petroleum Market: A Study in Government Policy and Down Stream Operations", Westview Press, 1983. Within this new capacity, new additional capacity in OPEC accounts for 56 percent.

OPEC thus will have a refinery capacity of around 8.5 MMBPD by 1990, of which about 3.5 MMBPD would be for domestic consumption and the rest would be available for export. Current refined export is less than two MMBPD. With the additional capacity, OPEC have to sell three MMBPD of refined product in the international market.

What are the effect of this OPEC's push into refining? To sieze the indication of this effect, the study "OPEC's Push into Refining: Dilemma of Interactions between Crude and Product Markets" by H. Razavi and F. Fesharak is timely available. The summary of the study outcome is as follows;

- The maximum revenue would be obtained when OPEC penetrates the product market formed by crude import/product export countries without domestic market, whose current market size is 13.8 MMBPD with reduction in crude oil exports to those countries.

- Opposing to the above, potential loss associated with supply in the product market is substantial when new refined products are simply added to the world product market keeping crude export unchanged.

- The increasing export of refined products will, in general, create a dichotomy of policy views among OPEC member countries.

- This will add incongruity of members' view on the OPEC price. Saudi, Kuwait and UAE will increase the export of refined products and will introduce another dimention to widen the gap between these countries and other members of OPEC (i.e. conflicts of interest between the product/crude exporting and crude exporting countries).

- Thus the calculated strategy will be required to benefit all OPEC member countries and coalition/coordinated product export policy will have increasing importance.

- The model adopted in the study suggests the downward shift of the product/crude price ratio with 1.3 percent per annum increase of average price of refined product for the period 1985 to 90.

In any event, the study illustrates that there will be a very remote chance that OPEC will push through the penetration of petroleum product market in abrupt manner by keeping crude export unchanged, since in this direction repercussional effects of lowering crude price is so apparent in view of strong link between crude and product price.

Furthermore considering the share of OPEC's refinery capacity of six percent including additional new capacity to the world total capacity, the pressure to lower the product/crude price ratio to the extent to wipe out the other refineries in the world, is said to be very little as opposed to what the study indicated.

It is envisaged that the effects of new additional refining capacity in OPEC would be realized in industrialized countries and crude import/product export countries in view of OPEC as a whole revenue maximization strategy to be adopted by OPEC.

In these instances, it is concluded that the effects of excess capacity in the world would not alter the presumptive viability for the refinery project in Krabi to the largest extent. The project's long enough gestation period makes it possible to reassess some of crucial factors influencing the vaiability of the project. Thus the refinery project at this point as an element of the Upper South regional master plan study presents the advantageous option for Thailand when rearranging the current petroleum procurement/replenishment practice in view of regional as well as national perspective.

Currently Shell refinery in Singapore with 600,000 barrels per day capacity is operating at 50 percent capacity and ESSO with 250,000 barrels per day capacity is also at 50 percent operation rate. Shell and ESSO naturally hold negative view on a new grass-root refinery in Thailand because of huge underutilization of their refineries in Singapore as well as other part of the world.

In the short run, Thailand can meterialize this situation i.e., excess refinery capacity in the world by importing petroleum products at lowest cost. However, in the long run Thailand should realize restructing trend in the world refinery industry.

It is estimated that about five US dollars difference exists between CIF petroleum products import price per barrel including distribution cost to the consumer end and that of the crude oil. Generally speaking a refinery alone makes two US dollars per barrel revenue however. With introduction of efficient crude oil procurement system and product distribution system, the refinery project may generate five US dollars per barrel foreign exchange savings. With 60,000 BPD demand in the South in the latter half of 1990s, Thailand can save 750 million US dollars by the year 2001 in terms of not importing petroleum products. A crucial key to this is cost savings in crude oil procurement and in efficient product replenishment system.

The problem of underutilization of existing refinery facilities should be solved by international oil companies themselves and not by the sacrifices of developing countries. Because the decision on setting up such facilities was made solely on profit maximization goal of such companies.

Developing countries especially, like Thailand, who needs significant amount of investment for industrialization without distorting domestic economy should utilize every opportunity to save foreign currencies. After having secured the initial investment on a new refinery in six to seven years, Thailand can choose the strategies whether to follow the international oil environment or seek further the opportunities to materialize cost saving on petroleum procurment and product replenishment.

5.3.3 Crude and Petroleum Product Prices

As having been stated the crude price will start to increase from the latter part of this decade. Here in this section, the relationship between crude oil price and that of product is focused in view of setting framework for the assumption required for the economic analysis of the refinery project.

The refinery crude in Thailand is expected to comprise principally of Arabian Light Crude Oil. Currently in 1982 the crude feed consists of 77 percent from Middle East and 16.5 percent from Malaysia and 5.2 percent from Brunei and 1.3 percent from China while Saudi Arabia alone occupies 66 percent of the total. The crude oil used in this project is assumed to be Arabian light for which the price escalation is assumed to be 2.4 percent per annum for the period 1990 to 2000.

Ex-refinery prices are set based on Singapore posted prices as seen on the Table 5.12. The petroleum product pricing mechanism in Thailand is that the ex-refinery prices are fixed by the Ministry of Industry and the retail prices are by National Petroleum

Table 5.12 PETROLEUM PRODUCT PRICE IN SINGAPORE/BANGKOK 1984

Unit: cent/liter

	Singapore Posted Jan 1984	CIF* Thailand 1982	Thailand Exrefinery Dec 1983	BKK Retail Mar 1984	Estimated Transportation BKK/Singapore
Gasoline					
Premium	24.28	40.56	23.87	50.87 (11.7)	.41
Regular	22.03		21.64	46.96 (10.8)	.39
Average	23.16	26.33			
Diesel					
High Speed	21.79	27.98	21.56	29.13 (6.7)	.23
Low Speed	21.51		21.29		.22
Average	21.65	27.93			
Kerosene	23.11	29.33 29.39	22.83	26.61(6.1)	.28
LPG	19.81	21.95 21.40	19.76	25.22(5.8)	.05
Fuel Oil	17.30	18.66 18.70	17.27	17.78(4.1)	.03

Source: The Team Survey

Note : * The above figures for each product express the CIF value in average and those below are for CIF value from Singapore. Figure in parentheses are expressed in baht/liter.

Table 5.13 EX-REFINERY PRODUCT/CRUDE PRICE RATIOS

	1985 Ratio	1990 Ratio	1995 Ratio
Premium Gasoline	1.50	1.48	1.42
Regular Gasoline	1.44	1.42	1.36
Jet Fuel	1.44	1.42	1.36
Kerosene	1.36	1.35	1.30
High Speed Diesel	1.30	1.29	1.25
LPG	1.44	1.42	1.36
Fuel Oil	0.81	0.82	0.85
Crude	1.00	1.00	1.00

Source : World Bank

Committee, in view of bringing efficiency in operation to refineries in Thailand so as to be competitive with Singapore.

World Bank furnishes a projection on the ex-refinery product/crude ratio based on this close association of local and Singapore prices for Bangchak Refinery Study as seen on Table 5.13 below. The table suggests the worldwide relative shift towards gasoline and middle distillates reaching its peak in 1990. Also the table indicates that the price difference between middle-distillates and fuel oil is expected to narrow by 1995 because of availability of new additional cracking facilities in the Far East including Thailand. With this assumed trend the price ratio of gasoline, diesel and fuel oil are projected to be changed from 1.44 to 1.36, 1.3 to 1.5, and 0.81 to 0.85 respectively. These ex-refinery product/crude ratios are utilized in the succeeding economic analysis.

5.4 REFINERY PROJECT

5.4.1 Why the Project

The refinery with hydrocracking process with the capacity of 67,000 BPSD is recommended to prepare for increasing petroleum demand in the South and to ease the problem of disadvantageous petroleum prices which portend opportunity of industrialization in the South.

In the national context, foreseeing shortcoming of the domestic capacity vis-a-vis the petroleum demand toward the year 2000, this refinery in the South materializes the following benefits. First construction of an oil refinery outside the Bangkok Region helps decentralization of industries. Second decentralization of refining facilities is desirable from the security point of view. Third, a new refinery brings foreign exchange savings. If Thailand goes along the world trend of petroleum product import, more burden on her balance of payment is expected in view of product/ crude ratio and increasing international freight costs for petroleum product logistic market. (see Section 5.2.1)

Here in this refinery project, it is considered that beautiful harmonization between a national interest and a regional interest can be achieved for the development.

Even though recognizing excess capacity currently appeared in international petroleum refinery market as discussed in the previous section, we still recommend a new refinery with hydrocracking process of 67,000 barrels per short day capacity for the above-mentioned merits. The following points should further be noticed.

- Less influence from the world trend; Currently crude oil demand in Thailand shares only 0.4 percent of the total world crude oil demand so that minimum impact of the world trend is expected.

- Possibility of early recovery of the refinery investment;

- This region will provide indigenous less expensive petroleum;

The scheme to set up a new refinery in the South is not new. National Energy Administration had studied on the additional refinery capacity requirement for Thailand toward the year 2000. This NEA study completed in 1981 recommended new refineries in the South during 1990s. However no further official recommendation has not been made to the interministerial level due to the changing circumstances in the petroleum market.

Opposing to the NEA study scheme of aiming to satisfy national petroleum demand of 626 KBPD with natural gas supply of 420 MMSCFD in the year 2000, we examine the viability of a new refinery under reduced national petroleum product demand reflecting the current trend and in view of satisfying regional petroleum demand keeping focus on the precedent problems.

5.4.2 Why the Capacity of 67,000 BPSD with Hydrocracking Process

After 1991, the country will increasingly suffer from refined oil product imports even with the planned expansion and modification of existing refinery as examined in Section 5.2. The volume of product imports is projected to reach in the range of 97 to 115 KBPCD by available forecast on their assumptions. We estimate volume of product imports in the nation at 75 KBPCD in 1996 and 107.3 KBPCD in the year 2000 and also project the petroleum demand of more or less of 65 KBPCD for the South in the year 2000. This regional demand and volume of petroleum product import together provide the frame for the capacity of the proposed refinery.

During the 1990s, the world petroleum product market, especially Far East market, would give rise to strong demand for gasoline and middle distillates and very weak demand for fuel oil. Thus the prices of white portion of oil would be expected to rise and it would be costly and difficult to import middle distillates. The reflection of this trend is that the demand for light product would be tight and its availability would decline in 1990s. Currently efforts have been made to replace heavy oil by indigenous natural gas and lignite. However, less efforts are made to cope with circumstances of the middle distillates. Having additional refinery with hydrocracking process would provide an option for the existing and planned expansion refinery in their feed stocks and their operations.

5.4.3 Why at Krabi

Among other regions, the southern region, its west coast in particular, seems to be a candidate area for local refinery development. The South has been far and isolated from Bangkok. In 1981, oil accounted for 25 percent of the goods transported to the South or 82 percent of those by ships. As the South will be more developed and industrialized, oil transportation from Bangkok to the South will further increase. On the other hand, the western coast of the South, has direct access to the Middle East capable of supplying the crude oil which is best fitted to Thailand oil requirement with 52 years of Reserve/Production (R/P) ratio.

Another factor to be noted is that off-shore oil exploration activities envisaged in Andaman Sea is still holding a chance of success.

A strategic element of locational aspects of a refinery is to minimization of logistical costs incurred in crude procurement and product replenishment. Thus existing refinery facilities over the world are either near at consumption centers or at crude production centers with latter being the case after the second oil crisis.

Cost minimization in crude procurement depends pretty much on the distance and the size of a crude carrier (tanker). The size of a tanker is limited by the port facility or by the sea depth when a mooring type of unloading facility is in consideration. Table 5.14 illustrates freight cost differencial by size of a tanker. Current practice of crude oil procurement at Sri Racha is utilization of 85,000 DWT tanker due to the limitation of the sea depth. The table suggests significant amount of cost savings in the case of 200,000 DWT tanker utilization. Table 5.15 presents the physical condition of possible sites for crude oil unloading sites. In considering sea depth with surrounding conditions, Krabi, after extensive study on possible locations by a port expert of our team, is recommended as the only best place fitted for the project. Although Phuket does not appear on the table, Phuket Island was another candidate for its deep seaport project. However an oil refinery there certainly damages the perceived images of Phuket as a tourism destination and can not enjoy the position of the petroleum product distribution center in the South.

Table 5.15 SUMMARY OF CRUDE OIL UNLOADING SITES

1.	Site	Ban Bang Ben (Located 30km south from Changwat Ranong)	Ban Pak Wip (Located 40km north from Changwat Phangnga)	Changwat Krabi	Changwat Satun
2.	Tanker Mooring Point	9°38' Lat 98°25' E	8°45' Lat 98°15' E	8°03' Lat 98°43' E	6°30' Lat 100°00' E
3.	Sea Depth	18.3 m	27.5 m	27.5 m	N.A.
4.	Distance from Coast	15 km	10 km	4 km	N.A.
5.	Factors to be considered	- Too near to the Burma border - Possibly be utilized by 200,000DWT - Distance from the mooring point to the coast requires additional booster pump station on the Sea	- Can accommodate up to 200,000DWT - A booster pump is necessary due to its distance to the shore - Probable wave effects due to no islands and peninsula around	- Enough depth to accommodate 200,000DWT - Good surroundings for sea break with small islands and peninsula around - Can answer for product distribution due to its middle location in the South	- Too far down South - No distributional locational advantage envisaged

Note : This table is a modified version from NEA's "Thailand Additional Refinery Capacity"

Source: The Team

Table 5.14 FREIGHT COST DIFFERENCIAL BY SIZE OF TANKER

Voyage	WS 100* (US $)	Ship Size (D/W)	Market Rate		Freight (US $ / LT)
A. Ras Tanura-Sattahip	11.30	100,000	WS	60	6.780
		200,000	WS	40	4.520
B. Ras Tanura-Songkhla	10.52	100,000	WS	60	6.312
		200,000	WS	40	4.208
C. Ras Tanura-Krabi	8.72	100,000	WS	60	5.232
		200,000	WS	40	3.488

* : World scale as of July, 1984

Source: The Team

Table 5.16 REFINERY CAPACITY AND ITS PRODUCT YIELDS

Design Capacity (BPSD)		67,000
Planned Charge Rate (BPCD)		62,400
Crude Stream Factor		0.93
Total Daily Product (BPCD)		60,000
Refinery Fuel & Loss (Vol %)		3.85%
Product Yields	Vol %	KPCD
Average Charge Rate	100.0	-62.4
LPG	4.0	2.5
Gasoline	28.9	28.1
Kerosene	16.9	10.5
Diesel	36.3	22.7
Fuel	10.0	6.2
Total Product		60.0

Source: The Team

Note : BPSD Barrels Per Short Day (330 days)
BPCD Barrels Per Calender Day (365 days)
KPCD 1000 BPCD

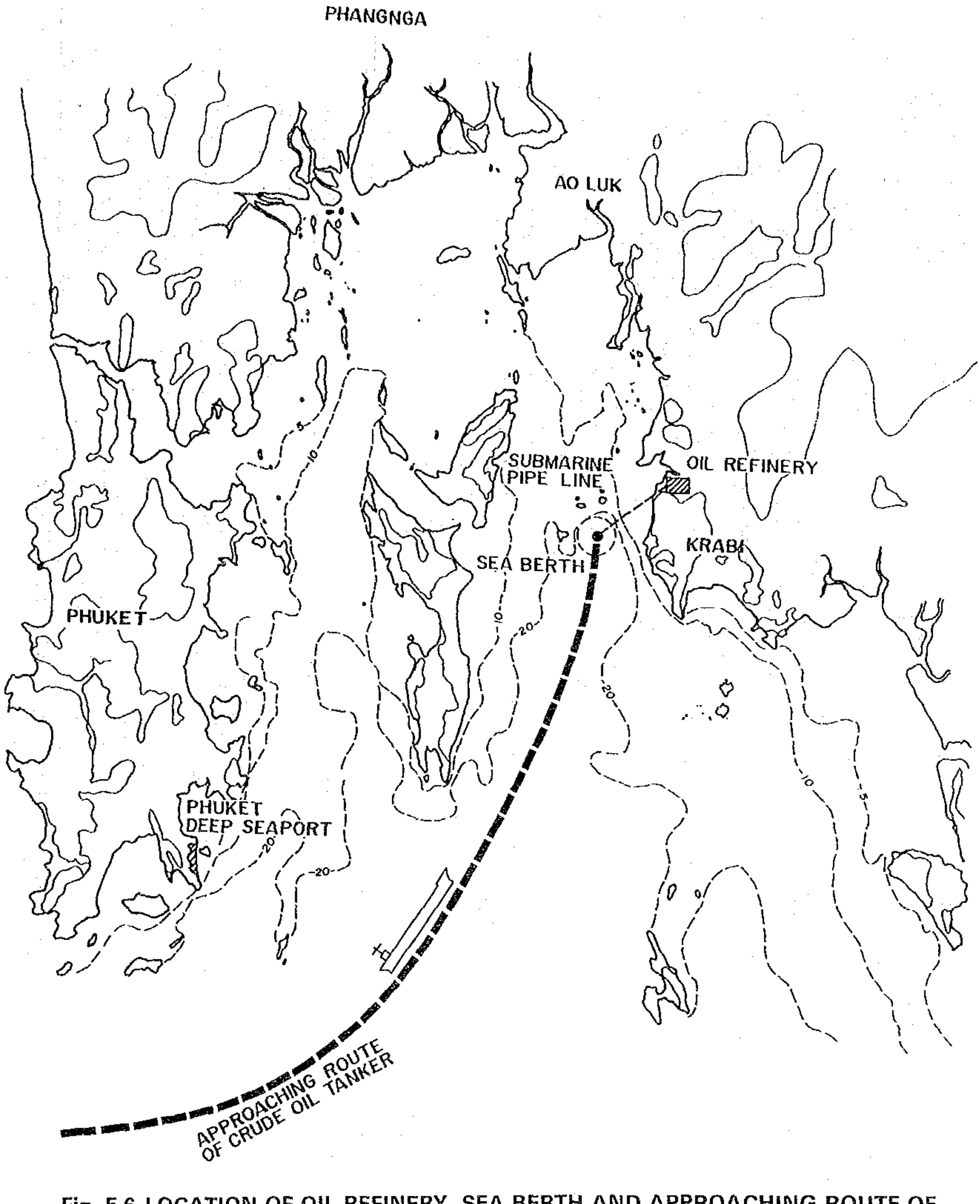


Fig. 5.6 LOCATION OF OIL REFINERY, SEA BERTH AND APPROACHING ROUTE OF CRUDE OIL TANKER

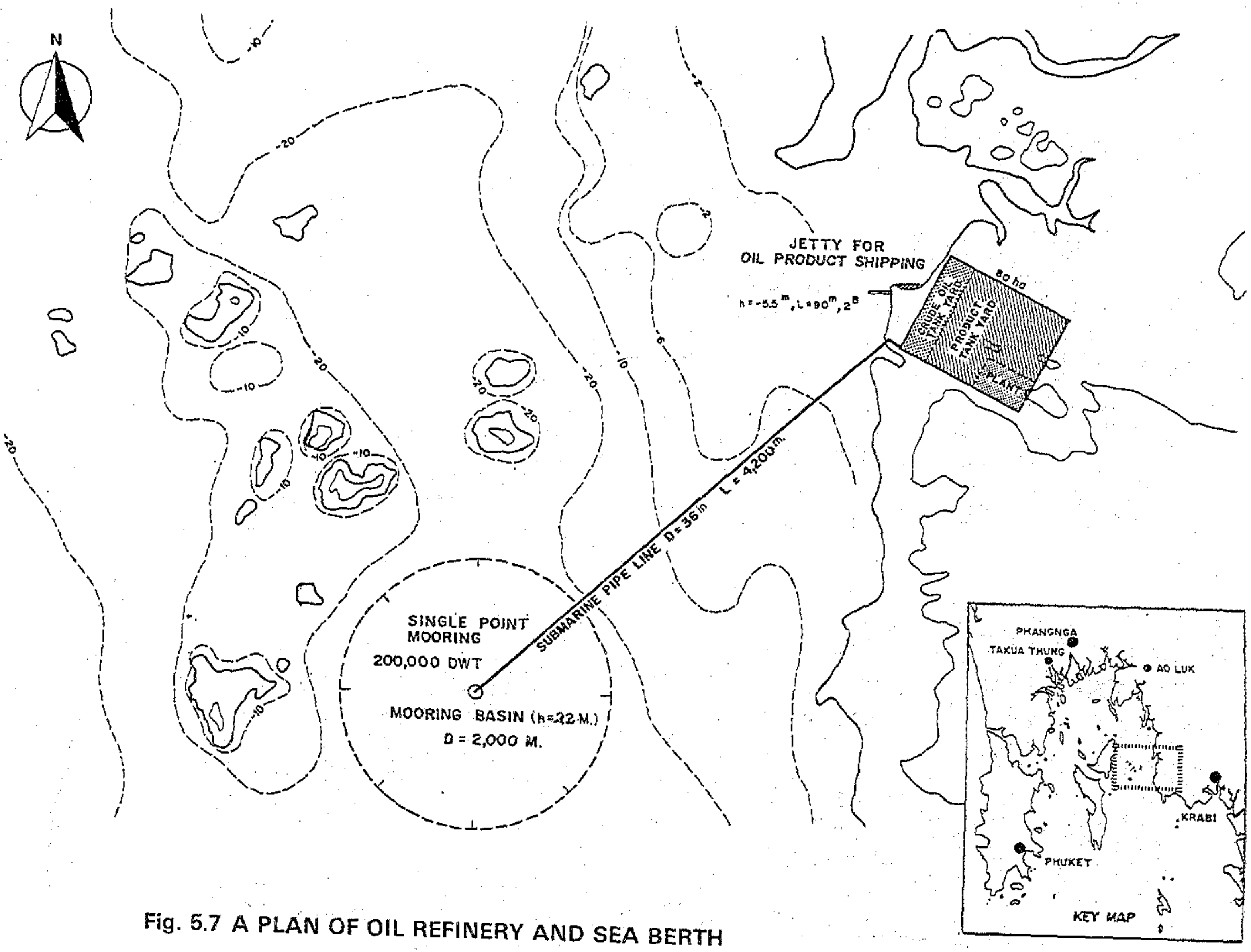


Fig. 5.7 A PLAN OF OIL REFINERY AND SEA BERTH

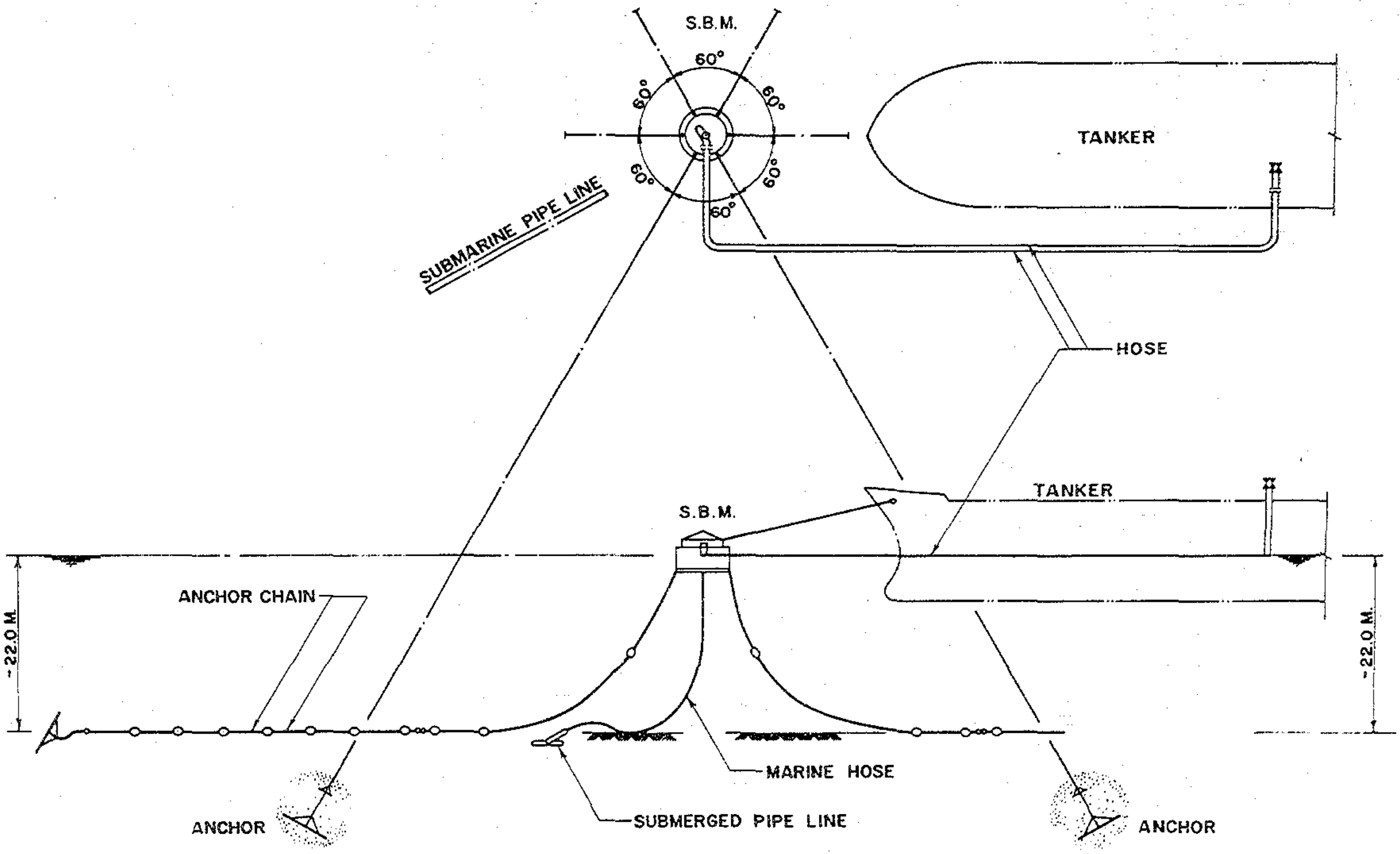


Fig. 5.8 SINGLE MOORING OF SEA BERTH FOR OIL PROCUREMENT

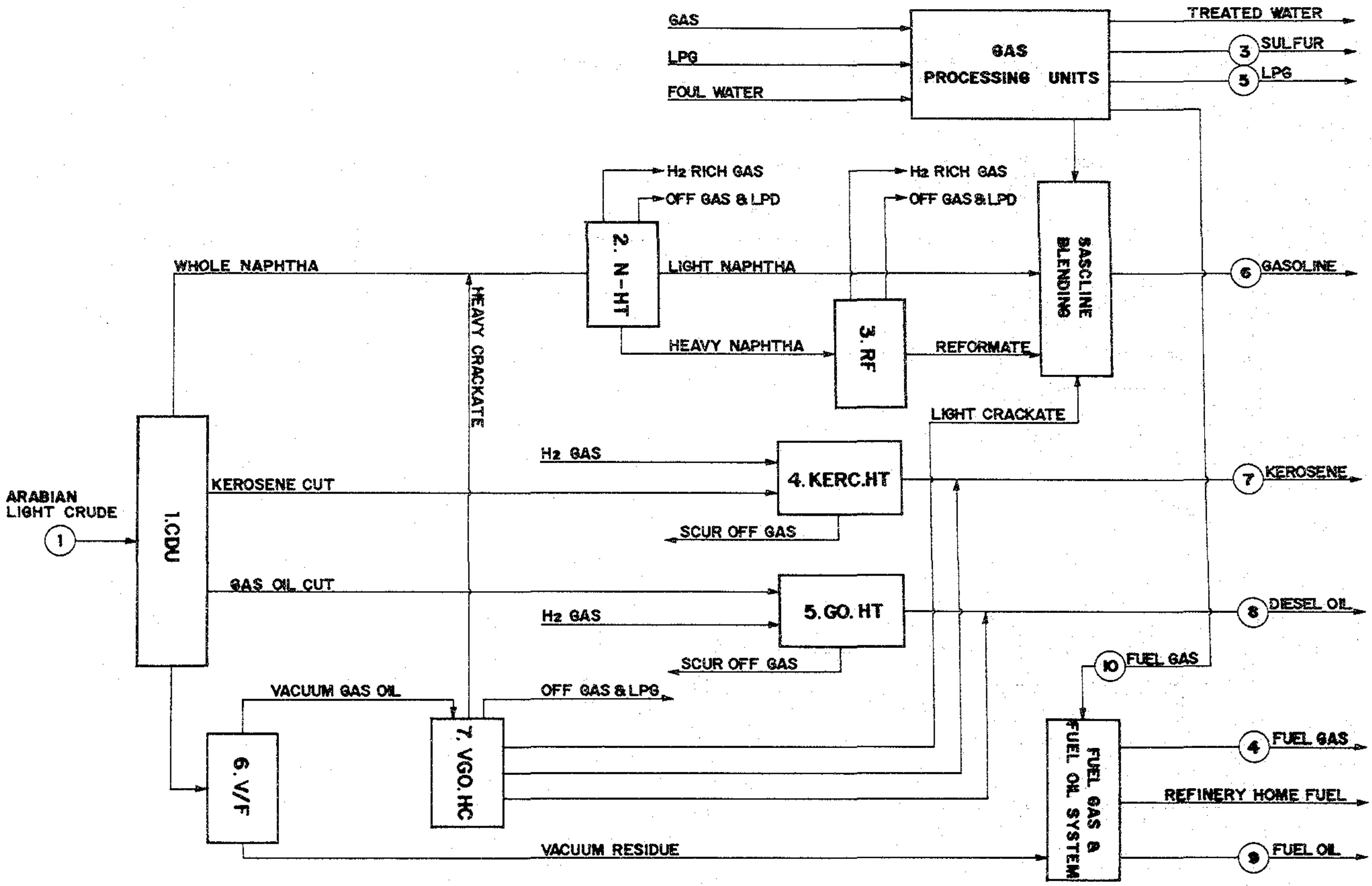


Fig. 5.9 REFINERY BLOCK FLOW SCHEME FOR ARABIAN LIGHT PROCESSING
— VGO HYDROCRACKING ROUTE —

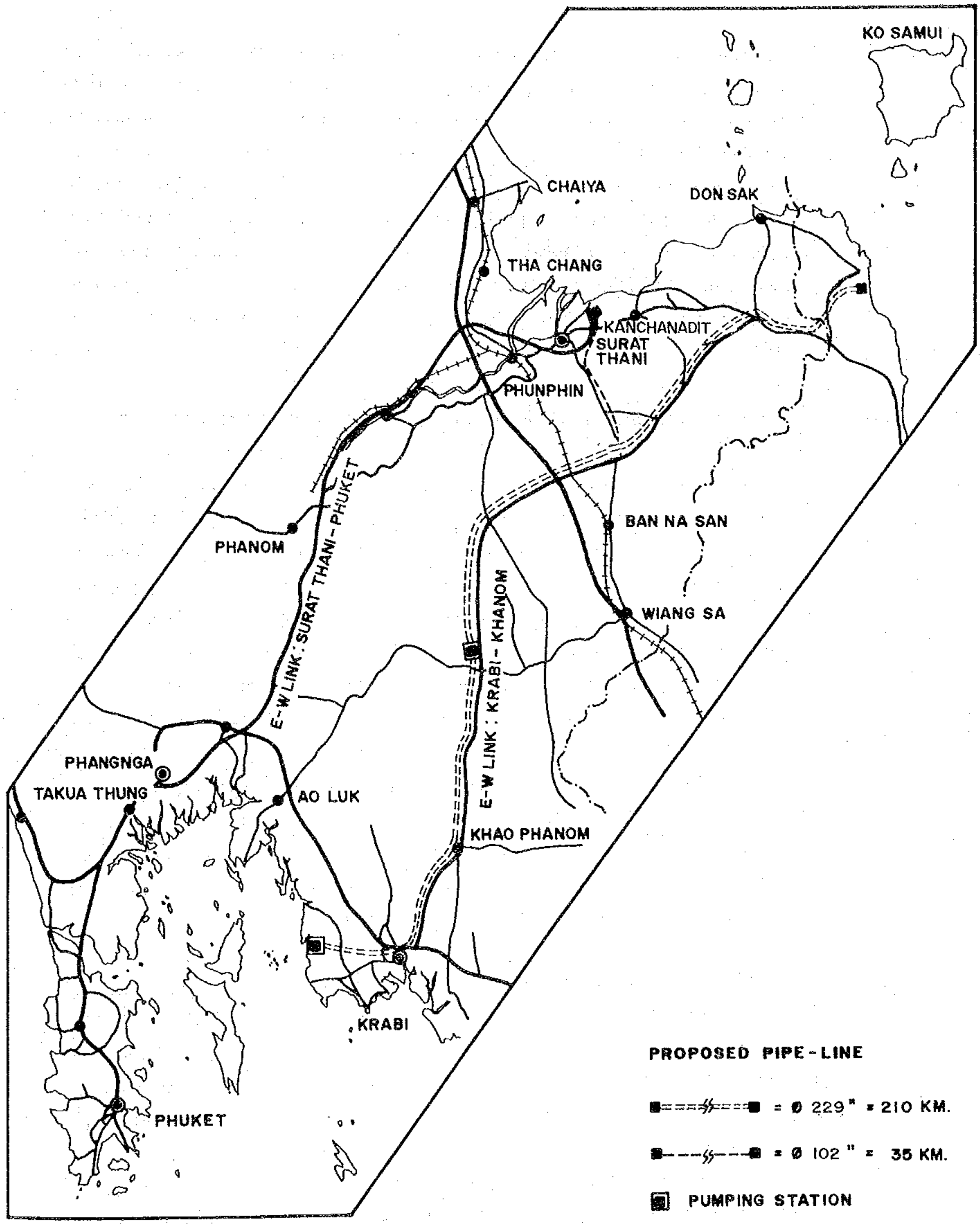


Fig. 5.10 SURAT THANI - KHANOM PETROLEUM PRODUCT PIPELINE SYSTEM

With the above locational consideration, Krabi has been chosen as a candidate site to set up a refinery. The refinery in Krabi particular can materialize the savings in crude oil procurement and in petroleum product replenishment. Crude procurement by 200,000 tonnage tanker from Arabian Gulf to Krabi will bring 3.3 US dollars per ton savings in comparison to 80,000 tonage tanker from Arabian Gulf to Sri Racha. In 1995 with precedent petroleum demand this saving will amount to eight million US dollars in a single year at 1984 price level. Savings from petroleum product replenishment from the refinery in the South, based on a rather brave assumption of eliminating 40 satangs difference, will reach 30 million US dollars in a single year of 1995.

5.4.4 Total Project Scheme, Timing of Implemention, Investments Required

The recommended refinery project comprises of three systems, namely, the crude procurement system , refinery system , and product distribution system including a pipeline connecting Krabi with Surat Thani/Khanom, in order to attain maximum return on investments (i.e., increased efficiency of petroleum product supply system in terms of savings achieved in comparison to the current system). Figures 5.6 to Figure 5.10 show a location of the refinery, an approaching route of a crude oil tanker, a sea berth, conceptual diagrams of the sea berth, the refinery configuration, and a route of pipeline. Table 5.16 shows the refinery capacity and its product yields.

The timing of project completion is considered at best in 1995 in view of projected demand in the South and projected petroleum product imports at national level at that time. Starting refinery operation in 1995 enables to rectify the forecasted product imbalance at national level as well as enable to satisfy the product demand pattern forecasted for the South and to attain a maximum return on the investment.

The total investments for this project amounts to 492.9 million US dollars including land acquisition and physical contingency. The figure does not include interests during construction and the initial working capital. With those the total financial cost for the project is estimated at 652.7 million US dollars in 1983 price.The refinery investment capital costs are estimated at 361 million US dollars with 9.4 million US dollars investments for the crude procurement system of marine terminal facilities. Table 5.17 shows the breakdown of such costs, while Table 5.18 illustrates the total capital requirements of the project, and Table 5.19 presents assumed feature of marine terminal and condition for cost estimation. The product distribution system including the 200 kilometer Krabi/Khanom petroleum product pipeline with 7,500 kiloliter/day capacity is estimated to cost 57 million US dollars including land aquisition and

Table 5.17 APPROXIMATE INVESTMENT COSTS FOR 67,000 BPSD REFINERY IN KRABI WITH HYDROCRAKER

Unit: million US dollars, 1983

Process Unit 1/	240.0
Off-site Facilities	121.0
Storage Tank 2/ (crude 2.8MMB+Products 1.8MMB)	60.3
Marine Terminal 3/ (Crude and Products)	9.4
Others 4/	50.3
Total Investment Cost 5/	361.0

Note : 1/ Substantial amount of the portion is occupied by a hydro of 27,000 BPD

2/ 41 days for crude oil and 30 days for products are assumed

3/ Includes Sea Berths, Submarine pipe of 4.2 kilometer long Jetty for oil Product Shipping, and Boards, and Costs are estimated by the TUSP port expert.

4/ Utillity facilities and operational auxiliary facilities are included

5/ Comprises equipment costs, engineering fee, super vision transportation, and erection/constraction costs, excludes land, physical contingency, initial working capital, and start up expenses. All figures based on 1983 dollars

Source : Based on informations gathered from Japanese Engineering firms and with appraisal of estimated costs in EMP, NEA and PEIDA/PENCOL studies.

Table 5.18 TOTAL CAPITAL REQUIREMENT FOR THE NORTH KRABI REFINERY PROJECT

Unit: million US dollars, 1983

		Foreign	Local	Total
1.	Land Acquisition	-	57.4	57.4
2.	Refinery Cost	252.7	108.3	361.0
3.	Physical Contingencies 1/	12.6	5.4	18.0
4.	Base Refinery Portion	265.3	171.1	436.4
5.	Pipeline 2/	36.7	19.8	56.5
6.	Base Total Requirement	302.0	190.9	492.9
7.	Interest During Construction 3/	37.7(33.0)5/	30.1(26.9)5/	67.8(59.9)5/
8.	*Total Fixed Cost*	339.7	221.0	560.7
9.	Initial Working Capital 4/	-	92.0	92.0(88.0)5/
10.	Total Capital Requirement	339.7	313.0	652.7(586.3)5/

Note : 1/ 5% of refinery cost

2/ includes land acquisition and physical contingencies

3/ foreign portion 8% and local portion 10% are assumed for 75 to 25 debt/equity

4/ 1.3 times of total cost of operation

5/ Figures in ( ) mean capital without product pipeline from Krabi to Khanom and the total amount is US$ 586.3 million.

Source : The Team

Table 5.19 FEATURE OF MARINE TERMINAL AND CONDITIONS FOR INVESTMENT COSTS ESTIMATION

Size of Tanker	:	200,000 DWT (L = 325m, B = 47.2m, H = 19.0m)
Sea Berth		
Type of Structure	:	S.B.M. (h = 21.0m)
Diameter of Basin	:	D = 2,000m
Cargo Handling Capacity	:	10,000 kl/hr
Diameter of Pipe Line	:	D = 36 in
Length of Submarine Pile Line	:	L = 4,200m
Shipping Berth of Oil Product		
Size of Vessel	:	2,000 DWT (h = 5.5m, L = 9.0m), 2^B
Berth for Small Craft		
Depth -2m, L = 200m		
Tank Yard		
Capacity of Tank (crude oil)	:	100,000 kl/tank x 4 tank
Area (crude oil)	:	160,000 m^2
Area (product)	:	540,000 m^2
Refinery Facilities		
Area	:	160,000 m^2

Source: The Team

physical contingencies. All the dollar figures in this study are in 1983 US dollar and provided by our civil engineers unless otherwise stated.

5.5 ECONOMIC ANALYSIS

5.5.1 Economic Costs and Benefits

The long duration for this project to be implemented almost 10 years ahead from now, necessarily reduces reliability of the project feasibility in its financial aspect, in view of dynamic nature of conditions governing the project such as a petreoleum product princing structure, availability of crude oil with respect to its type, volume and price, costs of plant facilities and their price escalation rates, interest rates applied, and so forth.

While the financial analysis being the less satisfiable means of evaluation particulary for this project, economic analysis can sufficiently provide judgement criteria in searching and evaluating a new option available in developing hydrocarbon supply systems in the national context as well as in the regional context. Thus the efforts here is directed to economic analysis. Nevertheless it is felt that essential assumptions for the economic analysis are valid enough to make the outcome of the study to stand as seen in the precedent sections.

The economic capital cost of the product is a derivative from the financial capital cost with deduction of interests during construction, import duties and local taxes on imported equipment and other items. The total economic cost amounts to 557.8 million US dollars against financial capital cost of 652.7 million US dollars shown on Table 5.18 and in the case of exclusion of pipeline scheme the total cost would be 504.4 million US dollars. The profile of expenditure is assumed at 40 percent in 1993 and 60 percent in 1994 and plant life of 15 years from its operation in 1995 is presupposed.

The cost of the crude oil to be used in this project comprises of FOB Arabian Gulf price plus freight costs and other expenses charged for the Gulf/Krabi route by a 200,000 DTW tanker, opposing to the CIF price currently paid by Thailand which amounts to about 29.75 US dollars per barrel for the Gulf/Sri Racha route by 85,000 DWT tanker. The crude oil price is assumed to stay at current level till 1986 and then to reach 37.65 US dollars per barrel in 1991, in 2000 46.5 US dollars, and in 2003 50 US dollars at 1983 price level with the average annual incremental rate of 2.4 percent from 1991 to 2003 in accordance with assumption applied for petroleum product demand projection. From 2003 to the end of the project life, 50 US dollars per barrel is assigned for crude oil price to check viability of the project under the severe condition. This crude oil escalation rate is derived from the analysis described in Section 5.2 and it is in conformity with a updated World Bank projection of the crude oil price.

There is a possibility for the price of crude oil to reach only 33.3 US dollars in 1991 and increase at 2.4 percent per annum hence forth. This case which would generate more petroleum demand is checked in sensitivity analyses.

The incremental rate of the ocean freight charge including insurance and other expences for the crude oil transportation, is assumed to follow the same path in real term as the crude oil escalation rate. A definite scale merit exists in the ocean freight rates, where the larger the tanker, the less is charged as seen on Table 5.14 in subsection 5.4.3. The scale merit targeted to be obtained by this project is currently in 1984 at 3.3 US dollars per ton with the difference of trip miles between the Gulf/Sri Racha and the Gulf/Krabi. This merit is presumed to be bigger with 5.6 US dollars per ton at 1984 price level in the year 2000 reflecting the assumed oil price increase as well as a trend of supply/demand factors in the ocean oil vessel market, where availability in larger vessels to small ones below 100,000 DWT is indicated.

Crude oil accounts for about 96 percent of total economic operating costs for the scheme without pipeline and about 95 percent for the scheme with pipeline. Other economic operating costs considered in the analysis include chemicals and utilities incremental to the project, maintenance, labour, insurance, and administrative/sales expenses of fixed cost portion.

The annual economic benefits derived from the project will include the amount of petroleum product import substitution achieved by the project and the savings realized by refinery at Krabi i.e., elimination of local transportation costs from Sri Racha to the South. Thus the economic benefit is expressed by the total of FOB product price at Singapore and transportation cost charged for Singapore/the South.

However in view of the Thai government policy on the ex-refinery pricing aimed to achieve efficient operation as in Singapore, the alternative case applying the ex-refinery price at Singapore/Bahrain instead of CIF product price from Singapore/Bahrain is examined. Thus the project is asked its viability under stringent condition. For calculation of the ex-refinery product price at Singapore, the product/crude ratio projected by World Bank for Singapore/Bahrain for Bangchak Refinery Study is utilized (see Section 5.2).

Thailand would continue to import petroleum products especially middle distillates of 79 KBPCD in the year 1995 even after the completion of the previously mentioned projects of expansion, modification and debottlenecking. Transportation of refined products is quite expensive because of use of white oil tankers. Substantial savings in freight both in crude oil precurment and product replenishment is expected.

In 1984, currently replenishment cost of product from Bangkok/Sri Racha to the east coast of the South ranges from 12.8 satang per liter to 22.0 satang per liter and from Bangkok/Sri Racha to Phuket is estimated at around 30 satang per liter. For economic analysis purpose this relenishment economic cost is assumed to be 12 satang per liter on average, and the same is assumed for the South/Singpore economic transportation cost.

5.5.2 Results of Economic Analysis

Having set the base case in the framework of above mentioned assumptions, the project yields 24 percent of Economic Internal Rate of Return (EIRR). The key assumptions involved in the base case are:

(1) Petroleum product demand in the South and the nation grows at 6.3 percent and 4.6 percent per annum during 1980 to 2000 period respectively.

(2) All the current expansion/rehabilitation plans for the existing refinery would be completed by 1989 and the probable natural gas supply to the nation would be at the level of around 1,000 MMSCFD peak production and is assumed to be utilized at the Eastern Seaboard.

(3) Current pricing structure will continue.

(4) World crude oil price reaches 36 US dollars per barrel in the end of this decade and henceforth increases at 2.4 percent per annum rate to the year 2003 and will stay at that level till the end of this project life.

(5) The project feature is the total system of the crude procurement system, the refinery system and the product distribution system and the refinery system with hydrocracker.

(6) All the conomic prices of petroleum products produced by the project is based on the projected Singapore ex-refinery price assuming a stringent condition to the project reflecting the governmental policy on ex-refinery pricing where the average product/crude price ratio of 1.219 is assumed.

(7) Domestic economic product handling cost mainly consisting of transportation cost from Sri Racha to the South is assumed to be 12 satang per litter, which incidentally is matched to Singapore/the South CIF economic freight cost. In the base case this local transportation cost is included as benefit born by the project.

This significantly high EIRR of 24 percent presents a new option available to Thailand to capitalize development opportunities in attaining the socio-economic goal of the country. Thus we strongly recommends this project, should the nation require an additional capacity in the latter part of 1990s. The outcome of the study plainly expresses occurence of such event.

There would be an argument in applying appropriate economic prices to the products which this project produces, especially when gasoline, kerosene and fuel oil show the surplus during the first couple of years of this project operation. For answering this argument, the alternative case should gather due attention. Under alternative case, the economic prices of all the products produced by this project are valued at ex-refinery price (i.e., FOB valuation rather than CIF valuation). The EIRR of the project with the pipeline scheme is still 17 percent and EIRR 19 percent of is calculated for the project without pipeline scheme.

Even with this Krabi refinery project, all the petroleum product balance at the national level presents deficits by the year 2000 except kerosene's balance of four KBPD surplus. In these regards, the viability of the project would not be reduced significantly by the wide range of applications of the appropreate economic prices to the product.

When applying zero value to gasoline, kerosene and fuel oil over the volume equivalent to the excess production, the EIRR of the project gets down only by two percent from the base case.

Table 5.20 presents the results of exercise in assessing the said project in comparison to alternative refinery schemes. The alternatives considered are :

i) Base with FOB - Under the same assumptions governing the base scheme except valuation of benefits (i.e. application of FOB valuation);

ii) W/O case-the project without the product pipeline system under the same assumptions governing the base case scheme (i.e., excludion of investments for the pipeline with FOB valuation for benefits);

iii) Reference 1- the reference project assumed to be set up in Bangkok Region with the same refinary capacity and configuration but five percent higher investment cost reflecting costly land and marine facilities; and

iv) Reference 2- same as the Reference 1 but the all products produced is targeted to satisfy the demand in the South. The economic transportation cost for Bangkok/the South is added on the total economic cost of production so that the evaluation of this scheme is compared with other schemes where economic prices of petroleum products are set equal to projected ex-refinery FOB price in Singapore.

The table shows clearly how the refinery at North Krabi is economically advantageous to satisfy the future petroleum product demand for the South or for the nation in view of deficit product balance in the latter part of the 1990s.

While in the base case North Krabi refinery is yielding EIRR of 24 percent under CIF

Table 5.20 ASSESSMENT OF REFINERY SCHEMES BY ECONOMIC RATE OF RETURN

Unit: %

Crude price Scenario Refinery Scheme	Base	Low
Base Case	24	21
Base with FOB	17	15
Base W/O	19	17
Reference 1	14	12
Reference 2 (Targeted to the South)	7	5

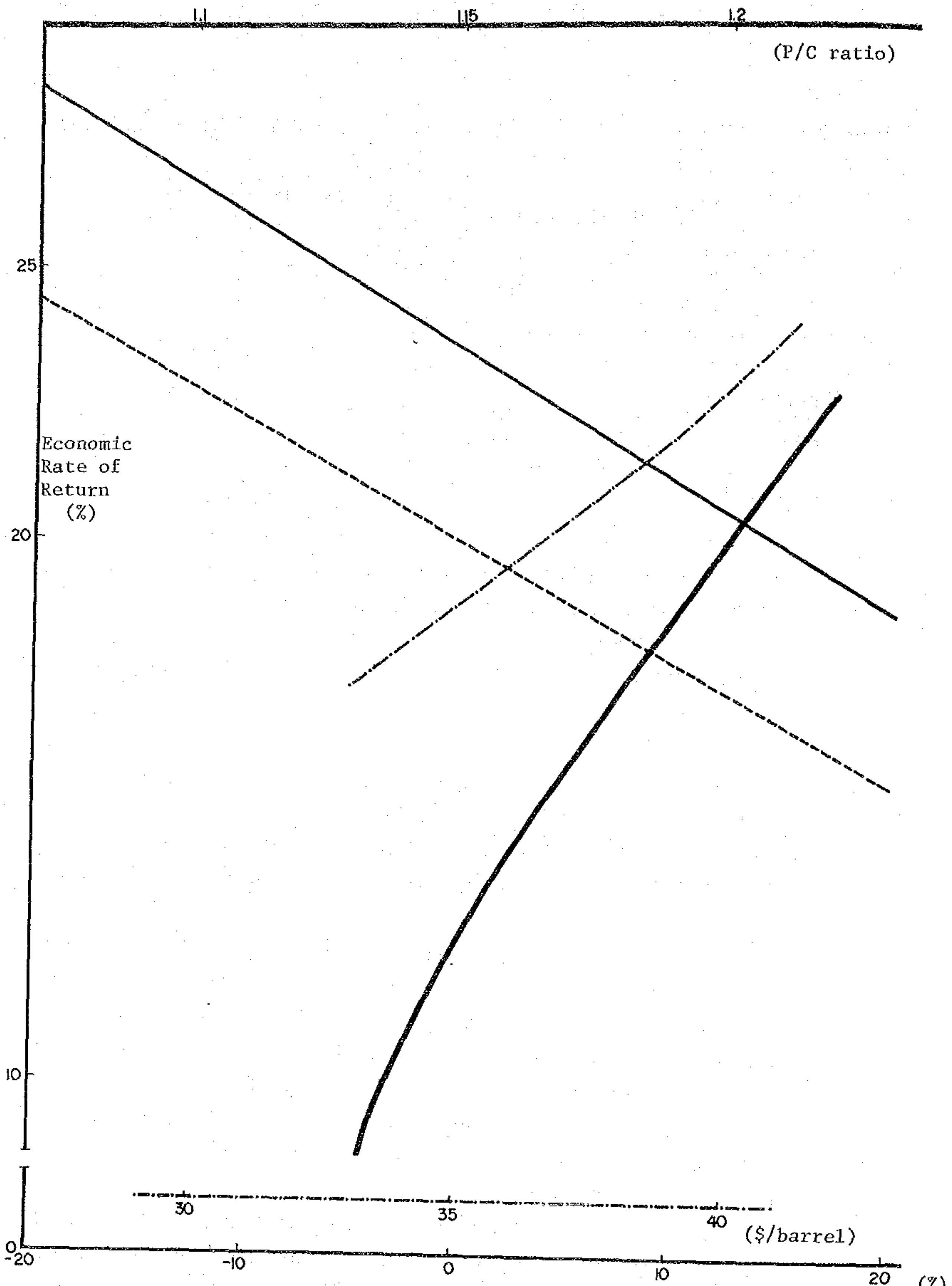
Source: The Team

economic benefit valuation and 20 percent under FOB economic benefit valuation, Reference 1 case yields merely 14 percent and Reference 2 case astonishingly low rate of seven percent. These results under the base scenario of world crude oil price increase do not alter relative advantage of the said project under the low world crude oil price scenario as seen on Figure 5.11.

The results of the sensitivity analysis show that under the base case scenario for the project, the Economic Internal Rate of Return (EIRR) of the project does not vary significantly with changes in fixed costs and in crude oil prices presumed for the project. All the discussions here refer to the base case project unless otherwise stated.

On average, the 10 percent change in fixed cost brings 2.2 percent change in EIRR, and by the 10 percent change in crude oil price, the project is affected by 2.5 percent. These EIRR changes are progressive in propotion to changes in those factors above. The wider the variation in both fixed cost and prices assumed for crude oil, the larger the change in EIRR. However the progressiveness is limited in the sense that at the 20 percent variation the EIRR changes 2.4 percent, and 2.7 percent with the change in the fixed cost and with the change in crude oil price respectively.

The product/crude ratio is the most influencial factor to the project. The impact of effect caused by variation in product/crude ratio is in the order of eightfold change in EIRR in comparison to fixed cost and the crude oil price variations. The 10 percent change in the product/crude ratio brings 17 percent change in EIRR. If the product/crude ratio gets down to 1.12, the project yields only 6.3 percent EIRR. The possibility of this detriomental situation for refinery industry over the world seems to be very remote considering the current average refinery operation cost of five percent



EIRR sensitivity to fixed cost variation
EIRR sensitivity to fixed cost variation at low crude price case
EIRR sensitivity to crude oil price
EIRR sensitivity to product/crude price ratio

Source: The Team

Fig. 5.11 SENSITIVITY ANALYSES OF EIRR OF THE PROJECT

to its revenue the outlook of world refinery market (see Section 5.3.2, Excess Capacity in the World Refinery Industry). Even if the product crude ratio gets down to 1.15, the project still yields 12.1 percent EIRR. In pursuing this project this product/crude ratio should be given careful attention.

Parameters used in this analysis are subject to the wide range of eventualities however, it is felt that the outcome of the analysis will stand up with on such eventualities. In an aspect of full analysis on the relative petroleum product value as seen in PEIDA/PENCOL's "Energy Pricing Study", it is argued that to secure the projected shortage of diesel oil, it should be assigned more value in envisaging its wide use in Thailand and its tightening demand in the Far East petroleum market. If the Thai Government maintains the current petroleum product pricing structure, the supply of diesel by this project would increase its value in terms of "Security Premium". In this way of consideration, the project would push its economic viability further up.

Due to the cost/revenue outlay of the project, the project viability indicator "EIRR" is sensitive to the relationship between product prices and the crude oil price, rather than the investment cost variation, as seen on Figure 5.11. The long-enough gestation period of the project enables to carry on a feasibility study with more concreate assumption on the product/crude price ratio which can be obtained after having observed the world crude price development and transition in the world refinery market during next four to five years. The team believes that the result of the feasibility study on this project in the end of this decade or in the biginning of the next decade will validate the outcome of the study here.

5.6 STRATEGIC ELEMENTS FOR IMPLEMENTATION OF THE REFINERY PROJECT

In view of the strategy of setting up a refinery in the South, it is possible to combine the national plicy on the petroleum stock-pile and, as a first step to the refinery project, to construct a petroleum stock yard for petroleum products or for dead crude stock.

In case of a petroleum product stock-yard, this scheme can take advantage of the current world petroleum product market glut and can share the amount of stock pile necessary to attain national goal. In other words, the product stock-pile scheme provides the following advantages:

- Thailand can enjoy product purchasing strategies of procuring products at a lower cost than current practices,

- The scheme can attain the optimal use of domestic refinery facilities and,

- The scheme can meet a required safety stock level expecting the demands to be increase by four times as much in the South in 2000 and,

- The scheme can be utilized as a petroleum product distribution center when the refinery is constructed.

The current petroleum stock tank capacity of private oil companies in the South reaches 580,500 barrels. This capacity can accommodate almost the 24 day demand in the South now, however, in 1991 the stock capacity will meet the demand for only 15 days.

It is quite natural for private petroleum companies to reduce the working capital as much as possible. Therefore, if the Thai Government in any form can support or invest into this scheme foreseeing the fourfold demand increase in the South, the private companies will certainly follow. The benefits gained from this investement will be appeared in term of reduced petroleum product market prices and secured stock level (i.e., stable supply).

The implementation timing for this scheme is recommended in 1990/1991 when the Bangkok concerntrated refineries can just supply national petroleum product demand excluding the South and cannot meet the demand in the South. Thus it might be beneficial to lift the codes limiting petroleum product import prior to the implementation of the petroleum product stock-pile yard so as to stimulate private companies' needs for additional stock capacities.

5.7 SALIENT ISSUES IN PROJECT IMPLEMENTATION AND FUTUREWORK

In implementation of this project, the following salient issues gather due attention. There exists a problem of the marketing of petroleum products. Refined products are sold to the retailers, however, those retailers who have already established market shares, are under direct influence of international oil companies. The difficulty to penetrate into this distribution channels requires assistance in the form of administrative guidances and petroleum policies on marketing and refining. Further there is a possibility that the international oil companies behave so as to attain maximum utilization of their facilities over the world. This may result in squeezing small capacity refineries, and it is beyond the scope of this study to analize this aspects of international oil corporate behaviors and the world oil market with respect to production and distribution. Thus it is only raised here as an exogenous issues of the refinery project.

Another major issue is related to energy pricing policy. Energy policy per se holds following characteristics;

- Firstly it requires integration of national goals of macroeconomics, balance of payments position and energy security.
- Secondly it should be evaluated in the context of efficiency through increasing overall welfare as wellas equity in distributing such welfare, and
- Thirdly it should be able to meet the responses of various energy related individual sectors in incorporating efficiency and equity in achivement of subject objectives.

The energy pricing, a main tool of the policy implementation, especially petroleum product policy, seems insufficient to reflect the above characteristics of energy policy. The petroleum product demand pattern based on the current price structure of domestic petroleum products (it is assumed in this analysis that the current price structure will continue), can not be matched by the production pattern to be achieved after completion of rehabilitation/debottlenecking/expansion plans of Bangchak, ESSO and TORC refiners.

The cost of importing petroleum products is not limited to the actual foreign exchange loss. There are long-term costs when such loss constrains expenditure on development related projects. The long-term costs of either reducing demand for other development oriented goods or of external borrowings are important consideration in weighing the implication of the price structure chosen.

In the above instance, there would exist large probability of reformation of petroleum pricing structure. The request of Royal Thai Government (RTG) for PEIDA/PENCOL's "Thailand Pricing Study" shows the evidence of RTG's move in this direction even though this pricing reformation would touch on some political off-springs. In the event of reformation in the pricing structure, a different demand level and a pattern are in view. In addition, toward targeted project completion year the restructuring of the world petroleum market especially in the refinery industry is envisaged.

Therefore it is recommended to perform a study on feasibility of the scheme of a refinery at Krabi again in the end of this decade having obtained more concrete informations by observing the expected dynamic evolvement in the world oil market, on which national decision with respect to additional refinery capacity would be made.

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ANNEX I TERMS OF REFERENCE FOR PROPOSED FEASIBILITY STUDY

1. TERMS OF REFERENCE FOR FEASIBILITY STUDY ON REFINERY PROJECT IN KRABI (DRAFT)

A. BACKGROUND

Currently people in the South pay 40 satangs higher price for every petroleum product than in Bangkok. If this practice continues, it will certainly be the obstacle to the industrialization of this region.

The disparity in price stems from the current petroleum product replenishment system which relies on the single remote supply center for various scattered consumption centers in the South. This system involves a long haul trip from Sri Ratcha around Singapore all the way to Phuket, and is made even more inefficient when crude oil is procured from the Middle East.

In view of an increasing demand for petroleum products toward the year 2000, the South will offer a petroleum market large enough to afford a refinery with its possible capacity of 60,000 barrels per day. Benefits from this refinery is the less expensive petroleum products for the South and the diversified petroleum supply centers for the nation. In addition, this refinery holds advantage of easing the problem of expensive petroleum products import. Supposing that Thai economy will grow at 6 percent per annum during the 1980s and thereafter at 4.8 percent toward the year 2000, the petroleum product import is estimated to increase from 97,000 to 115,000 barrels per day assuming natural gas supply of 1,200 to 1,600 million cubic feet per day and assuming the completion of existing refineries' expansion and debottlenecking programs.

The refinery in Krabi can materialize the savings in crude procurement and petroleum product replenishment by the locational advantage of Krabi to have easy access to both the Middle East and various parts in the South as well as be endowed with natural condition to accommodate over twice as large a tanker as the one utilized by refineries in Sri Ratcha.

B. OBJECTIVES

In view of the need of establishing an oil refinery, possibly in Krabi, it is the policy of the Government of Thailand to determine the feasibility of the refinery taking into account its possible location, timing, scale and other relevant factors. The refinery is aimed at:

(1) For southern regional development, coping with increasing petroleum products demand within the region to ease the current problem of relative petroleum prices in the southern region being disadvantageous over those in Bangkok. This problem would otherwise be increasingly serious in the way of regional industrialization.

(2) For national development, helping decentralization of refinery facilities as well as industries in the Bangkok Metropolitan Region thereby maximizing the effect of petroleum import substitution through reduced transport costs of both crude and products of petroleum.

The target is to produce and distribute in the South 60,000 barrels per day of petroleum products in correspondence to the pattern of future product demands in the South.

In view of such petroleum import substitution as to bring maximum economic benefits to the country, this feasibility study is necessary to evaluate the alternatives in the South with regard to material procurement and product replenishment systems and to determine the best alternative.

C. SCOPE OF WORK

The study shall cover the following items.

1) Domestic petroleum market analysis

2) Demand projection

3) Assessment of feed stock availability (crude oil)

4) Southeast Asian petroleum market analysis

5) Evaluation of the factors influential over the project

6) Evaluation of alternative locations

7) Optimal configuration of crude procurement refinery and product replenishment system

8) Organizational setup suitable for the project operation

9) Financial and economic analysis

10) Strategic elements to the project

Objectives and tasks are described below with reference to each study item:

1) Domestic Petroleum Market Analysis

The objective of this analysis is to pinpoint the reasonings for a refinery to be set up in the South, and to validate the discussion explored in the Upper South Study (USS). Subjects to be examined are:

(1) Current consumption structure characteristics

i Sectoral consumption by each product

ii Regional consumption by each product

iii Pricing structure by each product

(2) Current supply structure and its characteristics

i Existing refinery capacity/practice/expansion plans

ii Flow of imported petroleum products

iii Distribution system/sales practice with special reference to transport modes and prices

(3) Market Analysis of the South

i Consumption by products and by subregion

ii Seasonality of consumption, safety stock level and depots capacity

iii Product replenishment systems with cost by product

2) Demand Analysis

This analysis provides principle information on capacity and configuration of the planned refinery. The following steps shall be taken:

(1) Assess and evaluate existing demand forecasts by each product

(2) Forecast the demand in the South by each product

(3) Subregional demand forecast in view of optimum southern regional replenishment system for the refinery

3) Feed Stock Availability

By analyzing the availability of the crude in terms of volume and price during the project life, the optimal crude-mix for the previously obtained demand pattern shall be discussed.

(1) Domestic crude and condensate from natural gas

(2) International crude oil

i Arabian Gulf Crude (AG)
- AG extra light : Berri Murban etc.
- AG light : AL, Oman, IL etc.
- AG medium : AM
- AG heavy : AH, IH, Khefji etc.

ii Southeast Asia Crude
- Heavy low sulfer : Minas Tading
- Light low sulfer : Tapis Attaka

iii Others
- Mexican crude
- Nigerian crude

4) South East Asian Petroleum Market Analysis

This analysis highlights the prices to be adopted in financial and economic analysis and the grounds for evaluating the commissional refining option at Singapore.

In addition, international petroleum market analysis is recommended to supplement the above analysis. The tasks of this analysis are:

(1) Demand/Supply analysis of the Southeast Asia market,

(2) Petroleum product price forecast at Singapore during the project, and

(3) Analysis on the option of commissional refining with special reference to commission rate and product distribution cost.

5) Evaluation of Factors Influencial over the Project

Analysis here provides concrete information on crucial factors to be assumed in carrying out financial and economic analysis. Subject of the analysis are:

(1) Ocean transport of crude oil and products in view of CIF and FOB prospects during the project life in order to recommend the economical size of crude tanker and the costs of product tanker and barge,

(2) Import duty for petroleum products, construction materials and equipment in Thailand as well as the domestic availability and costs of these items.

(3) Financial condition in Thailand and,

(4) Other factors, namely, depreciation, tax and insurance, interest, price of labor and land, price of utilities, etc..

6) Evaluation of Alternative Locations

The objective here is to determine the best location for the project to yield maximum return on investment and to lay down the next best alternative. The analytical tasks are:

(1) Comparison in crude oil transportation coast between by a pipeline across the Peninsula and by tanker around Singapore,

(2) Comparison in petroleum product distribution cost among product pipeline across the Peninsula, rail, barge and trucks.

(3) Comparison of alternative sites in view of crude procurement and product replenishement system. In assessing the alternatives, the subregional consumption centers shall be identified in terms of demand volume and the distribution system and the cost for it to cover such demand centers shall clearly be stated. The alternatives shall include the followings.

i Refinery at Krabi with product pipeline from Krabi to the proposed Khanom Deep Seaport.

ii Refinery at Krabi with crude pipeline from Krabi

iii Refinery at Krabi with product pipeline from Krabi to Wiang Sa at which the products are to be transferred to the railway.

iv Refinery at Khanom or Songkhla with the railway to be used for product distribution.

7) Optimal Configuration of Crude Procurement, Refinery and Product Replenishment System

The objective of this analysis is to recommend the optimal project feature by taking the followings into account:

(1) Crude oil receiving facilities

(2) Handling of multiple crude oil and fuel oil

(3) Utilization of special process units such as coker, hydrocracker, etc., so as to increase middle distillates yield from feed stocks

(4) Refinery yield pattern to meet the expected demand structure in view of profit maximization.

(5) Reliability and safety measures for the project components.

(6) Necessary measures for pollution and environmental requirements in terms of products specification and effluents emitted from operation.

8) Organizational Setup Suitable for Project Operation

In view of marketing the refined products, the best form of project organization shall be discussed. How to establish an effective replenishment system and how to finance the project are the main focus in this analysis. The alternative setups may include:

(1) PTT or a Joint Venture responsible for the entire project or

(2) PTT responsible for the crude procurement system and product pipeline portion and a joint venture responsible for the refinery portion.

9) Financial and Economic Analysis

The viability of the project shall be clearly expressed in financial and economic terms. The financial analysis shall include the followings:

(1) Investment cost

(2) Rate of return

(3) Cash flow

(4) Refining operation cost and exrefinery cost of each refined product

(5) Sensitivity analysis

The economic analysis shall be carried out in terms of economic rate of return with the analysis of the sensitivity against the options of petroleum product import to the South and commissional contract refining at Singapore. As for commissional refining total CIF value should be applied i.e., all the cost from crude oil procurement to the various consumption ends at the South should be the economic benefits of the project.

10) Strategic Elements to Strengthen the Project

Environmental protection, safety measures and energy conservation measures for the entire system of the refinery project shall full be examined to make the project useful and acceptable to the area for location.

D. STAFFING

The study shall consist of experts at least in the following fields:

(1) Project management

(2) Data processing and modelling

(3) Financial and institutional analysis

(4) Economic analysis

(5) Petroleum market analysis

(6) Refinery/product distribution planning

(7) Refining process engineering

(8) Civil engineering

(9) Energy economics

(10) Environmental assessment

ANNEX II TECHNICAL PAPER

1. ANALYSES FOR ENERGY REQUIREMENT PROJECTION

1.1 ENERGY ELASTICITY AND ENERGY INTENSITY

In view of determining the long term relationship between energy and economic development, two indices are available. One is energy elasticity and the other is energy intensity. Two of these are written as below:

$$\gamma = (\Delta E/E)/(\Delta Y/Y) = \Delta \ln E/\Delta \ln Y \qquad (1)$$

$$\upsilon = E/Y$$

Where; E is primary energy consumption

Y is GDP

γ is gross energy elasticity and

υ is energy intensity

Here, a caution should be given on the term "energy elasticity". Whenever we set demand function, we can not ignore a price factor involved in it, i.e., E=f(Y, Pe) where Pe is price of energy. Therefore, we would have to argue price elasticity of energy demand simultaneously with income elasticity of energy demand.

Currently it has become a common practice however, to seize the relationship between energy demand and economic growth in the form of the gross energy elasticity as expressed in the above for the sake of simplicity and easiness in its application. This is based on the following studies which validate the gross energy elasticity as an effective analytical tool.

V. Smil & T. Kuz, "European Energy Elasticities", Energy Policy, June 1976.

J. Darmstadter, P.D. Teitelbaum & J.G. Polach, Energy in the World Economy, Johns Hopkins Univ. Press, 1971

L.G. Brookes, "More on the Output Elasticity of Energy Consumption", Journal of Industrial Economics, Vol. 21, Nov. 1972.

F.G. Adams & P. Miovic, "On Relative Fuel Efficiency and the Output Elasticity of Energy Consumption in Western Europe", Journal of Industrial Economics, Vol. 17, Nov. 1968.

W.S. Humphrey, "Economic Growth and Energy Consumption in the United Kingdom: A Note on Long-run Historic Trends", Mimeo., June 1976.

This gross energy elasticity reduces its effectiveness, when it is applied for projection purpose. The above studies provide different value of the elasticity depending on the cross sectional data and time series data. These different value mainly stem from two reasons. As an economy develops, an energy supply structure changes from an inefficient to a highly efficient one. Secondly an economic structural change itself affects both growth rate of energy demand and economy. Therefore, especially for the developing countries the indicator of the gross energy elasticity decreases its reliability for projection purpose. In addition, if either growth rate of energy demand or economy shows negative values, it is impossible to define the gross energy elasticity.

Having these arguments in mind, the energy intensity analysis is utilized in the Upper South Study in the projection of preliminary energy requirement and sectoral energy requirement. Since the energy intensity by its production functional characteristic at macro level, i.e., the energy intensity, is a reciprocal of energy productivity, it can cope with structural change of production through comparable analysis of energy intensity and economic structural change.

In further it should be noted that movement of energy intensity and elasticity will correspond to each other. Since from the previous Equation (2), we have $\ell n \upsilon = \ell n E - \ell n Y$ and further this will be expressed as $\Delta\upsilon/\upsilon = \Delta E/E - \Delta Y/Y$. (3) Comparing Equations (3) with (1), the correspondence occurs in the manner of $\Delta\upsilon/\upsilon \gtreqless 0$ against $\gamma \gtreqless 1$. In other words, when the energy intensity (interpreted as energy requirement to produce a unit of value added) records positive growth rate, the energy elasticity shows a value over 1.0 during the observation period and vice versa. In this regard it can be said that energy intensity holds ex ante characteristic, opposing to ex post characteristic of energy elasticity. Thus mere application of energy elasticity for projection purpose which assumes its stability can be unsatisfactory compared to the energy intensity.

1.2 PRELIMINARY ENERGY REQUIREMENT PROJECTION

A need to grasp the impact of energy requirement growth on the early stage of the Upper South development leads to fuller utilization of energy intensity analysis. Objectives here are to obtain the level of gross energy demand to be derived from the Upper South development plan and to check preliminarily whether such level of energy demand would be an obstacle to achieve such development. Prior to the analysis at the subregional level, the national level analysis has been carried out. The results are shown on the Table 1.1. From the table one can observe Thai economy's energy requiring nature of development process. Energy elasticity for the last decade is calculated at 1.4 with regression coefficient of 0.99 as expressed on Figure 1.1, and petroleum elasticity of 1.3 with regression coefficient of 0.97 for the same period. Therefore it is deduced that the economic development process of Thailand has been supported by high rate of energy consumption and mainly by petroleum. Energy intensity at national level is estimated at 41 liters of crude oil equivalent per 1,000 Bahts worth of Gross Domestic Product and petroleum intensity is 34 liters /฿1,000 GDP for the year 1970. These intensities show annual growth rate of 3.2 percents and 2.5 percent respectively up to the year 1980. Two apparent indications for energy outlook in Thailand stem from the above findings. They are; firstly even assuming a strong energy management, the development process of Thailand will require fast energy demand at least same as the growth rate of Thai economy i.e., energy elasticity of 1.0; secondly, petroleum will still play a major role in the energy supply structure of Thailand, even though petroleum contribution to the total energy supply has been reduced from 83 percent in 1970 to 75 percent in 1980. At this point, it is felt beneficial to define energy. Throughout this paper, unless otherwise specified, energy implies commercial energy i.e., primary energy sources such as petroleum, natural gas, lignite, and hydro except traditional energy such as charcoal, bagasse and firewood. Having the problem of ever increasing crude oil price and oil import bill for Thailand on one hand and evisaged energy demand on the other, it is natural that energy planning in the Upper South has to necessarily be coordinated with national goal of energy supply diversification with maximum development of indigenous energy sources. Of course this direction of planning depends on the availability of petroleum substitutable resources. Should such substitution possibility be reduced, the energy planning naturally seeks the least costly way to supply petroleum to the sub-region. In any event, the followings are the results of preliminary energy demand projection as the starting point of energy planning.

1.2.1 Petroleum

Confronted with rather short time series petroleum consumption data and lack of such data by economic sector, projection here necessarily limits its scope with just total petroleum product requirement.

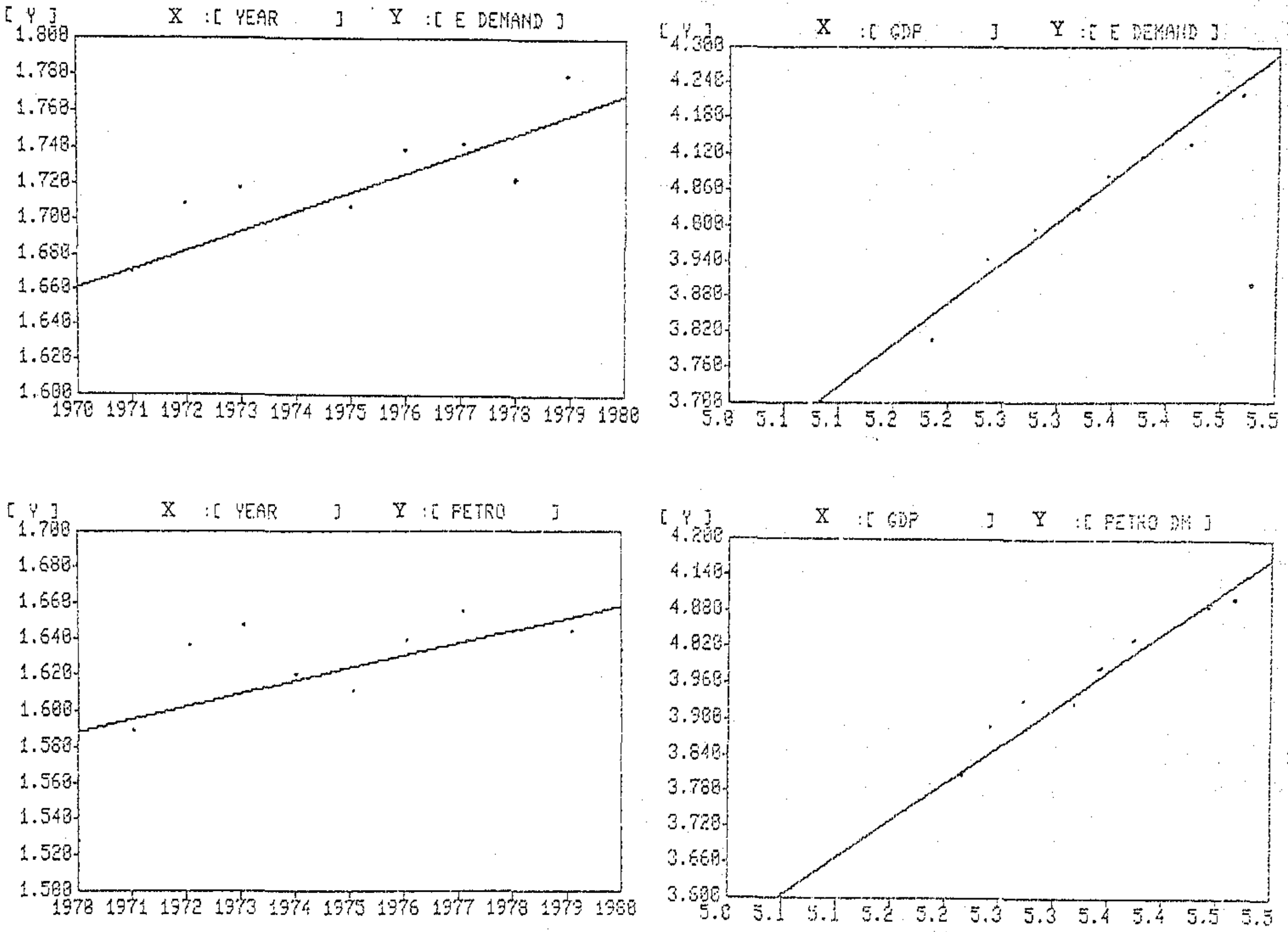
Table 1.1 GDP, TOTAL ENERGY AND PETROLEUM CONSUMPTION

	GDP (10^6฿)	POP (1000)	Energy Consumption (10^6)	Petroleum Consumption (10^6)	Energy Intensity (LCOE/฿1,000)	Petroleum Intensity (LCOE/฿1,000)
1970	151,897	35,550	6,303	5,123	41	34
1971	164,298	36,734	7,692	6,406	47	39
1972	170,656	38,369	8,694	7,455	51	44
1973	188,427	39,946	9,823	8,429	52	45
1974	197,334	41,335	9,999	8,209	51	42
1975	208,162	42,391	10,611	8,482	51	41
1976	221,225	43,214	12,109	9,581	55	43
1977	237,173	44,273	13,092	10,719	55	45
1978	261,097	45,222	13,775	11,536	53	44
1979	276,907	46,114	16,698	12,225	60	44
1980	292,852	46,961	16,643	12,609	57	43
Annual Av. growth-rate	6.8	2.7	10.2	9.4	3.2	2.5
Elasticity of E. Demand	–	–	1.4	1.3	–	–

Source : NEA

Note : LCOE = Litters of crude oil equivalent

Fig. 1.1 CHANGING GDP, ENERGY DEMAND AND ITS ELASTICITY



1: REGRESSION

Y=-3.38898
1.39514 X

2: X MEDIAN= 5.32398
X SD= 9.84257E-02

Y MEDIAN= 4.03871
Y SD = .127792

3: REG. COEFFCIENT

R= .98653

X G.R = 6.78493

Y G.R = 10.1966

1: REGRESSION

Y=-2.70239
1.24898 X

2: X MEDIAN= 5.32398
X SD= 9.84257E-02

Y MEDIAN= 3.94715
Y SD = .116092

3: REG. COEFFCIENT

R= .972417

X G.R = 6.78493

Y G.R = 9.4253

In 1981 petroleum intensity of the Study Area (SA) is 32.8 liter per 1,000 baht value added which is 24% lower than that of national average of 43 liter per 1,000 baht value added. This low energy intensity does not suggest the existence of energy efficient economic production system in the SA. The economic production structure and scale of production together work as a factor to vary the petroleum intensity.

Thailand Upper South Planning (TUSP) aims at attaining regional development goals in the SA with the scenario discussed in this main report. Thus under the provided scenario the economic structure in the SA in 2000 is quite different from the current structure.

Given a prospect that the economic structure in the Study Area will similarly change towards the national structure through rapid industrialization, the oil intensity of the Study Area will simultaneously catch up with the national level.

Based on this assumption, the oil intensity of the Study Area will grow up by 1.36 percent per annum, and the total demand of oil will increase by 8.45 percent per annum under the target projection of economic framework. Hence, the elasticity of oil demand growth rate to GDP growth rate is assumed to be about 1.2.

Table 1.2 shows the results of oil demand projection based on this assumption. The composition of use in the future is assumed to be similar to that as of 1981.

According to this projection, the total oil demand in 2000 is assumed to be about 25.3 thousand barrels per day or about 1,470 million liter per annum.

Table 1.2 OIL DEMAND PROJECTION IN THE STUDY AREA IN 2000

		Oil Demand (Barrel/day)	Share (%)
Total		25,325	(100.0)
Source-Mix	Gasolin	5,419	(21.4)
	Diesel	18,133	(71.6)
	Fuel Oil	633	(2.5)
	LPG	633	(2.5)
	Others	507	(2.0)
Sector-Mix	Transportation	11,320	(44.7)
	Agriculture	2,305	(9.1)
	Manufacture	4,812	(19.0)
	Elec. & Water	4,761	(18.8)
	Service/Households	2,127	(8.4)

1.2.2 Electricity

In a manner same as the above electric intensity (electricity consumed to produce per unit of GDP or GRP) was calculated and presented in Table 1.3.

From the table, less electricity dependent nature of the southern regional products is clearly observed. The Study Area as a whole shows 24 Kwh/฿1,000 while the lowest intensity of 7.06 Kwh/฿1,000 was found in Phangnga and high intensity of 62.65 Kwh/฿1,000 value added at Phuket. The reason for this comes from the fact that a large portion of provincial products in Phuket is generated by electricity intensive tourism industry and tin mining industry, and vice versa in Phangnga.

Table 1.4 and 1.5 provide supporting electricity consumption data for Table 1.3. From Figure 1.2 to Figure 1.4 the results of regression analysis on electricity consumption and value added (GDP, or GRP) are illustrated.

In order to achieve a target economic growth in the Study Area, there would be several scenarios from the one to hold last ten-year average economic structure of the whole kingdom in the Study Area to the extreme one to introduce Bangkok type economic structure.

In applying the electricity intensity of 37.11 Kwh/฿1,000 which is a mean average of the whole kingdom, the electricity demand in the Study Area would be about 658 Gwh by 1991. To reach at this consumption level, the growth rate of electricity demand is calculated at 9.2%/year. If the present level of 46.7 Kwh/฿1,000 of the whole kingdom is applied, the demand would be about 828 Gwh, and that the electricity demand is assumed to grow at 14.8%/year.

The latter case of 46.7 Kwh/฿1,000 intensity is brought by just the intensity of 20 Kwh/฿1,000 in study area growing at 7.7%/year. Thus the probable development framework of TUSP in view of electricity requirement would be around 700 Gwh in 1991.

Table 1.3 ELECTRICITY INTENSITY

YEAR.	NO.	WK.	BK.	SOUTH	S.A.	KRABI	PHANGNGA	PHUKET	SURAT THANI
1970	1	25.45	61.41	12.42					
1971	2	27.32	66.18	12.94					
1972	3	31.09	72.01	12.71					
1973	4	34.05	78.37	13.17	14	2.70	11.38	46.39	4.62
1974	5	33.96	75.79	14.59	15	3.05	11.15	50.68	4.61
1975	6	36.54	79.87	17.40	18	3.25	12.66	62.78	6.49
1976	7	39.36	82.47	19.59	19	4.30	8.72	62.43	11.01
1977	8	42.86	85.30	21.69	21	4.65	9.24	61.31	15.53
1978	9	44.18	87.14	23.60	20	4.68	6.63	65.11	16.27
1979	10	46.71	85.96	26.69	22	7.25	7.25	58.22	19.14
1980	11	46.69	82.64	29.37	24	10.34	7.06	62.65	22.37
MEAN		37.11	77.92	18.56	19.1				
E. Intensity Growth Rate		6.26	3.01	8.98	7.72				

Source : PEA and EGAT

Table 1.4 GPP & ELECTRICITY CONSUMPTION

Unit : million baht, megawatt hour

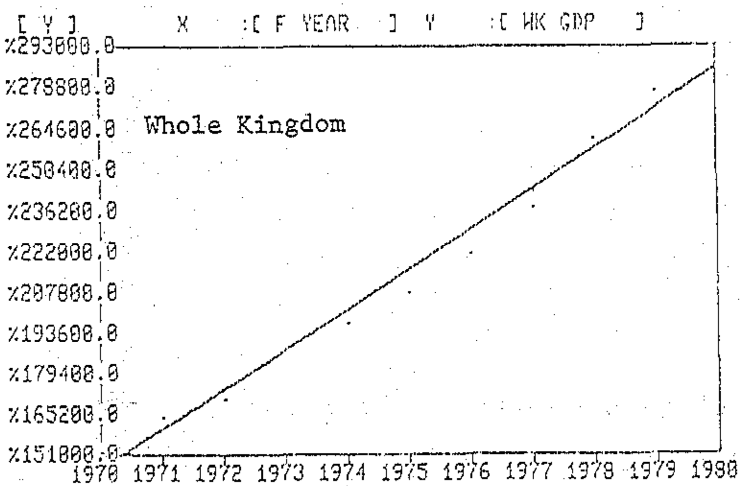
YEAR	SURAT GPP	PHANGNGA GPP	PHUKET GPP	KRABI GPP	SURAT ELC	PANGNGA ELC	PHUKET ELC	KRABI ELC
1973	2,136	1,251	955	608	9,878	14,235	44,307	1,640
1974	2,258	1,336	1,062	637	10,407	14,890	53,839	1,945
1975	2,336	1,373	1,007	663	15,150	17,391	63,216	2,157
1976	2,455	1,428	1,055	709	27,027	12,447	65,861	3,049
1977	2,607	1,875	1,200	892	40,489	17,326	73,578	4,149
1978	3,114	2,318	1,316	1,043	50,672	15,361	85,689	4,880
1979	3,203	2,537	1,612	860	61,306	18,386	93,846	6,233
1980	3,196	2,956	1,707	896	71,481	20,880	106,946	9,269
Average Annual Growth Rate	5.92	13.0	8.65	5.69	32.67	5.63	13.42	28.07
Elasticity of Elec.Demand					4.59	.35	1.25	2.64

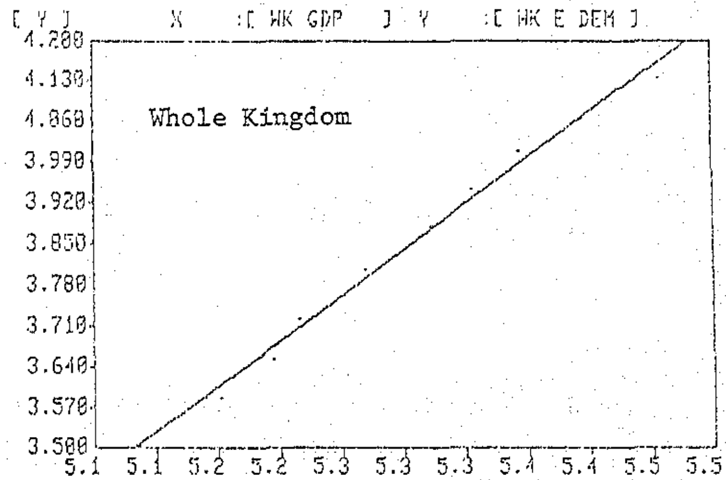
Table 1.5 GRP & ELECTRICITY CONSUMPTION

	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	Av Annual Growth Rate	Elasticity of E. Demand
Wk GDP	151,897	164,298	170,656	188,427	197,334	208,162	221,225	237,173	261,097	276,907	292,852	6.78	0
Bk GRP	44,831	48,002	51,283	56,603	58,953	63,241	67,992	74,939	82,005	92,715	100,270	8.38	0
South GRP	16,099	17,691	18,832	20,124	20,424	21,377	22,406	25,536	27,626	28,889	30,236	6.51	0
SA GRP	-	-	-	4,950	5,293	5,380	5,647	6,574	7,791	8,212	8,755	8.49	0
Wk (GWh)	3,866	4,488	5,306	6,415	6,701	7,606	8,708	10,165	11,534	12,934	13,673	13.46	1.94
MEA (GWh)	2,753	3,177	3,693	4,436	4,468	5,051	5,607	6,392	7,146	7,970	8,286	11.65	1.36
PEA (GWh)	786	931	1,235	1,575	1,797	2,125	2,655	3,315	3,916	4,542	4,966	20.24	2.88
South ELC (GWh)	200	229	240	265	298	372	439	554	652	771	888	16.07	2.48
SA ELC (GWh)	50	62	67	70	82	98	108	136	157	180	209	16.87	1.69

Note : SA ELC is the Electricity Consumption in the Study Area i.e., the Upper South.

Fig. 1.2 REGRESSION ANALYSIS FOR ELECTRICITY CONSUMPTION FOR THE WHOLE KINGDOM AND BANGKOK





1: REGRESSION

Y=-6.45258 + 1.94173 X

2: X MEDIAN= 5.32396
X SD= 9.84257E-02

Y MEDIAN= 3.86502
Y SD = .176274

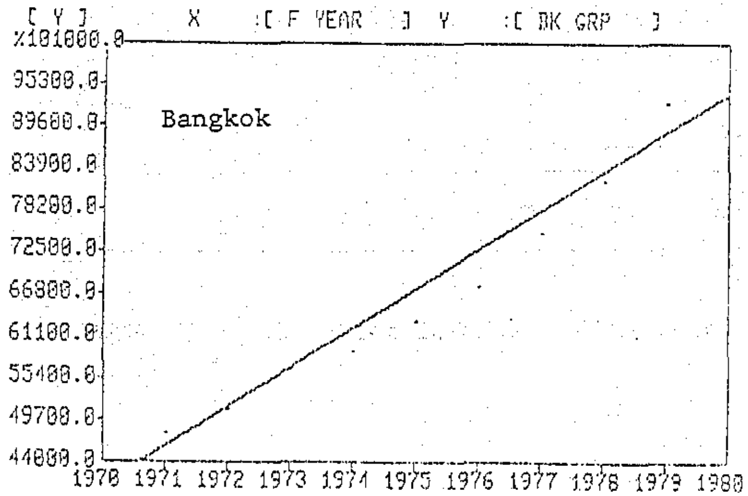
3: REG. COEFFCIENT

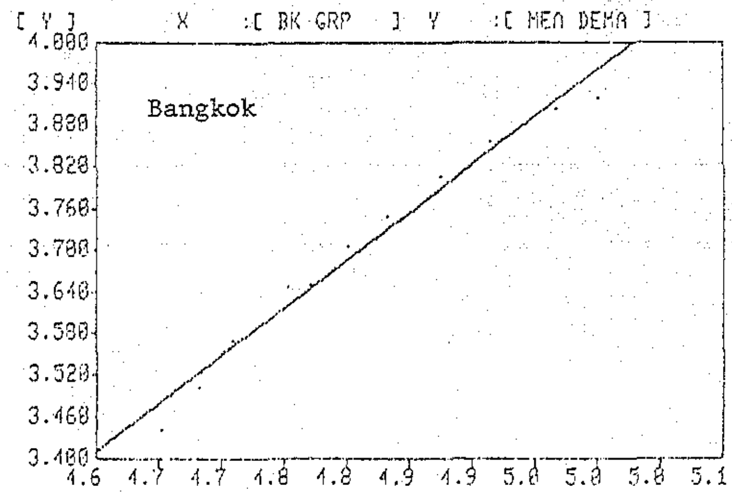
R= .994974

X G.R = 6.78493

Y G.R = 13.4646

[X]





1: REGRESSION

Y=-2.88403 + 1.36834 X

2: X MEDIAN= 4.81423
X SD= .110853

Y MEDIAN= 3.70345
Y SD = .152337

3: REG. COEFFCIENT

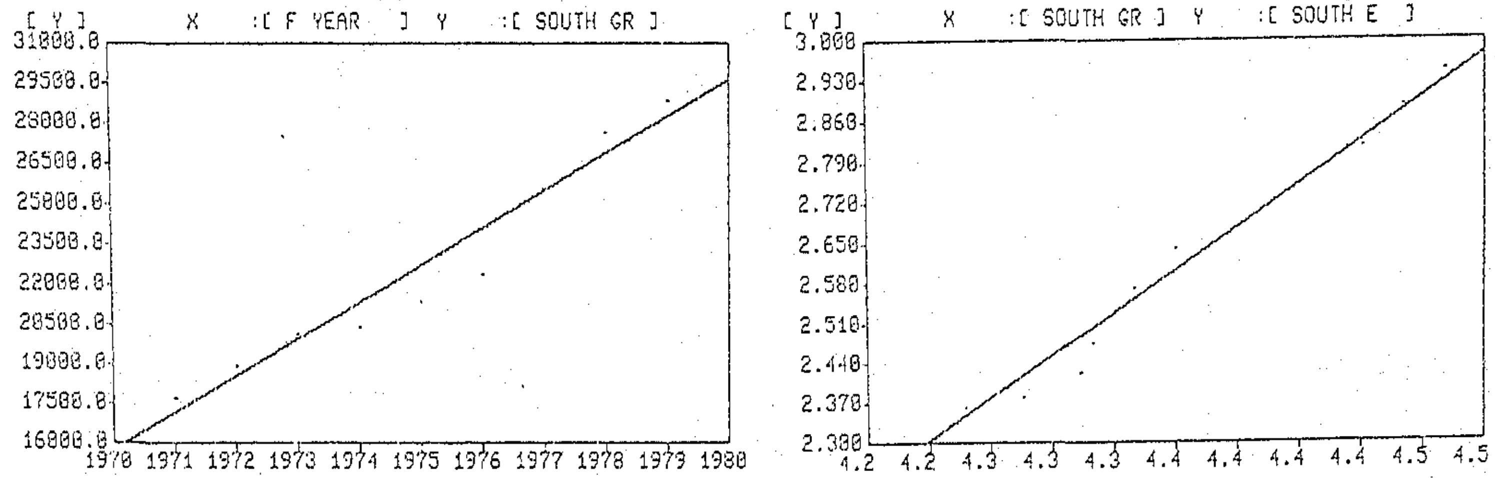
R= .988192

X G.R = 8.38252

Y G.R = 11.6488

[X]

Fig. 1.3 REGRESSION ANALYSIS FOR ELECTRICITY CONSUMPTION FOR THE SOUTH



1: REGRESSION

Y=-8.21162
2.48612 X

2: X MEDIAN= 4.34677
X SD= 8.60706E-02

Y MEDIAN= 2.59498
Y SD = .216407

3: REG. COEFFCIENT

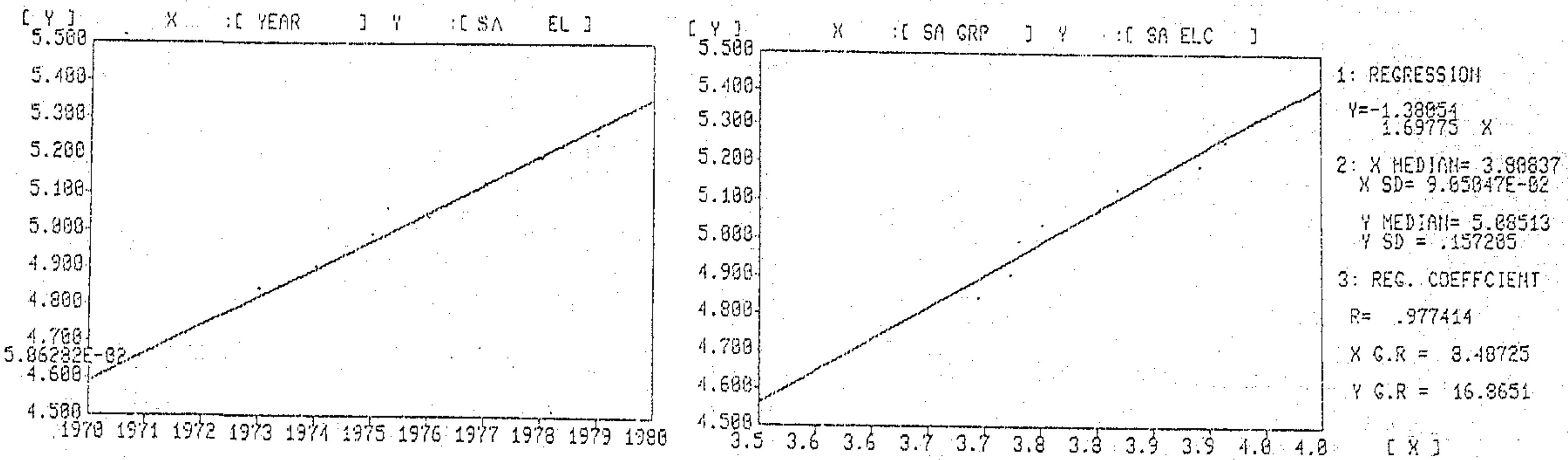
R= .987605

X G.R = 6.50563

Y G.R = 16.8749

[X]

Fig. 1.4 REGRESSION ANALYSIS FOR ELECTRICITY CONSUMPTION FOR UPPER SOUTH



1.3 ENERGY INTENSITY ANALYSIS FOR THE MANUFACTURING SECTOR

In view of rather massive industrialization in the Upper South along with the development master plan, elaborated energy intensity analysis has been carried out.

The manufacturing sector, historically grown at 8% per annum, will grow at much faster rate under our scenario. This fast growth is accompanied by the changing manufacturing structure, which leads to an increased electricity requirement as well as petroleum requirement per unit of manufacturing value-added. Thus the historical consumptive indices remain irrelevant for projection. The same applies to the service sector.

In these instances energy intensity analysis is effective to provide energy requirement projection. For this bottom up energy requirement projection method, comparative analysis of energy intensities among national level, that of Japan and that of Energy Master Plan has been performed. Table 1.6 presents the bases for energy requirement projection. Tables 1.7 and 1.8 provide projection of energy requirement for the manufacturing sector. In these tables "with" reflects the target economic projection and "without" represents trend economic projection of the master plan. Energy requirement has been obtained in the following manner:

$$ER = VA \times EI$$

where; ER is energy requirement for each manufacturing sector,

VA is projected value added for that sector, and

EI is energy intensity for that sector.

The projected energy intensities for the year 1991 and for the year 2000, have been derived from the analyses of current intensities in national average of Thailand and of Japan and then followed by assessment of individual industry transformation within the manufacturing sector with due attention to energy conservation. With regard to assessment of individual industry transformation, the translog cost function analysis is utilized, which is described in the proceeding section. The data are derived from Energy Master Plan (EMP) in 1983, the I-O Table of 1975 in Thailand, and the Manufacturing Industrial Survey by Center for Industrial Estate of Japan in 1981. The intensities in 2000 have been reduced by 5% on average from those in 1991 considering actualization of energy conservation technologies.

Table 1.6 ENERGY INTENSITY IN UPPER SOUTH, 2000

	1991		2000	
	Petroleum ℓ/1000฿	Electricity kWh/1000฿	Petroleum ℓ/1000฿	Electricity kWh/1000฿
Food	8.48	29.88	8.06	28.39
Textile	20.15	66.90	19.14	63.56
Nonmetallic	15.87	39.97	15.08	37.97
Wood & Lumber	20.34	39.97	19.32	37.97
Paper & Pulp	11.43	23.25	10.86	22.09
Chemical & Petroleum	104.54	101.76	99.31	96.67
Metal	59.37	1,174.80	56.40	587.40
Metal Products	3.33	22.40	3.16	21.28
Machinery	3.67	24.23	3.49	23.02
Others	6.99	43.27	6.64	41.11
Manufacturing Total	26.10	59.88	24.80	56.88

Table 1.7 PETROLEUM REQUIREMENTS FOR MANUFACTURING, YEAR 2000

	"Without" Case		"With" Case	
	(ℓ)	(1,000 BDOE)	(ℓ)	(1,000 BDOE)
Food Stuff	13,158	227	41,822	721
Spinning, Wearing & Bleaching	3,893	67	9,326	164
Wooden Furniture	14,032	242	32,069	553
Pulp & Paper	4,800	83	10,902	188
Petroleum	2,235	39	21,775	375
Ceramic	63,669	1,097	147,077	2,534
Iron & Steel	795	14	13,018	224
Nonferrous Metal	403	7	403	7
Fabricated Metal	578	10	578	10
Transport Equipment	6,507	112	14,781	255
Leather Products	1,081	19	11,414	197
Manufacturing Average	170,089	2,931	506,335	8,724
Total	127,237	2,192	337,203	5,810

Table 1.8 ELECTRICITY REQUIREMENT FOR MANUFACTURING, 2000

	"Without" Case		"With" Case	
	(GWh)	MW	(GWh)	MW
Food Stuff	46,346	5,293	147,310	16,823
Spinning, Wearing & Bleaching	12,929	1,476	31,633	3,613
Wooden Furniture	35,331	4,035	80,748	9,221
Pulp & Paper	9,433	1,077	21,426	2,447
Petroleum	4,546	519	44,293	5,058
Ceramic	61,976	7,078	143,167	16,350
Iron & Steel	8,276	945	135,578	15,483
Nonferrous Metal	9,311	1,063	9,311	1,063
Fabricated Metal	3,893	445	3,893	445
Transport Equipment	42,920	4,901	97,497	11,134
Leather Products	6,695	765	70,669	8,070
Manufacturing Average	390,105	44,550	1,161,304	132,621
Total	278,050	31,753	862,078	98,449

1.4 TRANSLOG COST FUNCTION FOR ENERGY CONSUMPTION ANALYSIS FOR THE MANUFACTURING SECTOR

In evaluating the results of precedent energy intensity analysis in view of establishing the base energy intensity coefficients for the projection purpose, the results of translog cost function analysis were utilized. It contributes very much to projection of energy requirement for the Upper South industrialization so that substitutability and complementary relationships among production factors in the manufacturing sector in this country are to be plainly indicated.

Translog cost function analysis provides us insights into peculiarities of each type of industry with respect to its production structure in terms of substitutive relationship among production factors, such as labor, capital and energy. Results of the analysis based on the Industrial Census of 1975 and 1969 are shown in Table 1.9.

Table 1.9 ESTIMATES OF PRICE ELASTICITIES OF DEMAND IN THAILAND

Sector	Cross Price Elasticities		Own Price Elasticities	Degree of Economy of Scale
	ELK	EEK	EEE	$1 - \alpha$
Food and Beverages	-0.188	-0.4744	6.940	0.0897
Textile	0.573	-0.476	-1.615	0.0090
Leather, Wood, Wood Products and Other Mfg. Products	0.024	-0.196	-0.663	0.1637
Paper, Paper Products and Printing	-0.499	1.347	-3.792	0.1219
Chemical	0.912	1.848	-4.894	0.1007
Rubber, Plastic and Non-metallic Products	0.337	-0.063	-2.413	0.1459
Metal Products	-0.090	-0.884	1.277	0.1273
General Machinery	-0.239	-0.077	-1.496	0.0023
Electric Machinery	-0.441	-0.229	-2.339	-0.0620
Transport Machinery	-0.733	5.794	-9.241	0.1439

2. ENERGY SUBSECTOR CONSUMPTION ANALYSIS AND PROJECTION

2.1 ELECTRICITY

2.1.1 Consumption in Study Area (SA)

In Surat Thani during 1973/1980 period the Electricity Consumption (EC) grew at 32.7% per annum, while Gross Provincial Product (GPP) recorded the growth rate of 5.9%. This enormous speed of EC growth rate resulted in the Elasticity of Electric Demand (EED) of 4.6. The reason for this stems from three-fold increase of residential customers and five-fold increase of business and industrial customers. In 1973 the share of EC between residential and the growth of business and industrial were 67% and 33% respectively and in 1982 those share reversed as 30% for residential and 70% for business and industrial.

This rapid growth of EC are recognized in every SA changwat except Phangnga which showed the moderate EC growth rate of 5.63%/year. In Phangnga, the share of residential EC was 14% in 1973 and in 1982 it increased to 45%. This implies less electricity intensive GPP producing economic structure which is tin mine oriented, and the highest level of GPP per capital in Whole Kingdom (see Table 2.1)

In 1982, the EC by economic sector in SA consists of 28.7% residential, 19.2% business, 50.4% industrial, and 1.7 others, while Whole Kingdom picture is 23.7% residential, the group of business and residential 75.5% and the other 0.8% (see Table 2.1)

Towards year 2000, SA generates economic activities along with the development scenario. Thus it is envisaged that the EC structure come close to that of Whole Kingdom or even to that of Bangkok, where residential, business & industrial occupies their share as 19.2%, 29.8% and 47.1% respectively.

However due attention has to be paid in the impact of electrification program. By the end of 1982, the electrification rate of households in SA is merely at 29% while Bangkok reaches 88%.

PEA has been putting efforts in implementing the Accelerated Rural Electrification Program II which aims to electrify 7,878 villages in South. In SA, by 1986 90% of villages are electrified through ARE I and other programs. PEA estimates initial connection rate with the electrified village at 65% and 12%/year growth of connection rate afterwords so that by 1991 almost all the houses in electrified village are assumed to have access to the electricity.

We estimate number of households growth rate at 3.4%/year in the case of "with" scenario considering population growth rate of 3% per annum and tendency of decreasing members per household (in year 2000, 5.03 person/household is projected). Thus the current 203,471 households would almost double by the year 2000, and if 90% of household electrification is assumed, the residential demand would grow 5 times as much as today's level. Therefore, it is felt necessary to carry out an elaborate analysis in residential electricity use.

Table 2.1 ELECTRIC CONSUMPTION IN STUDY AREA

Unit: 1,000 kWh,%

	1980	1981	1982
Phangnga			
Residential	9,235.2(44.2)	9,967.8(44.4)	11,146.2(44.5)
Business	4,474.1(21.4)	4,211.0(18.7)	4,548.9(18.2)
Industry	6,817.6(32.7)	7,928.2(35.3)	8,973.4(35.8)
Ag. Pumping	-	-	-
Others	352.7(1.7)	366.2(1.6)	367.9(1.5)
Total	20,879.6(100)	22,473.0(100)	25,036.5(100)
Surat Thani			
Residential	19,221.6(26.9)	23,253.7(28.5)	25,609.0(29.5)
Business	13,535.6(18.9)	12,504.4(15.3)	15,845.3(18.3)
Industry	38,400.3(53.7)	45,597.0(55.8)	43,284.0(49.9)
Ag. Pumping	-	-	1,654.1(1.9)
Others	323.4(0.4)	357.6(0.4)	336.9(0.4)
Total	71,481.0(100)	81,712.6(100)	86,729.3(100)
Phuket			
Residential	18,350.2(17.2)	21,351.5(20.5)	23,378.1(22.6)
Business	29,393.8(27.5)	20,344.6(19.5)	21,522.2(20.8)
Industry	57,842.8(54.1)	61,510.1(58.9)	57,095.6(55.2)
Ag. Pumping	-	-	-
Others	1,359.0(1.3)	1,169.8(1.1)	1,463.6(1.4)
Total	106,945.7(100)	104,376.1(100)	103,459.5(100)
Krabi			
Residential	4,529.0(48.9)	5,221.5(45.8)	6,176.5(39.2)
Business	1,999.4(21.6)	2.086.2(18.3)	2,334.8(14.8)
Industry	2,536.4(27.4)	3,892.7(34.1)	7,043.9(44.7)
Ag. Pumping	-	-	59.5
Others	204.5(2.2)	203.5(1.8)	202.8(1.3)
Total	9,269.3(100)	11,403.8(100)	15,758.0(100)
Study Area			
Residential	51,336.0(24.6)	59,794.5(27.3)	66,309.8(28.7)
Business	49,402.9(23.7)	39,146.2(17.9)	44,251.2(19.2)
Industry	105,597.1(50.6)	117,664.7(53.8)	116,396.9(50.4)
Ag. Pumping	-	-	1,654.1(0.7)
Others	2,239.6(1.1)	2,097.1(1.0)	2,371.2(1.0)
Total	208,575.6(100)	218,702.5(100)	230,983.2(100)

2.1.2. Residential Electric Consumption

In 1982, the annual average residential electric consumption customer in Study Area (SA) is 1,114.8 Kwh with the highest consumption in Phuket at 1,410 Kwh and the lowest in Surat Thani at 939.6 Kwh. (see Table 2.2)

In Bangkok the average residential electric consumption per customer is 2,466.9 Kwh in 1982. This level of consumption exceeds the level recorded in Japan in 1980, which was 2,227 Kwh/customer. (see Table 2.3)

Thus the level of consumption per customer in SA is only half of electricity consumption in Bangkok and corresponds to the level of Japan in 1965, which was 1,122 Kwh/customer. The total residential electric consumption in SA during 1973/82 period grew at 16.4%/year from 16.16 Gwh in 1973 to 66.31 Gwh in 1982. During the same period the number of residential customer showed 10.6%/year growth and the average consumption per customer increased at 5.8%/year from 673 Kwh/ customer to 1,114.6 Kwh/customer.

Therefore 65% of the increase in residential electricity consumption is explained by growth of new customer, and 35% by increase in electricity use per customer.

The same picture applies to whole of PEA and MEA residential demand. PEA's rapid growth rate of 18.5%/year during the last decade consists of 16.2%/year increase in customer and 2.3%/year increase in consumption per household. MEA's per customer grew at the same speed of PEA's 2.3%, during the same period, while total residential electricity consumption and total number of customers showed 10.6%/year and 8.3%/year respectively. New customer explains 88% of demand growth for PEA and 83% for MEA.

As mentioned earlier, in assessing future demand, careful investigation of electrification program and increase in new households are in due attention as well as changing level of electric consumption per household/customer for TUSP. The proceeding pages provide more elaborate picture of electricity consumption per household.

The Table 2.2 presents the residential electric consumption in 1982 in each subject changwat by Kwh per household per month. In the table Surat Thani and Krabi showed significant increase while Phangnga exhibited declining trend. SA average consumption in TUSP Survey (98.4 Kwh) is 5% larger than PEA's (93.9 Kwh).

However, consumption level in newly electrified houses especially in rural area differ greatly from those figures. The figure with parentheses under in Surat Thani is obtained from "Summary of Electrification Monitoring Program of ARE II (as of March 31, 1983)". The newly electrified household electricity consumption level stays only 40% of SA average (39.4 Kwh).

Table 2.2 RESIDENTIAL ELECTRIC CONSUMPTION 1982
(Kwh/household/month)

	Surat Thani	Phuket	Phangnga	Krabi	SA Av.[1)]
PEA[2)]	78.3	117.5	91.7	93.1	93.9
TUSP Survey[3)]	92.9 (39.4)[4)]	113.2	74.5	111.24	98.4 (35.4)[5)]

1) Study Area Average

2) Calculated from PEA complied data of 1982

3) Estimates from TUSP Survey Undertaken in August 1983 (1,000 samples)

4) From Rural Electrification Monitoring Program 1982/83

5) Rural Household Energy survey 1980, NEA

Source : PEA, TUSP

Table 2.3 RESIDENTIAL ELECTRIC CONSUMPTION PER CUSTOMER
(Kwh/customer/year)

Unit: kWh

Thailand, 1982		Japan	
PEA	70.9	1961	786.0
SA	1,126.8	1965	1,122.0
Whole Kingdom	1,094.9	1970	1,574.4
MEA	2,466.9	1980	2,227.2

Source: PEA, EGAT and Institute of Central Electric power Japan

NEA's "Rual Household Consumption 1980" also suggests that the village level electric consumption is 36% of SA average or 35.4 Kwh/household/month. NEA's sample are 150 in total and drawn from villages in Trang, Chumporn, Krabi and Songkhla.

In order to look into the picture of this difference in household electricity consumption more clearly, Table 2.4 and Table 2.5 are prepared. SA average households daily use of electricity being 3.13 Kwh consists of lighting 37.6% (1.18 Kwh), housewares 33.8% (1.06 Kwh) and cooking 13.4% (.42 Kwh), while newly electrified rural household consumes 1.18 Kwh a day for lighting 41.1% (.48 Kwh) housewares (.36 Kwh) and water pumping 12.5% (.15 Kwh).

Table 2.4 UNIT CONSUMPTION OF ELECTRICITY BY HOUSEHOLD APPLIANCES (Kwh/day)

Rice cooker	.52
Refrigerator	1.67
Air conditioner	2.30
Color TV	1.07
Black & White TV	.32
Electric lights	1.17
Fans	.10
Portable water pump	.37
Iron	.98
Laundry machine	.10
Vacuum cleaner	.36

Note: Estimate are based on "National Living Standards and Energy Demand", Institute of Energy Economic, Sept. 1980, "Rural Household Energy Consumption 1980" NEA, and "Bangkok Household Energy Consumption 1980" NEA.

Table 2.5 RURAL HOUSEHOLD ELECTRICITY USE

	Electricity Use 1)			KWh/day/household	
	Whole	Kingdom	South	SA Average	South Rural Av.
Cooking	10.8	13.4	11.1	.42	.13
Light	19.2	37.6	41.1	1.18	.48
Irong	4.9	7.7	5.1	.24	.06
Houseware	65.1	33.8	30.2	1.06	.36
Water Pump	-	7.5	12.5	.23	.15
Total	100.0	100.0	100.0	3.13	1.18

Note: 1) Calculated from "Rural household Energy Consumption 1980", NEA.

Table 2.6 ANNUAL ENERGY CONSUMPTION FOR RESIDENTIAL HOUSEHOLDS

Province	Average annual cash income per household (1,000 Baht)		Consumption per household (KWh/year)	
	Electrified villages	Unelectrified villages	Electrified villages	Unelectrified villages (projected)
Yala	30.6	28.0	218	178
Pattani	30.6	23.4	236	192
Narathiwat	29.5	22.1	236	183
Songkhla	29.6	17.4	268	207
Satun	38.2	19.7	259	222
Phatthalung	36.3	20.7	334	286
Nakhon Sithammaret	29.6	23.2	230	178
Suratthani	31.2	23.0	210	162
Phang-Nga	32.3	27.4	356	290
Trang	30.0	18.6	254	197
Krabi	31.8	22.7	259	222
Phuket	38.3	28.8	268	197
Phetchaburi	33.7	26.1	370	286
Prachuabkhirikhan	44.1	34.0	251	185
Chumphon	42.6	37.5	212	173
Ranong	32.8	20.8	237	203
Ratchaburi	29.0	-	415	338
Nakhon Pathom	62.4	-	621	456
Kanchanaburi	32.8	28.8	326	240
Suphanburi	38.8	-	254	197
Chantaburi	47.1	38.0	396	323
Prachinburi	29.5	28.4	269	208
Phatchabum	38.3	39.3	212	182
Phitsanulok	25.0	22.0	301	258
Nan	22.6	17.5	183	149
Chiang Rai	22.6	21.0	242	178
Phayao	22.5	22.0	276	214

Source: Based on PEA's 1977 ORE Survey E for electrified households and Survey B for unelectrified villages.

2.1.3 Income and Electricity Consumption

This difference in electricity consumption are considered to be caused by the difference in income level as well as stock level of electric appliances and the shift from traditional energy to electricity between non electrified rural households and electrified municipal & rural households.

To assess the future demand of electricity for residential households, it is necessary to seize the relationship between price of electricity, income level and electric consumption through item series data or cross sectional data. Unfortunately such data are unavailable for TUSP, even though the efforts are made through pilot sampling for the energy study.

PEA's AREII Program base study and NEA's "Rural Energy 1980" provide variable information on this point as shown on Table 2.6 and Table 2.7 respectively.

Table 2.7 ANNUAL INCOME AND ELECTRICITY CONSUMPTION IN RURAL AREA

	Income/household	Income/person	Kwh/person
North	23,479	4,353	17.37
North-east	15,738	2,469	4.40
Central-1	34,212	5,842	38 96
Central-2	29,670	4,276	35.57
South	21,873	3,800	13.60
National Average	21,458	3,564	15.58

Source : "Rural Household Energy Consumption 1980" NEA

Logarithmic regression analyses are carried out for both series of data. Income elasticities of electricity demand for PEA's electrified villages and non-electrified villages turn out as 2.3 and 1.1 respectively, and income elasticity for NEA case is 1.86. Regression coefficients are at the satisfactory level in all cases except electrified villages case's 0.3.

The experience of Japan from 1965 to 1979, provides the following regression line.

$$\ln ELEC = -4.6429 + 1.3602 \ \ln CYD \ -0.10803 \ \ln REC \quad R^2 = 0.988$$

Where ELEC = Electricity consumption per household

CYD = Real disposable household income (1976 constant)

REC = Real electricity cost (1976 constant)

As for elasticity for the total electricity demand for residential use, it is calculated at 1.51 by Institute of Electric Power Development and at 1.48 by Institute of Energy Economics in Japan. These differences are due to deflator for the disposable income.

Both studies estimate short-term income elasticities as well. They are 0.44 and 0.52 with the elasticities of stock level of appliances of 0.59 and 0.62 respectively, assuming the following electricity demand function.

$$ELECt=(AY)^x(ELECt-1)^y$$

Where x = short-term elasticity

y = elasticity of last period consumption, which indicates degree of electric appliance ownership

B/(1-y) = long-term elasticity

Thus it is recognized that electricity demand in short-term is more influenced by the stock level of appliances then by income.

Through the above elasticity analyses and in recognition of tendency in developing countries where income elasticities for energy demand per se plays bigger role than in industrialized countries, it is felt reasonable to assume the long-term income elasticity for residential demand in Thailand in the range of 1.1 to 1.86.

When electricity elasticity of 1.2 is assumed with per household electric consumption growth of 2.3%/year during the last decade in MEA and PEA service area, the household income growth is calculated at 1.92%/year. GDP per capita during the same period shows 4.1%/year and that this difference between household income and GDP per capita growth casts the shadow to income distribution in Thailand.

In the Study Area, per household/customer electric consumption growth was 5.8%/year, and GPP per capita grew 4.9%. Then if the elasticity of electricity demand of 1.2 is assumed, the growth rate of household income is given as 4.8%/year. In considering the per capita GPP in the Study Area of 4.9%, the disparity between household income and GPP per capita seems extremely small. However, if the elasticity of 1.8 is assumed, the growth rate of household income gets down to 3.1%/year.

In relation to this income distribution issue, it is beneficial to understand the share of electricity bill over household income.

As for household income, NSO's "Report, Socio-Economic Survey 1975/76 Southern Region" indicates ฿1,056/month/rural household as money income with non-money income (the value and services produced domestically including the rental value of owner occupied dwellings) of ฿421/month, which is 28% of total income. This report also estimates the regional average total household income in the South Region as ฿1,788/month/household consisted of money income 77%(฿1,384) and non-money income 23% (฿404). Thus the rural household money income accounts 76.3% of the regional average household income.

According to NEA's "Rural Energy Consumption 1980" the average rural household income of the South Region is ฿1,788/month. Assuming this figure as the cash income, the growth of rural household income is estimated at 3.1%/year with implicit income deflator growth of 11%. With this the average subregional household income is estimated at ฿3,030/month in 1980.

Thus the electricity bill of a rural household in the South (฿49.56/month) accounts 2.5% of the monthly income and the share of the SA average monthly electricity bill (฿131/month) becomes 4.3% of the monthly income. In the case of household in Japan, the expenditure for electricity in average merely occupied 1.6% in 1965 and 1.2% in 1976 of the household income.

In any event, as an assumption for electricity demand for residential sector through the precedent analyses, the electricity demand growth rate of 2.3% for already electrified residential customers is adopted.

2.1.4. Electricity Tariff Structure

The electricity tariff is different among customer (see Table 2.8). The price of electricity has increased at a rate of 11.2%/year during the last decade while the consumer price index has recorded annual increment of 10%/year.

The tariff structure has been revised in April 1st 1983. This revise generally speaking reduced the price of electricity, lowering the small customer's burden more than large customers.

According to the new tariff structure residential tariff is same for PEA and MEA, while PEA's tariffs of business and industry are higher than those of MEA, in addition that MEA offers special rate for off-peak consumption while PEA does not. The electricity bill is still a large burden to SA households (about % of household income).

For the large industrial customers the distribution line average expenses including transformers are charged to customers ฿ 170,000/km for 33 KV and ฿ 150,000/km for 11 or 22 KV. The PEA's average price of electricity is 1.67/KWh for large industry, ฿ 2.00/KWh for business and ฿ 1.4/KWh for household.

Currently EGAT sells electricity to PEA at an average price of ฿ 1.24/KWh, to Malaysia at ฿ 1.9/KWh, and to direct customers at ฿ 1.64/KWh.

Table 2.8 Trend of Total Revenue and Average Revenue/kWh Sold

Year	Total Revenue from Electric Sales (1,000 US$)			Average Revenue/kWh Sold (US. Cents)		
	Lighting	Power	Total	Lighting	Power	Total
1970	47,652	42,866	90,518	3.54	1.74	2.38
1971	53,014	49,272	102,286	3.49	1.70	2.31
1972	56,207	60,190	116,397	3.38	1.65	2.19
1973	71,652	65,060	136,712	3.27	1.63	2.21
1974	102,127	101,758	203,885	4.52	2.38	3.12
1975	102,419	132,437	234,856	3.89	2.74	3.14
1976	118,858	150,696	269,554	3.89	2.72	3.14
1977	143,139	194,301	337,440	4.01	3.05	3.39
1978	199,707	250,780	450,487	4.69	3.54	3.97
1979	212,390	278,142	490,532	4.54	3.59	3.95
1980	292,607	449,500	742,107	6.11	5.38	5.65
1981	368,335	652,811	1,021,146	7.59	7.28	1.707

Source: EGAT, MEA, PEA, POF

Note: 1970-1980 1 US$ = 20.45 ฿
1981 1 US$ = 23.10 ฿

2.1.5 CURRENT DEMAND FORECAST BY EGAT & PEA FOR REGION 3 AND STUDY AREA

1) EGAT FORECAST

EGAT's total energy generation and peak requirement are calculated in a manner of summing up individually projected EGAT's direct customers (currently there are eleven customers), MEA's and PEA's.

EGAT's PEA demand is forecasted through time series analysis by customer category and regression analysis with macro-economic indicators, as shown below. The results of these forecast are subject to the judgemental information criteria of location of new industrial plants, expansion plans of business and industry, migration trend, and residential electrification programs.

Time Series Analysis

Residential	$Y = 675.1 + 129.36x + 10.45959x^2$
Business	$Y = 587.1 + 81.39x + 3.29165x^2$
Industrial	$Y = 1,278.1 + 209.94x + 6.22020x^2$
Street Lighting	$Y = 16.0 + 1.10x - 0.03821x^2$
Others	$Y = 13.3 + 3.81x + 0.40523x^2$

Regression Analysis

$y = 52.383751 - 0.002669422x - 0.000009561x^2$
No regression coefficient is expressed but expect it is good enough to fit (y = per capita KWh consumption, x = per capita GDP)

Direct Customers:

Energy sales forecasts for these customers were derived from review of these customers' production schedules in relation to their records of power and energy utilization.

Currently the share of those direct customers demand over EGAT total demand is 4.1% and this share is projected to decrease 3.7% in 1991 due to PEA's rapid growth during 1980s.

2) Electric Demand for Region 3

EGAT estimates the average annual growth rate of energy generation and peak generation for Region 3 (South as a whole) at 9.16% and 9.93% with average load factor of 63.3% during FY 1982 to FY 1991 period. (see Table 2.9)

Table 2.9 THE PROJECTION OF ELECTRICITY SUPPLY & DEMAND FOR REGION 3

	Installed Capacity (MW)	Peak Generation (MW)	Energy Generation (GWh)	Annual Load factor %
1971		42.00	229.08	62.3
1981	404.6	196.70	1,063.93	61.8
1983	404.6	242.60	1,299.10	61.1
1984	404.6	276.50	1,460.60	60.3
1985	404.6	311.30	1,687.00	61.9
1986	404.6	344.30	1,862.20	61.7
1987	644.6(July)	373.20	2,061.80	63.8
1991	718.6	499.70	2,836.10	64.8
1996	943.6	682.10	3,963.20	66.3

3) PEA's Estimate of Demand in Study Area

Table 2.10 presents two different projections both of which are derived from the micro forecasting method of detailed sector analyses. PEA's figures of the Table 2.10, correspond to EGAT's Region 3 supply/demand projections. Table 2.11 exhibits the average annual growth rate and SA's share in the South and whole kingdom electricity demand.

Now recalling the indicative estimates of electric energy demand estimation by the electricity intensity, PEA's forecast falls within the previously estimated demand range. Although, it is too bold to project the economic structure just from electricity intensity, there is a possibility to assume that the Study Area's economic structure in 1991 will be close to the one that existed in 1980 at the national level.

Table 2.10 MAXIMUM DEMAND (MW) AND ENERGY REQUIREMENT FORECAST (GWh) FOR SA

Year		1981	1986	1991	2001
Energy Requirement (GWh)					
PHUNPIN (SURAT)	PEA	104.48	175.74	291.83	
	CT	(100.47)	(181.38)	(275.71)	(464.94)
PHUKET	PEA	120.17	321.99	410.13	
	CT	(118.26)	(153.93)	(215.44)	(355.97)
PHANGNGA	PEA	16.96	27.92	46.17	
	CT	(25.38)	(44.42)	(66.01)	(130.56)
KRABI	PEA	14.99	27.92	49.22	
	CT	(14.26)	(38.99)	(66.60)	(71.50)
Total	PEA	256.6	552.57	797.35	
	CT	(258.37)	(418.72)	(623.76)	(1,022.97)
Maximum Demand (MW)					
PHUNPIN (SURAT)	PEA	19.55	32.33	52.95	
	CT	(21.1)	(42.1)	(58.3)	(94.8)
PHUKET	PEA	21.10	54.12	68.33	
	CT	(20.9)	(27.3)	(38.4)	(62.5)
PHANGNGA	PEA	3.58	5.68	9.15	
	CT	(5.5)	(11.1)	(14.8)	(27.6)
KRABI	PEA	3.21	5.76	9.75	
	CT	(3.3)	(11.1)	(15.8)	(27.7)
Total	PEA	47.44	97.89	140.18	
	CT	(50.8)	(91.6)	(127.3)	(212.6)

Source : PEA and EGAT

CT(CTM): Charts T. Main's Report