GENERAL ARTICLE

J.Sci.Soc.Thailand 11 (1985) 161-176

THE PETROCHEMICAL PROJECT AND THE EASTERN SEABOARD DEVELOPMENT*

SIRI JIRAPONGPHAN, PAILIN CHUCHOTTAWORN and SUPATTANAPONG PUNMEECHAOW
National Petrochemical Corporation Limited, 10th Floor, Petroleum Authority of Thailand Building, 14 Soi Yasoob 1, Vibhavadi-Rangsit Road, Bangkok 10900, Thailand

(Received 31 October 1985)

Abstract

The production of natural gas from the Gulf of Thailand has ushered in a new era of energy self sufficiency for Thailand. Further developments in utilizing natural gas as feedstock for petrochemical production is leading Thailand into a new era of industrialization. The implementation of basic industries in producing olefins and fertilizer is changing the structure of the chemical industry in Thailand from small conversion plants dependent on imported intermediates to an integrated, full-cycle industry using basic feedstocks to final finished product. This new basic industry will create opportunities for basic and applied research and development work for Thai's scientific and technical community in areas involving catalyst development, chemical synthesis and improved energy and production efficiency.

On the social and environmental aspects, the aggregation of this new industrial development as an integrated Eastern Seaboard Development Program is an attempt to address the consequences that resulted from this new industrial development. Follow up and analysis of the changes of the surroundings during the implementation of this program would provide an excellent opportunity in understanding the effect of industrialization and the effectiveness of various social and environmental programs.

* Presented at the 11th Annual Conference of Science and Technology in Thailand, Kasetsart University, Bangkok, 24-26 October 1985.

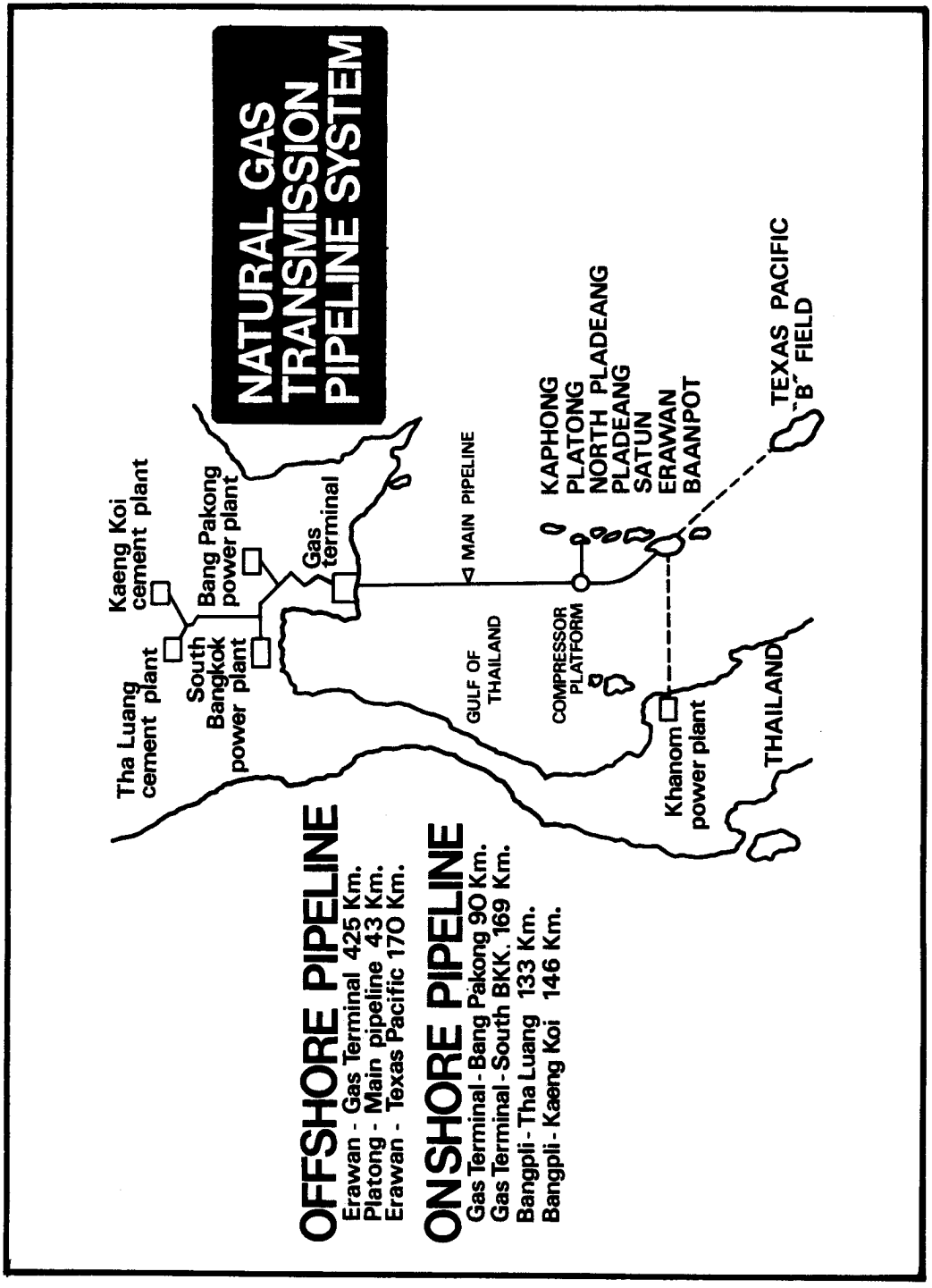

Fig. 1 Natural gas transmission pipeline system in the Gulf of Thailand.

Introduction

Following five sucessive 5-year National Economic and Social Development Plans, Thailand, with a population of more than 51 million, has realized a healthy and steady economic expansion at the rate of 7-8% per annum in the past two decades, and, even in the difficult period between 1982 - 1984, has managed to expand at 5% per annum.

With this steady economic development, the Kingdom's energy requirement grew at the rate of 7.6% annually between 1978 and 1981. By 1981 Thailand consumed the equivalent of 300,000 barrels of crude oil per day (BCPD). As 73% of energy requirement had to be imported as oil, the Kingdom was paying as much as 42% of her export earning for this oil import.

This heavy dependence on imported oil, inevitably, led the Thai government to step up energy conservation program and at the same time encourage exploration for oil and gas. In 1982 the energy conservation program together with a lower economic growth has reduced the growth in energy consumption to 5.4%.

Oil and Gas Development Program[1] (Fig. 1)

Oil and gas exploration were conducted over the past decade by more than 20 international oil companies. Results of the exploration efforts have yielded more than 3 trillion cubic feet of proven natural gas deposits in various fields in the Gulf of Thailand and oil in the central plain. In September 1981 natural gas started to be tapped at the rate of 100 million cubic feet per day (MMSCFD) brought in from the Erawan field in the Gulf of Thailand through a 595 kilometers offshore/onshore pipeline. This gas, which was used at two electricity generation plants in Bangkok area, reduced the dependence on imported oil by 8%. With reduced oil demand, and by using indigenous natural gas, Thailand's dependence on imported oil is reduced to 61% of her energy needs for 1982. Currently, natural gas production from more than 5 fields in the Gulf of Thailand has reached 350-450 MMSCFD.

In January 1983, Thailand began producing oil from onshore Sirikit field in the north at the rate of 5,000 barrels per day (BPCD). By the end of the Fifth Five Year National Economic and Social Development Plan in 1986, natural gas production is projected at 500 MMSCFD and oil production at more than 20,000 BPCD.

These developments in domestic oil and gas production mean that by 1986 Thailand will need to import slightly less than half of her energy requirements.

Utilization of Natural Gas from the Gulf of Thailand (Fig. 2)

Natural gas from the Gulf of Thailand has been used as an alternative energy source in substitution of imported crude oil. Natural gas was distributed directly to two power generation plants, one in Bang Pakong and the other in Bangkok South. Other

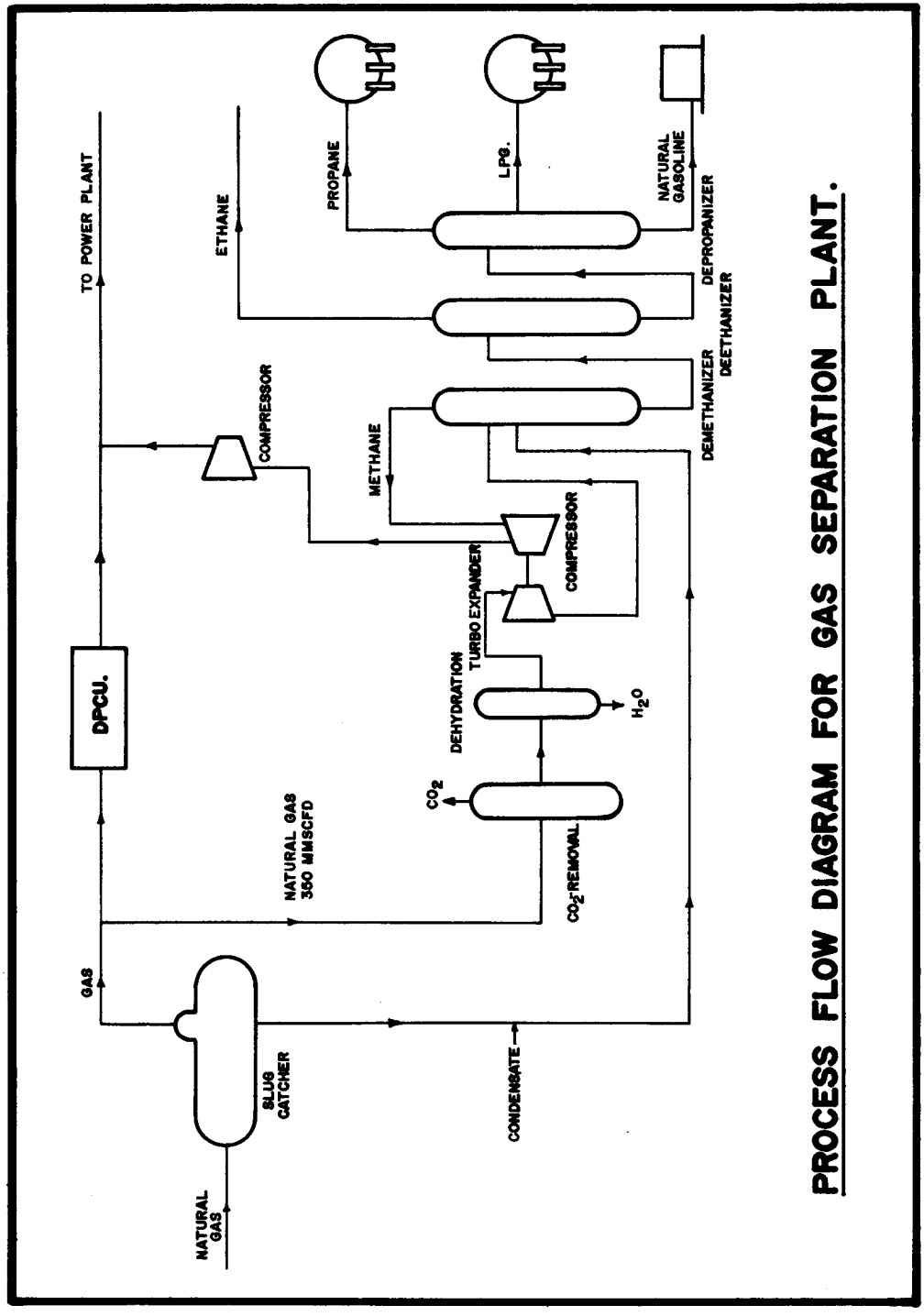

Fig. 2 Flow diagram of PTT's gas separation plant in Rayong.

heavy fuel consuming industries, such as cement and ceramics manufacturers, are also using this gas pipeline and benefit from this new energy source.

Since the natural gas being produced from the fields in the Gulf of Thailand is rich in heavy hydrocarbons (ethane, propane and butane), it is possible, as an alternative to total firing of the valuable natural gas, to use it as feedstocks in petrochemical industries which would increase the benefits to be derived from this valuable resource to the maximum. In this respect, the Petroleum Authority of Thailand (PTT) has constructed a natural gas separation plant in Rayong province with a capacity to handle 350 MMSCFD. This plant started to operate in November 1984 and is capable of producing 1,600,000 tons of methane gas for the power generation and as feedstock for fertilizer production, 240,000 tons of LPG for transportation and urban usage, 220,000 tons of propane, and 354,800 tons of ethane annually. The ethane and propane have been earmarked for use as feedstocks for petrochemical production. The site of the new fertilizer and petrochemical plants are also located adjacent to the gas separation plant in Rayong Province.

Eastern Seaboard Development Program[2] (Figs. 3, 4)

In order to accelerate and to support steady and orderly development of a new natural-gas-based industrial center in Rayong, the Thai government has established a supervisory body, the Eastern Seaboard Area Development Committee in 1981, to coordinate the development of the industry and to provide technical and social infrastructure. Included in the Eastern Seaboard Development Program, infrastructures such as deep sea port, raw water supply, access roads, railways, waste treatment system, electricity and telecommunication network and a new community center will be provided to support the two new industrial complexes, namely the Fertilizer Complex and Petrochemical Complex. These complexes, when completed in 1988, will be Thailand's first full scale chemical plants based on indigenous gas as feedstock.

Fertilizer Complex (Fig. 5)

In December 1982, the National Fertilizer Company (NFC), a joint venture with 60% share owned by the private sector, was established. The NFC's role is to construct and commission a new one million tons per year NPK fertilizer complex using methane gas from PTT's gas separation plant as feedstock. The complex will consist of six modern plants, ie., ammonia plant, urea and urea granules plants, sulfuric acid plant, phosphoric acid plant and MAP/DAP/NP/NPK plants. The creation of this industrial complex will not only accelerate employment but will also help reduce chemical fertilizer imports by $170–190 million annually. Moreover, the National Fertilizer Project will bring about an efficient development in agricultural production which consequently will benefit to the majority of Thai farmers.

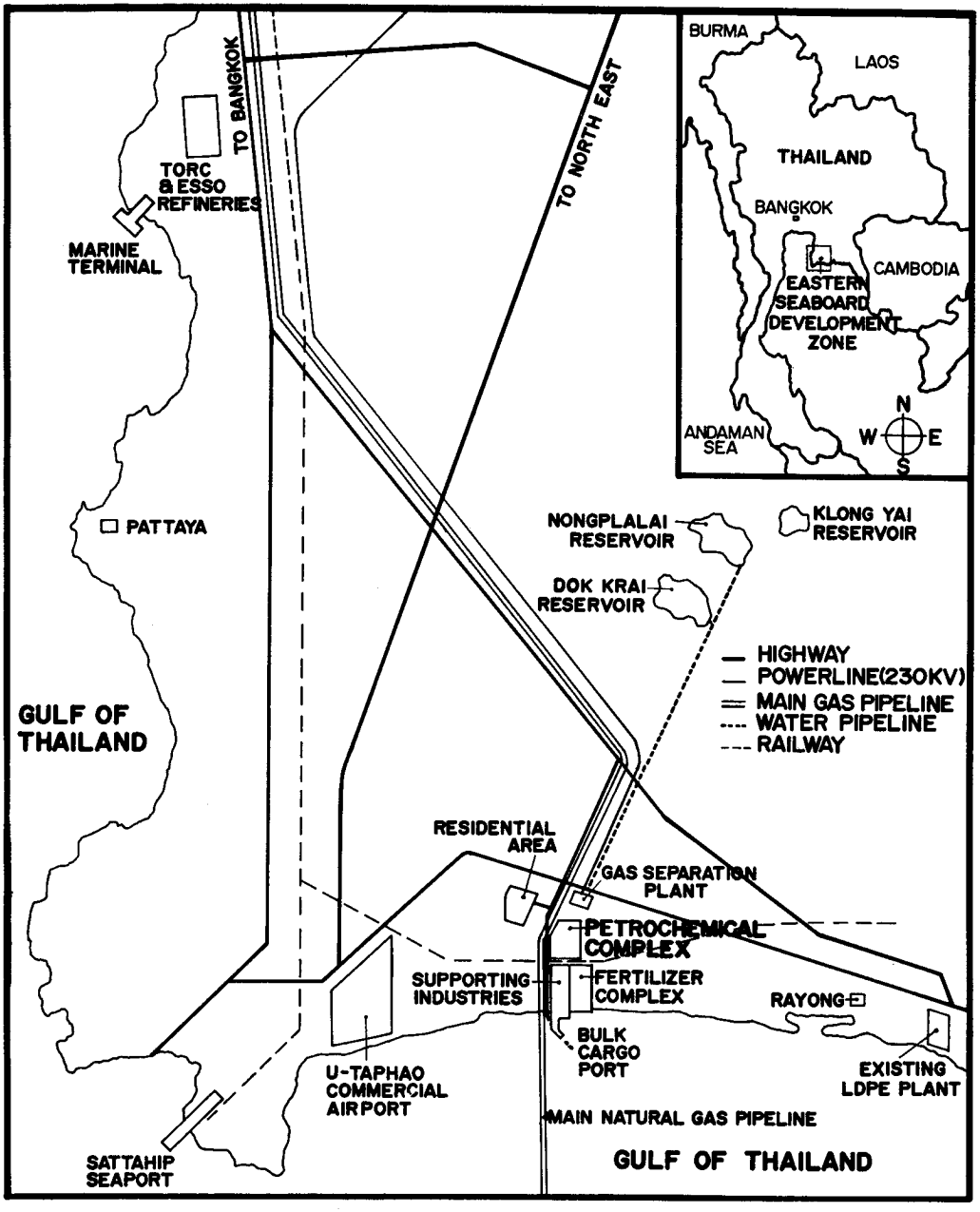

Fig. 3 Schematic diagram of the Eastern Seaboard Development program.

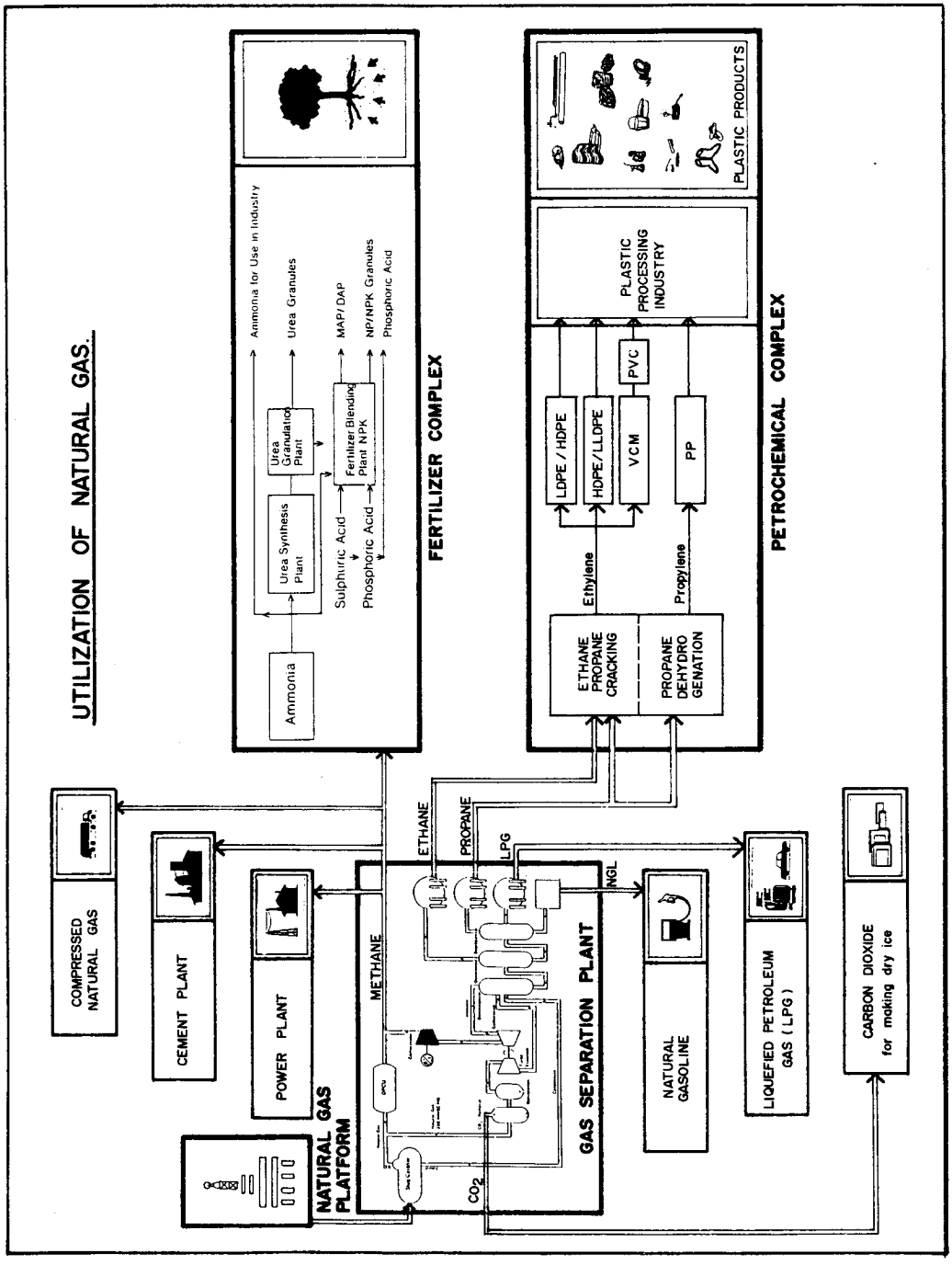

Fig. 4 Planned utilization of natural gas from the Gulf of Thailand.

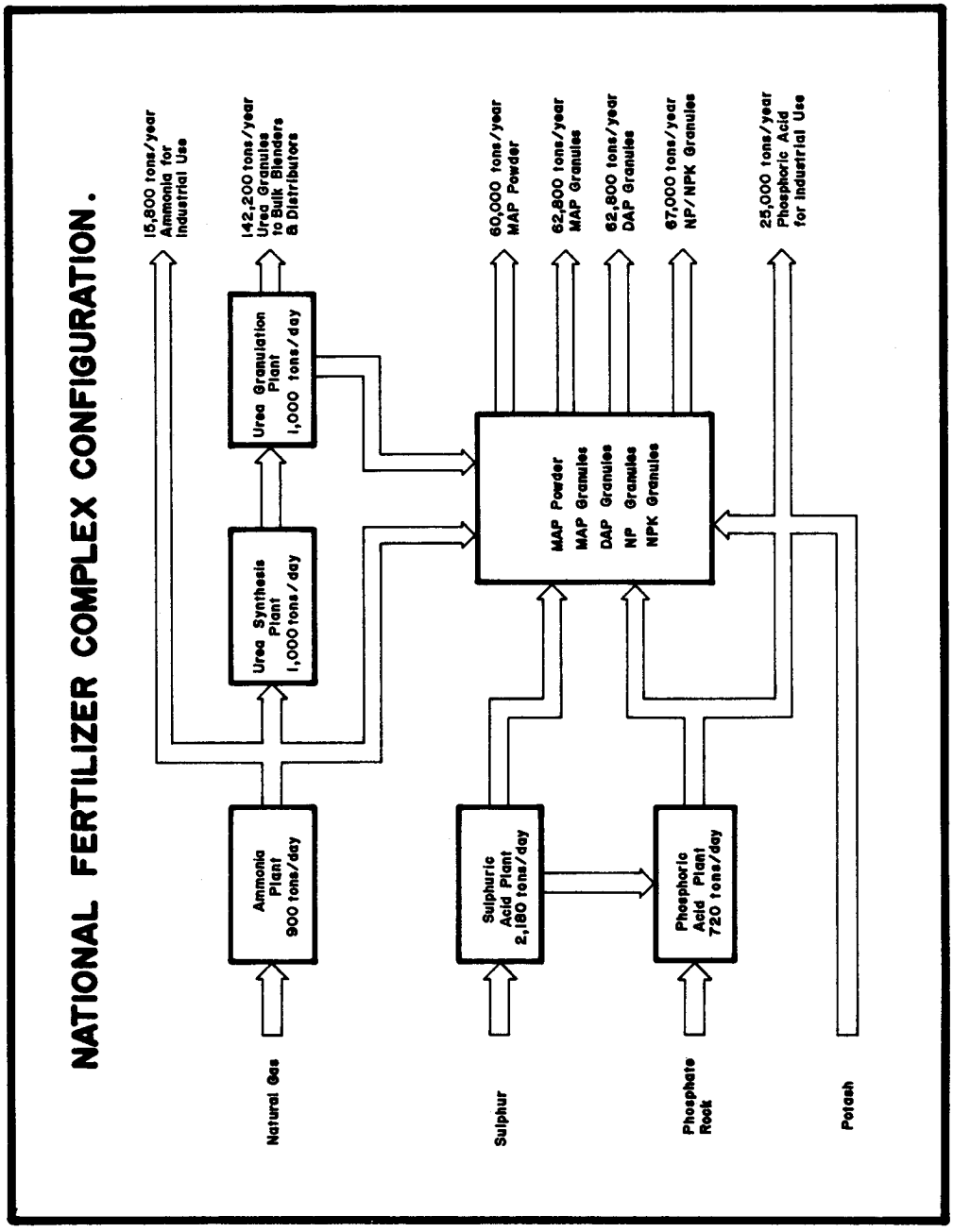

Fig. 5 Configuration of National Fertilizer Complex

Petrochemical Complex[3] (Figs. 6, 7, 8)

This natural gas based Petrochemical Complex will involve construction of five major petrochemical units. The first unit, the Olefins Plant (upstream unit) will use products from the PTT's gas separation plant, ethane and propane, as feedstocks and produce intermediate chemicals, ethylene and propylene, which are the two most important basic raw materials for the plastic industries.

The capacity of the whole petrochemical complex, both the upstream and downstream units, is designed to meet the growing demand for plastic products in Thailand. Average polyolefins (LDPE, HDPE and PP) imported in 1983/1984 were approximately 150,000–160,000 tonnes per years. The demand for PVC has increased rapidly from 30,000 tonnes per year in 1980 to more than 60,000 tonnes per year in 1984.

With the anticipation of an increasing demand for plastic products in the domestic market, the production of each downstream unit has been set to satisfy market demand in 1992 which is the first year the whole complex will be operating at its full capacity. Figure 8 shows the forecasted market demand for polymer from 1989–1995. The proposed production capacity of the upstream and downstream units are as follows:

Company	Product	Capacity (Tons/years)
National Petrochemical Corp., Ltd.	Ethylene	315,000
	Propylene	105,000
Thai Petrochemical Industry Co., Ltd.	LDPE	65,000
	HDPE/LLDPE	60,000
Thai Polyethylene Co., Ltd.	HDPE/LLDPE	137,500
Thai Plastics and Chemicals Co., Ltd.	VCM/PVC	140,000
HMC Co., Ltd.	PP	100,000

Upstream Unit

National Petrochemical Corporation Limited (NPC): In order to coordinate on and to promote the establishment of the petrochemical complex, the National Petrochemical Corporation Limited, a joint venture between the government and private downstream firms, was established in February 1984. NPC's main responsibilities are to build and operate the Olefins Plant and the utilities center for supplying the needs of the whole complex.

At present, NPC has completed an extensive study to determine the viability of the complex and the investment for the upstream unit and is currently proceeding with the selection for successful contractor who will carry out the design, engineering and construction of the Olefin Plant on turn-key-lump-sum basis. The feasibility study

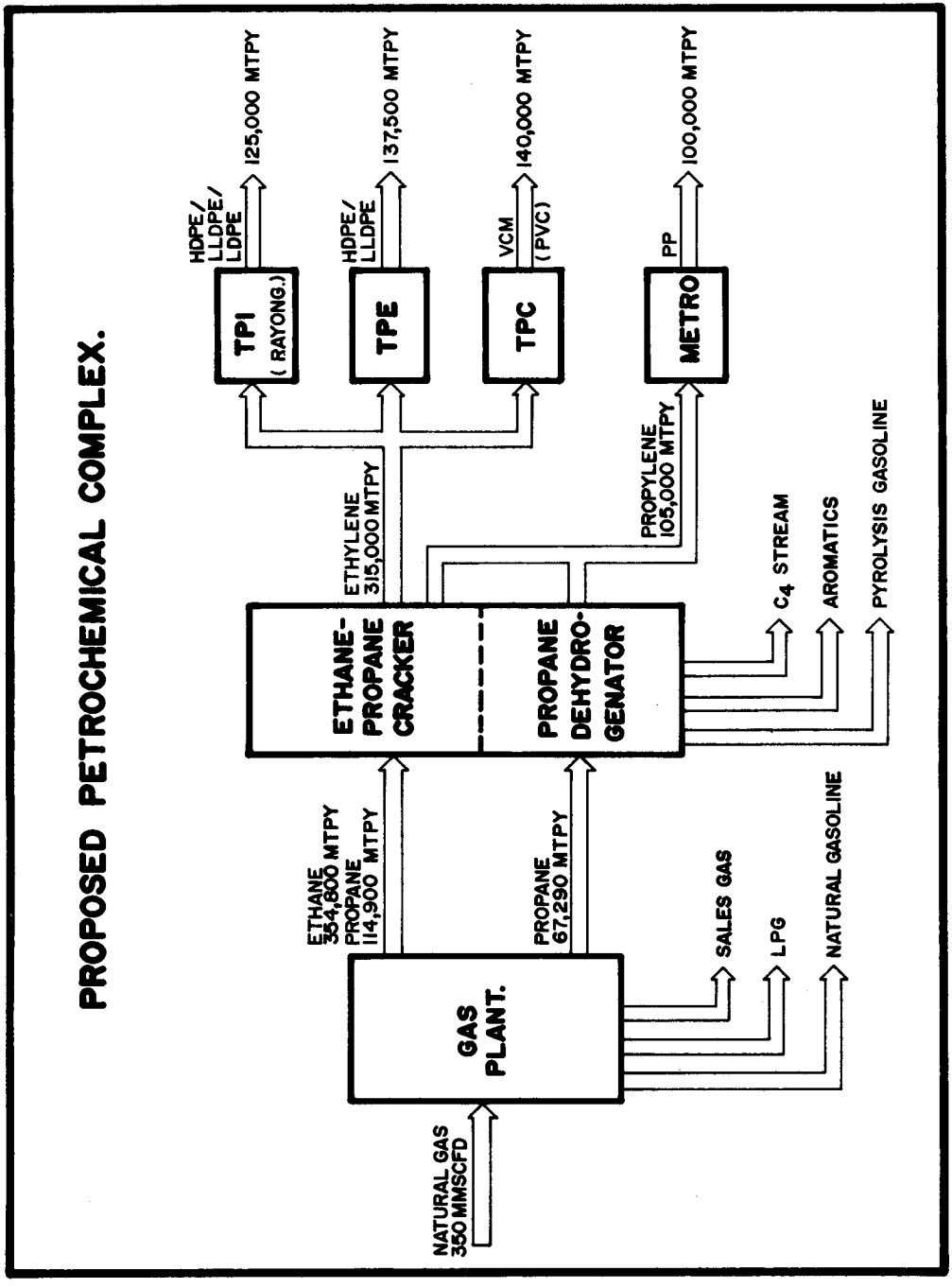

Fig. 6 Configuration of Petrochemical Complex

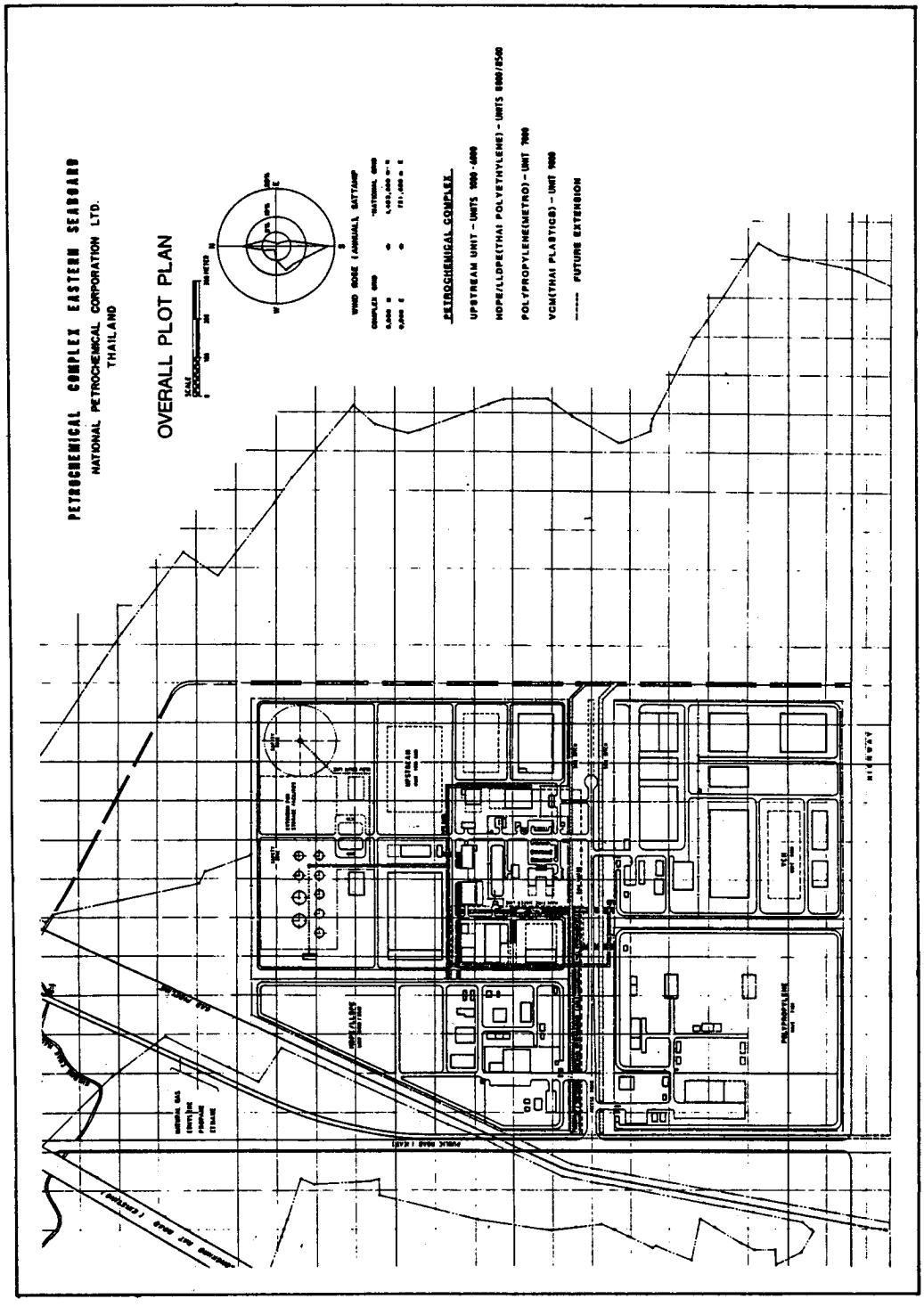

Fig. 7 Plot plan of the Petrochemical Complex at Mab Ta Pud

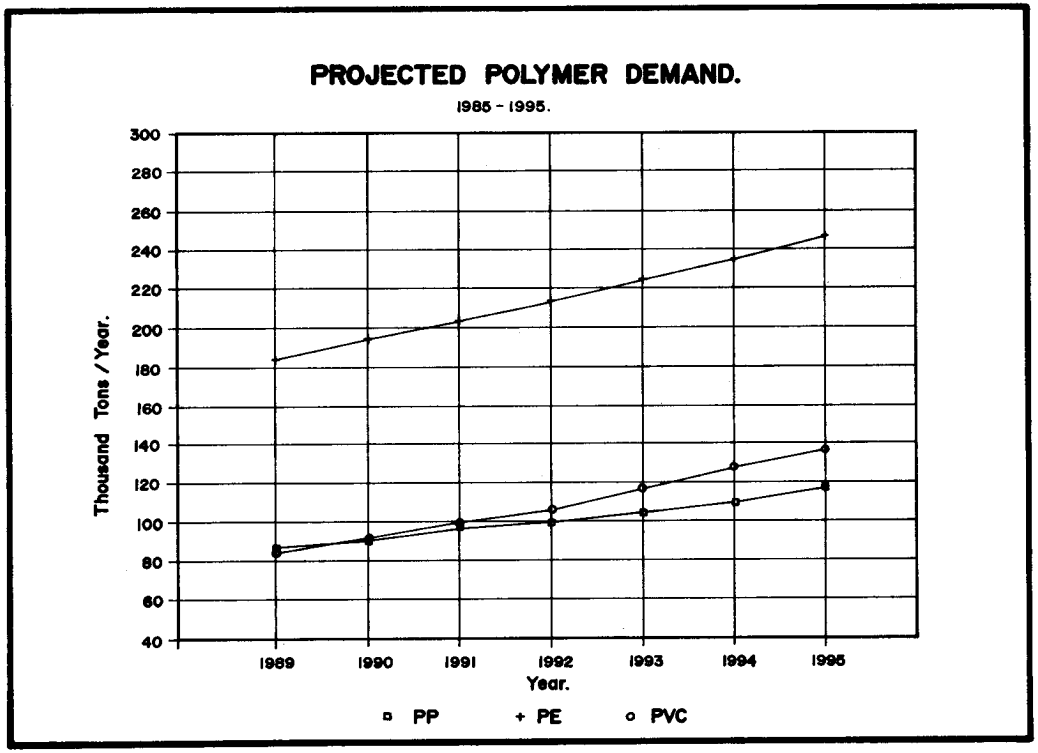

Fig. 8 Projected polymer demand from 1989 to 1995

has shown that the whole complex is profitable. Under normal market conditions, the return on investment for the whole complex will be around 22%. The investment for the upstream unit is estimated to be approximately $220 million.

In determining the production scheme for this new plant, detailed economic and technical analysis has shown that the most optimum route for the joint production of ethylene and propylene is a combination of ethane cracking for ethylene and propane dehydrogenation for propylene. Although at present, the process for catalytic dehydrogenation of propane is not yet commercially proven, an extensive study shows that propylene production by dehydrogenation of propane is viable on a commercial scale. NPC has already arranged for a licence agreement with Universal Oil Products (UOP) for its Oleflex's propane dehydrogenation process using platinum base catalyst.

Downstream Units

Thai Petrochemical Industry Company Limited (TPI): TPI has been operating a 65,000 tonnes/year LDPE plant at Rayong since late 1982. The plant used the Imhausen tubular high pressure process and was built by Uhde GmbH. TPI is currently expanding its production capacity at Rayong by building a new 60,000 tonnes/year plant capable of producing either HDPE or LLDPE using the Hoechst process. The total production capacity which TPI expect to reach in 1988 is 125,000 tonnes per year.

Thai Polyethylene Company Limited (TPE): TPE will be producing of 60,000 tonnes per year of HDPE and 77,500 tonnes per year of LDPE/LLDPE. The HDPE facilities will use Mitsui Petrochemical's technology.

HMC Company Limited (HMC): HMC is a joint venture between Metro Company Limited and Himont (Hercules/Montedison) in which Himont's technology will be used for production. HMC intends to build a polypropylene plant with the capacity of 100,000 tonnes per year.

Thai Plastics and Chemical Company Limited (TPC): TPC has started the production of PVC in 1971 with a small (8,300 tonnes per year) plant, located near Bangkok using Dynamit Nobel Process. In 1973, the production scheme is changed to Mitsui Toatsu Process with the overall capacity of 50,000 tonnes/year. Further expansion is currently under way for TPC and by 1986 the plant will have a new capacity of 98,000 tonnes per year. TPC is planning to build a 140,000 tonnes per year VCM plant and another 60,000 tonnes per year PVC plant at the complex's site. TPC also intends to install a chlor-alkali plant with a caustic soda production capacity of 26,000 tonnes per year. Production of VCM would thus be based partly on imported ethylene dichloride (EDC) and partly on domestic EDC made from ethylene and chlorine.

Contributions of the Petrochemical Complex

The $1 billion investment in the Petrochemical Complex will yield significant benefits for the country, both directly and indirectly. At full capacity, plastic resins produced from the complex will result in the saving of foreign currency that would have been spent for imports at a total value of $355 million per year. By utilizing our own natural gas as feedstock, the production of petrochemicals would be adding value to it by more than four-fold from $90 million per year for ethane and propane.

The use of natural gas as feedstock and the integration of production facilities into a full scale complex has resulted in a highly efficient and economical production. Economic analysis has shown that products from the complex could be priced to the users no higher than the existing costs. Therefore, the establishment of the complex will not pose any extra burden for plastic users. Moreover, the favorable economics may create an opportunity where plastic resins produced from the complex could be sold to users at a price lower than current cost structure.

In addition to promoting industrial development in the Eastern Seaboard area, which serves the Government's policy of decentralization of business activities and the promotion of investment, the availability of domestic production of plastic resins would also stimulate the development of a high-quality plastic processing industry. For more than 1,000 plastic processing plants in the country, all of which rely only on imported materials, the supply of plastic resins from the Petrochemical Complex would provide the technical services and the assurances of product availability and price stability which

TABLE 1. SUMMARY OF TECHNOLOGIES USED IN PETROCHEMICAL COMPLEX

Unit	Technology	Catalyst/Absorbent
Upstream Unit		
CO_2 Remover	Amine Scrubber UCAR - Amine Guard	MEA Inhibited MEA Solution
H_2 Purification	Pressure Swing Absorbtion	Molecular Sieve
Dehydrater	Pack-Bed with Absorbent	Alumina or Molecular Sieve
Caustic Scrubber	Scrubbing Column	Caustic Solution
C_2-Hydrogenation	Gas Phase Catalytic C_2 Acetylene Converter	Palladium or Nickel Catalyst Palladium on Alumina
C_3-Hydrogenation	Gas/Liquid Phase Catalytic C_3 Acetylene Converter	Palladium Catalyst Palladium on Alumina
Propane Dehydrogenation	Catalytic Dehydrogenation	Platinum on Alumina Base
Downstream Unit		
Polyethylene	Gas Phase/ Slurry Polymerization	Chromium/Molybdenum/ Titanium - Containing Catalysts
Polypropylene	Liquid Phase Polymerization	Titanium on Magnesium Halide/Organometallic Component/Lewis Base (Eletron Donor)
Caustic Soda	Asahi Glass Flemion Process	Ion-Exchange Membrane
VCM Oxychlorination (Ethylene Dichoride EDC)	Fluidized Bed Reactor	Micro-Spherical Catalyst of Cu-Al Compounds

are not currently possible. These favorable factors would enable the plastic processing industry to improve its quality and services and thereby be more competitive in the domestic and foreign markets for finished products.

The Petrochemical Complex will also provide job opportunities to more than 3,000 people directly and possibly another 5,000 in related activities such as in the transportation and other service sectors in Rayong Province. The increased activities in the plastic processing industry will also provide more than 20,000 additional job opportunities to the existing 15,000 currently employed.

From the technical view point, the Petrochemical Complex, the first of its kind in Thailand, will bring about a whole new sector of technology concerning organic chemical processing and synthesis. Technologies used in the development of the Petrochemical Complex are summarized in Table 1. The transfer of this new branch of technology will not only benefit industrial development but also stimulate and promote the research and development activities in academic institutes at large, for example in the field of catalyst engineering, polymer science and product diversification. The modern complex will also pose as a model plant to provide the best opportunity for training and internship of young engineers and scientists. This will result in accelerated industrialization of the Eastern Seaboard and the Kingdom as a whole.

As for the environmental impact of Petrochemical Complex, it is emphasized from the very beginning of the design and engineering stage that due consideration must be put on the control of any possible pollution. Every available up-to-date pollution control measures has been assessed and put into use to assure safe operation and to meet the stringent environmental standard.

Conclusion

With the aim to maximize the utilization of natural gas from the Gulf of Thailand, the Petrochemical Complex was proposed and integrated as part of the Eastern Seaboard Development Program. The complex, consisted of one upstream unit for producing intermediate monomers and four downstream units producing final products of LDPE, HDPE, VCM/PVC and PP. The complex, when completed, will bring Thailand into a new era of industrialization. By producing most of the essential commercial plastics, the Petrochemical Complex will change the structure of the petrochemical industry in Thailand from small scale conversion plants dependent on imported intermediates to an integrated, full-cycle industry utilizing local basic feedstocks to produce the final plastic products. The evolution of this new branch of basic chemical industry will create opportunities for basic and applied research and development work for the scientific and technical community in areas involving catalyst engineering and organic chemical synthesis.

The impact on social and environmental aspects as a result of this industrial development is also a major point of concern. Due consideration and sufficient measure had been taken. However, follow up and analysis of the changes of the surroundings during the implementation of the development program would provide an excellent opportunity for understanding the effect of industrialization and the effectiveness of various social and environmental programs.

References

1. The Petroleum Authority of Thailand. (1983) *Oil & Gas Development in Thailand,* Bangkok.
2. The Eastern Seaboard Development Committee. (1982) *Prospectus: Thailand's Petrochemical Complex.*
3. Feasibility Study. (1983) *Part B: Definition of Complex & Upstream Unit,* prepared for National Petrochemical Corporation Ltd. by Lurgi GmbH and Trichem Consultants Ltd.

บทคัดย่อ

การผลิตก๊าซธรรมชาติจากอ่าวไทยได้นำประเทศสู่ยุคใหม่ของการพึ่งตนเองในเรื่องพลังงาน การพัฒนาการใช้ก๊าซธรรมชาติเป็นวัตถุดิบสำหรับอุตสาหกรรมปิโตรเคมีจะนำอุตสาหกรรมของประเทศเข้าสู่ยุคใหม่โดยการเปลี่ยนโครงสร้างจากการพึ่งการนำเข้าวัตถุดิบกึ่งสำเร็จรูปจากต่างประเทศ ในการแปลงเป็นผลิตภัณฑ์ในขั้นปลายมาเป็นอุตสาหกรรมแบบครบวงจร คือเริ่มจากวัตถุดิบพื้นฐานถึงผลิตภัณฑ์สำเร็จรูป อุตสาหกรรมพื้นฐานที่จะเกิดขึ้นตามโครงสร้างใหม่นี้จะเปิดโอกาสให้วงการวิทยาศาสตร์และเทคโนโลยีของประเทศมีการทำการวิจัยและพัฒนาในสาขาต่าง ๆ ที่เกี่ยวข้องกับตัวเร่งปฏิกิริยาการและการสังเคราะห์เคมีภัณฑ์และการเพิ่มประสิทธิภาพของการผลิตและการประหยัดพลังงานในการผลิต

ในประเด็นเกี่ยวกับผลกระทบของอุตสาหกรรมใหม่ต่อสภาพสังคมและสิ่งแวดล้อมนั้น การรวบรวมการพัฒนาอุตสาหกรรมพื้นฐานทั้งหมดนี้ให้เป็นโครงการพัฒนาพื้นที่บริเวณชายฝั่งทะเลตะวันออก เป็นการสร้างฐานรองรับผลกระทบที่เกิดขึ้นจากอุตสาหกรรม การติดตามและวิเคราะห์ความเปลี่ยนแปลงในสภาพสังคมและสิ่งแวดล้อมที่เกิดขึ้นในระหว่างการพัฒนาอุตสาหกรรมดังกล่าวจะให้ประโยชน์ในการศึกษาถึงผลกระทบของการพัฒนาและประสิทธิภาพของโครงการในด้านสังคมและสิ่งแวดล้อม