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Industrial Progress of Selected Sectors in the

Developing ESCAP Region

Volume III

THE PETROCHEMICAL INDUSTRY IN THE DEVELOPING ESCAP REGION: PAST REVIEW AND FUTURE PROSPECTS

Sectoral Working Paper Series

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SECTORAL WORKING PAPERS

In the course of the work on major sectoral studies carried out by the UNIDO Division for Industrial Studies, several working papers are produced by the secretariat and by outside experts. Selected papers that are believed to be of interest to a wider audience are presented in the Sectoral Working Papers series. These papers are more exploratory and tentative than the sectoral studies. They are therefore subject to revision and modification before being incorporated into the sectoral studies.

This paper was prepared by Dr. A.A. Faruqui as UNIDO consultant. The views expressed are those of the consultant and do not necessarily reflect the views of the UNIDO secretariat.

Preface

UNIDO's Division for Industrial Studies and the ESCAP/UNIDO Division of Industry, Human Settlements and Technology have jointly carried out a project on "Review and appraisal of industrial progress at the regional level". This project has been executed in two phases. Phase I of the project consisted primarily of the analysis of statistical data and based on the findings and recommendations a summary was prepared under the title "Industrialization trends in developing ESCAP countries" (E/ESCAP/IHT.6/10). Phase II of the project included the preparation of several sectoral studies, specially in those sectors more relevant for the region. The selected sectors were as follows: capital goods industries, iron and steel, petrochemical and chemical industries and wood and wood products.

The studies prepared by consultants to UNIDO and ESCAP were submitted for discussion in the Workshop on Accelerated Growth Through Co-operation in Selected Industrial Sectors in the Developing Countries of the ESCAP Region which was convened at Bangkok from 1 to 5 July 1985. This sectoral working paper, therefore, presents as volume III the study prepared on the situation of the petrochemical industry in South-East and East Asia.

Other Sectoral working papers will be issued covering the other industrial sectors under analysis in the project.

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1. INTRODUCTION

1.1 General overview

Petrochemical products and their derivatives run into many hundreds ranging from fertilizers, solvents, plastics, fibres, rubbers to base material for detergents and pharmaceuticals. The petrochemical industry has been the most rapidly developing branch of the chemical industry and now encompasses much of the earlier established organic chemical sector. The industry is being dominated by the developed regions of the world, however, in recent years the growth of this market has slowed down. The market growth is still quite high in the developing regions due to the low level of market penetration of materials produced by this industry. Another development which has taken place in recent years is the increasing interest of developing countries to establish this industry, however, till today only some developing countries, (e.g. India, the Latin American countries, the Republic of Korea, Singapore, Turkey, etc.) have operational basic petrochemical facilities. In the remaining developing region the petrochemical industry is limited to downstream processing facilities. Many developing countries (specifically the OPEC group) engaged in rapid industrialization, have ranked the establishment of a petrochemical industry quite high in their development plans. The OPEC countries have started implementing their plans. The Qatar facilities are in operation and the Saudi Arabian facilities are in the final stages of construction. OPEC countries have been motivated to establish petrochemical industries primarily because the available gas resources, with essentially a zero value, can be utilized to produce high value petrochemicals and secondly because of the desire to possess sophisticated infrastructures based on oil/gas resources. These countries have a limited market and as such the facilities being planned are export oriented. In many non-OPEC developing countries, plans to establish a petrochemical industry have not been implemented due to lack of capital resources, raw material, and technology as well as uncertainty connected with export prospects.

The petrochemical industry in the years to come is expected to be highly price/cost competitive in view of the excess of production capacity in industrialized countries and exports from new facilities of the OPEC countries.

The existing producers in developing countries such as the Republic of Korea are expected to lose their competitiveness in export.

1.2 Objective and scope

To investigate the possibility of regional co-operation among developing countries, ESCAP and UNIDO decided to review and appraise industrial progress at the regional level. In phase II of this project selected sectoral studies were carried out. The present study deals with the petrochemical sector in the developing ESCAP region. Its main objective is to review and analyze past developments in the petrochemical industry of the developing ESCAP region vis-à-vis the world situation, to identify future trends, prospects and problems as well as potential projects of regional co-operation.

The study covers:

- A global review of the petrochemical industry;
- A review of the petrochemical industry in the developing ESCAP region;
- Basic problems and issues of the petrochemical industry;
- Future outlook of petrochemical demand in the world and the developing ESCAP region;
- Supply/demand gap of petrochemicals in the developing ESCAP region;
- Co-operation in the development and operation of the petrochemical industry.

The study is basically a review report and is based on data available in the United Nations, UNIDO and other published sources.

1/ First world-wide study on Petrochemical Industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.

1.3 Summary of study report

Petrochemical products currently form an essential base for the production of a wide range of industrial and consumer products. The petrochemical industry is termed as one of the fast growing industrial sectors. Many developing countries have emphasized the establishment of a petrochemical industry with a view to accelerate the industrial development in their countries leading to the achievement of the developing countries' target share of 25 per cent in world industrial production. The petrochemical industry very well contributes to the objective of rapid progress and balanced expansion in industry. The industry also leads to the development of small-scale industries and their linkage with large and modern industries.

Until 1973 world production of basic as well as final petrochemical products showed a rapid growth which considerably slowed down in subsequent years. Gases (e.g. natural, associated and refinery) as well as liquids like naphtha and gas oils are the main source of feedstock for all petrochemicals produced around the world.

World consumption of petrochemical end-products showed a tendency of high growth during the 1965 to 1975 period, with relatively slow growth in later years. The developed regions dominated the consumption of petrochemical end-products. The main products consumed were plastics, fibres and synthetic rubber. The developing countries had a small share in the consumption of world petrochemicals. However, especially during the last decade, developing countries' growth in petrochemical consumption has been quite high as compared to countries of the developed world.

During the last decade the chemical and petroleum sector has been a fast growing industrial sector in the developing ESCAP region. The existing petrochemical industry of the region (primarily based on naphtha feed) is concentrated in India and the Republic of Korea. Singapore's facilities have recently gone into operation. Iran's facilities are partially constructed and will be operational in the late 1980s. In the remaining countries which include, Thailand, Malaysia, the Philippines, Indonesia and Pakistan, downstream production facilities of thermoplastics and synthetic fibres are

available. The region also has sizeable processing facilities for plastic materials and synthetic fibres. The existing petrochemical production capacity of the region is not being fully utilized while at the same time the region is importing a major proportion of its requirements from the developed world.

During the last two decades the ESCAP region's consumption of petrochemical end-products showed an impressive growth, with plastics (primarily thermoplastics) and synthetic fibres (primarily polyester) dominant. The synthetic rubber consumption remained at nominal levels. Despite impressive growth in petrochemical end-products the per capita consumption remained very low as compared to developed countries, showing an existing potential for a petrochemical industry in the region. Wide variations also existed in the per capita consumption of countries of the region.

Many countries of the region have been actively pursuing the establishment of a petrochemical industry, however, to date have not been able to implement their plans primarily due to international economic conditions, limitations of market size and uncertainity about export prospects. These countries include Indonesia, the Philippines, Thailand and Pakistan. The problems and issues responsible for restricting the development of the petrochemical industry in the region are economic and technological in nature. Among the economic problems are lack of government support, limited size of domestic markets, uncertainty of export prospects, size of facilities and constraints of capital resource. Among technological issues, the selection of various technologies, technological innovation, non-availability of local machinery and equipment manufacturing capability as well as constraints in availability of skilled manpower are active.

The world petrochemical industry is not expected to show impressive growth in view of the recessionary economic conditions, the diversification of the industry's base from consuming areas to oil rich countries and the exhaustion of substitution opportunities in industrialized countries. The international market is expected to be highly price/cost competitive with oil

producing regions using cheap and currently wasted raw materials to their advantage while the developed countries are taking advantage of available technological infrastructure.

The developing ESCAP region is expected to still show high growth in petrochemicals compared to other regions of the world. However, the growth will be considerably lower than observed during the last decade. The demand growth can be high if all the countries planning to establish petrochemical industries are successful in implementing their plans. Thermoplastics and polyester fibres will remain dominant among the petrochemical end-products. By the end of the current decade, the petrochemical production capacity in the ESCAP region is expected to expand considerably as the facilities of Singapore, Iran and Indonesia will be operational along with expansions in the capacities of India and the Republic of Korea. The major expansion will be for ethylene and its derivatives. Despite the planned expansion, the region will have significant deficits of almost all the petrochemical end-products among which thermoplastics and polyester will be leading. Based on the projected deficits by 1990 the region will be requiring an ethylene production capacity of about 1.2 million metric tons with a polyester capacity of 1.0 million metric tons.

The region's existing producers of petrochemicals i.e. India, the Republic of Korea and even Singapore are expected to lose their competitiveness in exports. This will lead to non-implementation of the industry's expansion plans in these countries and possibly a low level of capacity utilization. This situation calls for regional co-operation whereby the region's existing petrochemical producers save high costs (due to the expected low level of capacity utilization) and new entrants to the petrochemical industry are provided with the necessary assistance to establish and operate a petrochemical industry and finally market their products.

1.4 Main findings of the study

The study has revealed that:

(a) The petrochemical industry has the required potential for accelerating the industrial development in developing countries;

(b) The world's petrochemical industry growth will be slower in future as compared to the high growth observed during the past. The developing countries' petrochemical consumption growth will be higher than that in developed countries;

(c) The petrochemical industry is going through a process of restructuring and rationalization calling for co-operation both at the global and regional levels;

(d) World petrochemical industry will face high competition among producers with respect to price and technology;

(e) The current basic and intermediate petrochemical production of the developing ESCAP region is limited to few countries;

(f) The problems faced by the developing countries in the establishment and successful operation of the petrochemical industry can be overcome through co-operation among developing countries themselves;

(g) The developing ESCAP region has considerable potential for the production of petrochemicals in view of the low market penetration of these materials;

(h) The developing countries which have established or plan to establish a petrochemical industry are expected to face problems because of the highly competitive situation on the international market. This will be more pronounced for energy deficient countries such as the Republic of Korea;

(i) Despite the planned expansion of the petrochemical industry in the developing ESCAP region considerable deficits in almost all petrochemical end-products will exist by the end of the current decade;

(j) Based on the projected petrochemicals deficits of the ESCAP region by 1990, four sizeable petrochemical projects should be considered for implementation under regional co-opration arrangement;

(k) The expected situation of the petrochemical industry in the developing ESCAP region necessitates highly activated regional co-operation;

(l) The regional co-operation plans for the establishment of the petrochemical industry in the developing ESCAP region (if implemented) will also be affected by international market forces. Through regional co-operation it would also be possible to introduce specialization in petrochemical production;

(m) The successful implementation of regional co-operation plans for the development and successful operation of the petrochemical industry would require considerable involvement on the part of governments of the member countries. In some cases member countries will have to provide tariff protection giving special treatment to imports originating from regional projects. The success of such an arrangement would depend on the benefits to be gained by member countries in these arrangement.

2. THE DEVELOPING ESCAP REGION: ECONOMIC PROFILE

The developing ESCAP region is situated in the Southwest and East Asian continent. The fifteen countries which are part of the developing ESCAP region are:

Afghanistan	Indonesia	Pakistan
Bangladesh	Iran	Philippines
Burma	Republic of Korea	Singapore
Area of Hong Kong	Malaysia	Sri Lanka
India	Nepal	Thailand

The developing ESCAP region is a heavily populated area of the world and currently about 30 per cent of the world population is living in countries of the region. The region consists of a diverse group of economies with differing economic structures. A review of these indicates that the leading contributors to the region's GDP are India, Indonesia and the Republic of Korea. Traditionally, the agriculture sector had the largest share of GDP in the majority of the region's countries. However, during the last two decades the service sector has taken the lead followed by industry and agriculture. In almost all of the countries of the region a rapid drive towards industrialization was noticed. This drive was in fact responsible for much of the economic growth and prosperity as well as structural changes seen in many economies of the region. During 1960-1970 the GDP of countries like the Iran, the area of Hong Kong, Singapore and the Republic of Korea showed an average annual growth of 8 to 11 per cent. In the remaining economies the growth rate varied between 2 and 7 per cent per annum. In almost all the countries of the region, the growth in GDP during 1970-1982 was slightly lower than that recorded during the previous decade.

Industrial output in all developing ESCAP countries during 1960-1982 continued to expand at a faster rate than GDP. The Republic of Korea's industrial sector showed the highest growth rate of 17 per cent per annum during the 1960-1970 period, while the sector's growth declined to 14 per cent per annum during the 1970-1982 period. India's industrial sector showed a consistent growth of 4 per cent per annum during the 1960-1982 period.

3. THE PETROCHEMICAL INDUSTRY: ITS IMPACT ON ECONOMIC PROGRESS IN THE ESCAP REGION

In the developing ESCAP region only two countries, the Republic of Korea and India, had operational basic petrochemical industries by the end of the last decade. Singapore's petrochemical facilities have recently started operation. The region has a sizeable market for petrochemicals. However, feedstock from oil and gas resources in the region is limited to Indonesia, Iran, Malaysia and Thailand. The remaining countries are deficient in this resource. The region is a net importer of petrochemicals, even after Singapore facilities go into operation, and this situation is not expected to change significantly by the end of current decade. Many countries of the region have ambitious plans to establish a basic petrochemical industry. However, these plans have not materialized in view of prevailing economic conditions, scarcity of capital resources, development of other priority sectors, low level of technical know-how and limitation of the market size in individual countries.

The petrochemical industry's economic benefits are generally considered to be:

(a) A rapid expansion of the countries' or region's manufacturing sector;

(b) A direct contribution to gross domestic product by value added to the raw material and indirectly through expansion of downstream industries;

(c) Foreign exchange savings;

(d) Supply of raw material and support to other industries.

In the paragraphs to follow the impact of the petrochemical industry on the overall economic development in relation to policy objectives laid down in international development strategy, which has been considered as a guiding policy for industrial development in the developing ESCAP region, is discussed.[2/]

2/ Re-orientation of Industrial Policies studies undertaken by ADNOC Group of Ministry of Industry, ESCAP.

The policy objectives are:

(a) Strengthening of linkages between industry and agriculture;

(b) Development of the industry to satisfy the basic needs of the poor;

(c) Development of small-scale industries and their linkages with large and modern industries; and

(d) Dispersal and location of industries away from metropolitan areas.

3.1 Strengthening of linkages between industry and agriculture

Most of the initial industrial development of the region has been in industries having strong backward linkages with agriculture. An example can be the cotton textile industry in Pakistan, here the agriculture sector acts merely as a supplier of inputs to industry. In the recent past the forward linkage has been strengthened and industries like fertilizer, pesticides and engineering goods have been developed. The petrochemical industry also provides help in establishing these linkages both directly and indirectly. The industry's backward linkages are limited when its primary feed is based on oil/gas resources, and strong where the petrochemical production is based on some forms of biomass utilization (as is the case partly in Brazil and India). In Brazil ethanol is manufactured from molasses from sugarcane. The industry's forward linkage is represented by the production of insecticides and pesticides, as well as chemicals for irrigation facilities and by control of water logging and reducing land erosion.

3.2 Development of the industry to satisfy the basic needs of the population

In many countries of the region, food production is inadequate. The establishment and expansion of the petrochemical industry is expected to release land which currently is used for production of wood, cotton, etc., as petrochemical products will substitute these natural materials. As such the region's food availability position will be considerably improved.

The industry is also instrumental in providing clothing, water supply, sanitation and numereous household items.

3.3 Development of small-scale industries and their linkages with large and modern industries

The petrochemical industry is an excellent example of this type of linkage. The industry leads to numerous types of small-scale industries for example plastic processing, textile weaving, etc. This part of the industry is in continuous contact with petrochemical end-products producers who disseminate the required technical back-up, changes in product characteristics and product development.

3.4 Dispersal and location of industries away from metropolitan areas

The manufacture of basic as well as petrochemical end-products is normally established near its feed source i.e. near gas fields and refining facilities. The achievement of the above objective depends on the location of the available feed source in a particular country. However, the processing facilities for the manufacturing of consumer goods can be located away from metropolitan areas.

4. THE PETROCHEMICAL INDUSTRY: GLOBAL REVIEW

4.1 General

Petrochemical products currently form an essential base for the production of a wide range of industrial and consumer products. The petrochemical sector has been the most rapidly developing part of the chemical industry and now comprises much of the earlier established organic chemical sector which was based on by-products of coal carbonization. The present industry is based on petroleum/gas feedstock.

4.2 Production trends in basic and petrochemical end-products

Broadly speaking, production of basic as well as final petrochemical products showed a tendency towards growth, which was rapid up to 1973. In the later period the industry's growth slowed down and gave way to recessionary conditions.

(a) Basic products

The world basic petrochemicals production during the period 1965 to 1981 is shown in table 1.

The regional breakdown of world basic petrochemicals production from 1975-1981 is given in table A.1.

It can be seen from the above figures that basic petrochemical production showed rapid growth during 1965-1970 with a maximum increase in ethylene production, i.e. 2.3 times. During 1970 to 1975 the growth in petrochemical production considerably slowed down resulting in an annual compound growth of 6 per cent as compared to a growth rate of 18 per cent per annum during 1965 to 1970. During 1975 to 1979 ethylene production recovered from an earlier slow growth, and achieved an annual compound growth rate of 11 per cent per annum. In 1981 the world basic petrochemical production generally declined, the only exceptions were xylenes and butadiene. Ethylene production which stood at 37,630 thousand metric tons in 1979 declined to 35,253 thousand metric tons in 1981.

Table 1. World petrochemical production of basic products, 1965-1981 (thousand metric tons)

	1965[a]	1970[a]	1975[b]	1979[b]	1981[c] [d]
Ethylene	8,000	18,500	24,400	37,630	35,253
Propylene	4,400	9,530	12,590	19,720	18,445
Butadiene	1,900	3,130	3,445	5,060	8,201
Benzene	4,780	8,820	11,310	17,180	16,501
Xylenes	...	...	3,770	6,110	9,512
Methanol	...	...	7,540	11,720	...

Source:

a/ First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.

b/ Second world-wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981, and Annex ID/WG.336/3/Add.1, 20 May 1981.

c/ Opportunities for co-operation among the developing countries for the establishment of the petrochemical industry, paper presented by the UNIDO secretariat at the Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemical Industries, Vienna, 7-9 March 1983.

d/ Hydrocarbon processing, Gulf Publishing Co., United States, August 1983.

(b) Petrochemical end-products

The petrochemical end-products are grouped into four categories i.e. plastics, synthetic fibres, synthetic rubbers and detergents. Table 2 shows the growth in the production of these four main end-products.

The regional break-up of world petrochemical end-products production from 1975 to 1981 is given in table A.2.

(c) Plastics

Plastics account for more than half of the world's petrochemical end-products production followed by synthetic detergents and fibres. The plastics production during 1960 to 1970 increased at an annual compound

growth rate of 16 per cent. The growth in production of plastics during 1970 to 1974 was at a rate of 10 per cent per annum which after taking into account the low level of production of 1975 dropped to 5 per cent per annum. The production of the five thermo-plastics (LDPE, HDPE, PVC, PP, PS), which was estimated to be 38,5 million metric tons in 1975 increased to 41,165 million metric tons in 1979, showing a growth rate of 14 per cent in five years. In 1981 thermo-plastics production declined to 37,436 million metric tons.

Table 2. World production of petrochemical end-products (thousand metric tons)

	1960[a/]	1970[a/]	1975[a/]	1979[b/]	1981[c/]
Plastics	7,000	30,200	38,500	41,165	37,436
Synthetic fibres	700	5,100	7,500	10,040	12,069
Synthetic rubbers	2,000	5,900	7,400	6,390	8,494
Detergents	3,500	9,000	10,800	...	...

Source:

a/ First world-wide study on the petrochemical industry 1975-2000 UNIDO/ICIS.83, 12 December 1978. The individual product groups include all categories of products.

b/ Annexes to second world-wide study on petrochemical industry: process of restructuring UNIDO, ID/WG.336/3/Add.1, 20 May 1981. The individual product groups cover major products e.g. in case of plastics only thermo-plastics are included.

c/ Opportunities for co-operation among the developing countries for the establishment of the petrochemical industry, paper presented by the UNIDO secretariat at the Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemical Industries, Vienna, 7-9 March 1983. The individual product groups cover major products e.g. in case of plastics only thermo-plastics are included.

(d) Synthetic Fibres

Synthetic fibres production which started from a nominal level of less than 1 million metric tons in 1960 touched a level of more than 5 million metric tons in 1970. The growth in production recorded an unprecendently high

rate of 22 per cent per annum during the 1960 to 1970 period. The increase in production of this magnitude was due to the fact that most of the synthetic fibres were developed during the intervening period. The synthetic fibres production grew at an annual compound growth rate of 8 per cent per annum during 1970 to 1975. The three leading synthetic fibres (acrylic, polyamide, polyester) production of which in 1975 was around 7,500 thousand metric tons increased to 10,040 thousand metric tons in 1979 and 12,069 thousand metric tons in 1981. The increase in production during the 1975-1981 period was at a compound growth rate of 9 per cent per annum.

(e) Synthetic rubber

Synthetic rubber production increased at an annual compound growth rate of 11 per cent, the growth declined to 5 per cent per annum during the 1970-1975 period. The two leading synthetic rubbers which accounted for about 70 per cent of total synthetic rubber production, grew at 6 per cent per annum during 1975 to 1979. In 1981 the production of SBR and PBR was estimated to be around 8.5 million metric tons.

The world petrochemical industry is concentrated in the developed regions of the world with the United States, Western Europe and Japan being the leading producing areas. The share of developing countries in world petrochemical production is nominal. In basic petrochemicals production, developing countries had a share of only 8 per cent. In petrochemical end-products production developing countries had a share of about 12 per cent. Among petrochemical end-products synthetic fibres is one product group in which developing countries had a high share i.e. 18 per cent. In fact synthetic fibres was the developing countries' first venture in the petrochemical industry, since relatively small plant sizes are required for economic production and labour represented a large share in total production cost. The developing countries as a whole are relative newcomers in the petrochemical industry. More recently the OPEC countries have made a breakthrough and huge capacities are being planned. These facilities are expected to be operational during the mid-1980s and this decade will see a significant diversification in the world petrochemical industry.

4.3 Feedstock pattern

Since its inception the petrochemical industry has been based on hydrocarbon resources starting with coal, then shifting predominantly to petroleum based resources, including natural gas. Petrochemical feedstocks in general are categorized as gas-based feedstocks or liquid feedstocks. Gas-based feedstocks include methane, ethane, propane, all of which make up the bulk of constituents of natural gas (including associated gas) and refinery gases as well as synthesis gas. Liquid feedstocks, on the other hand, are mainly crude oil refinery fractions, NGL and condensates. The most noted of these cuts are butane (in LPG), naphtha and gas oil. Synthetic fuel from coal, liquid products from coking plants as well as biomass ethanol are also classified as liquid feedstocks.

Natural gas and refinery gases as well as refinery liquids are the main sources of feedstock for all petrochemicals around the world. However, different feedstock patterns exist in different regions.

(a) United States

In the United States of America, traditional feedstocks for ethylene production are ethane and propane. Trends in recent years have been towards increasing the use of naphtha and middle distillates.

(b) Western Europe

The petrochemical industry in Western Europe has been primarily based on naphtha. However, during the 1970s a shift towards heavier middle distillates such as gas oil, and LPG/ethane has been observed.

(c) Japan

Japan is in a similar position as Western Europe and as such all olefin production of ethylene, propylene and butadiene is based on naphtha feedstock.

(d) Remaining world

Information on feedstock patterns in the USSR, Eastern Europe and other centrally planned economies is not available. However, the general feeling is that the major part of petrochemical production is gas based and the remainder naphtha based. In developing countries naphtha followed by gas are the feedstocks for the production of a limited quantity of petrochemicals. A small quantity of biomass ethanol is also being utilized in countries like Brazil and India. The petrochemical industry of the oil rich countries is primarily based on associated, raw and refinery gases.

4.4 Consumption trends in petrochemical end-products

In view of the fact that consumption of petrochemical end-products is the key factor in determining the basic demand for petrochemicals, the discussion on consumption trends has been concentrated on them. The consumption of the main petrochemical end-products in the past has followed the S-shaped curve reflecting the extent of product and technology substitution. Typically, almost all production of petrochemical end-products initially started slowly followed by very rapid growth during the substitution phase and then declining. Once the substitution phase was completed, the growth rate started to become similar to that of the consuming sector as well as the economic activity in general.

The world petrochemical end-products consumption during 1965 to 1981 is presented in table 3.

The regional breakdown of world petrochemical end-products consumption covering the 1975-1981 period is given in table A.3.

(a) Plastics

Plastics is the leading petrochemical end-product and accounts for almost 60 per cent of total tonnage. The growth in plastics consumption has been fastest. During 1965 to 1970 plastics consumption increased at a compound growth rate of 14 per cent per annum.

Table 3. World consumption of petrochemical end-products, 1965-1981 (thousand metric tons)

	1965[a/]	1970[a/]	1975[a/]	1979[b/]	1981[c/]
Plastics	13,501	26,275	38,460	41,000	36,862
Synthetic fibres	2,140	4,616	7,400	10,030	12,069
Synthetic rubber	3,720	6,860	7,870	6,380	8,427
Synthetic detergents	6,110	7,920	10,850	...	...

Source:

a/ First world-wide study on the petrochemical industry 1975-2000 UNIDO/ISIC.83, 12 December 1978. The individual product groups include all categories of products.

b/ Annexes to second world-wide study on the petrochemical industry: Process of restructuring UNIDO/ID/WG.336/3/Add.1, 20 May 1981. The individual product group covers major products e.g. in case of plastics only thermo-plastics are included.

c/ Opportunities for co-operation among the developing countries for the establishment of the petrochemical industry, paper presented by the UNIDO secretariat at the Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemical Industries, Vienna, 7-9 March 1983. The individual product group covers major products e.g. in case of plastics only thermo-plastics are included.

The growth rate dropped to 8 per cent per annum during 1970 to 1975. The figures for 1975 and 1979 are not comparable, since the first include all plastics, the second thermo-plastics only. The world thermo-plastics consumption declined to 36.8 million tons in 1981.

Plastics consumption during the period under study remained concentrated in the developed region of the world. In 1979 developing countries had a share of 16 per cent in total world consumption. Among the developed regions North America and Western Europe were the leading consuming areas followed by Japan and the centrally-planned economies. Among developing countries Asia and Latin America were the main consumers. Throughout the period from 1965 to 1979 the developing countries' consumption kept growing at a very fast pace with growth rates between 15 and 20 per cent. Compared to this, the developed countries' consumption growth remained in the range of 5 to 7 per cent.

(b) Synthetic fibres

The synthetic fibres consumption increased from 2 million tons in 1965 to 10 million tons in 1979. The consumption during 1965 and 1975 increased at an annual compound growth rate of 13 per cent. In the 1975 to 1979 period the growth was at 9 per cent per annum. Currently, leading synthetic fibres are polyesters, acrylic and nylon. During 1979 to 1981 the synthetic fibres consumption increased at an annual compound growth rate of around 10 per cent.

Consumption of synthetic fibres also remained concentrated in the developed regions. The developing countries' share in the three leading synthetic fibres i.e. polyesters, acrylic and polyamide was around 25 per cent in the year 1979. The developing countries' fibres consumption growth was higher than that of the developed countries due to increased market penetration and a higher population base. The growth in fibres consumption of the developed countries was lower due to the fact that their markets have already been saturated. In the developed region North America was the leading consumer and in the developing region Asia was the main consuming area.

(c) Synthetic rubbers

Throughout the 1965 to 1975 period synthetic rubber consumption grew at an annual compound growth rate of 8 per cent. During 1975 to 1979 the growth rate was slightly lower. Styrene butadiene and polybutadiene rubbers emerged as leading synthetic rubbers, their consumption increased at an annual compound growth rate of 15 per cent during 1979 to 1981. The developed region's consumption of the two leading synthetic rubbers accounted for about 90 per cent of total world consumption.

(d) Synthetic detergents

Synthetic detergents on a columetric basis are next to plastics. Their consumption during 1965 to 1975 increased at a marginal growth rate of 6 per cent per annum. Alkylbenzene, sulfonates and non-ionic surfactants were

the leading detergent materials in use. The developing countries together accounted for 20 per cent of total world synthetic detergent consumption in the year 1975.

4.5 International trade pattern

Petrochemical products have an important share in the international chemical trade. Among the petrochemicals the bulk of the trade is in petrochemical end-products. The trade flows for basic petrochemicals is concentrated among the developed region in the form of inter-trade in Europe. International trade as such in bulk petrochemicals has been very nominal. In general, the biggest exporters of basic petrochemicals have been the EEC countries and Japan. The basic petrochemicals trade has been in aromatics, propylene and methanol, in case of ethylene the quantity has been very small. World trade in intermediate petrochemicals has not been very significant and like basic petrochemicals has been concentrated heavily within the developed regions. Inter-trade of intermediates (e.g. styrene) among countries of the same developed regions has been more pronounced in the case of the EEC. Exports of intermediates to developing countries have been very minimal due to a non-existence of capacity for further processing. The bulk of trade in petrochemicals has been in end-products i.e. plastics, resins, synthetic fibres and synthetic rubber. The main world trade flow in petrochemical end-products has been from the developed region, where most exports were generated, to developing countries, where production facilities were non-existent or insufficient. Plastics had the highest trade volume. Western Europe dominated the world trade of plastics followed by Japan, whose concentration has been in South-East Asia, and the United States. Eastern European and other centrally planned economies also been active in international trade of plastics, more specifically in PVC. The share of the developing countries in world trade of petrochemicals has been low (i.e. about 5 per cent in 1978).[3/] In recent years some exports, mainly fertilizers and natural gas derivates and ammonia, have been undertaken.

3/ Second world-wide study on petrochemical industry: process of restructuring UNIDO, ID/WG.336/3/Add.1, 20 May 1981.

5. THE PETROCHEMICAL INDUSTRY IN THE DEVELOPING ESCAP REGION

5.1 General

As is the case for almost all industries, the petrochemical industry is also concentrated in the developed region of the world. The developing countries in total have a small share in petrochemicals production. As far as the developing ESCAP region is concerned the chemical and petroleum sector has been one of the fast growing industrial sectors during the last decade. However, the share of the chemical industry, without petroleum refineries and products, in total manufacturing value added has been in the range of 10-13 per cent. Table A.4 gives the data by country on the chemical/ petrochemical industry's contribution to GDP, employment and the average size of establishments.

The existing petrochemical industry is concentrated in countries like the Republic of Korea, India and Iran with a recent addition of facilities in Singapore. The region has net deficits in almost all the petrochemical products. The deficits are met through imports from developed countries e.g. Japan, the United States and Western Europe. It should be noted that, although the region has net deficits in basic as well as petrochemical end-products, it has a sizeable petrochemical-based consumer products manufacturing capacity. A typical example is the plastic products and synthetic wearing apparel industry. The products of these industries are exported to developed as well as developing countries of the world. The primary reason for the existence of processing capability is the availability of cheap manpower, as in the case of plastic fabrication, labour costs are quite significant.

5.2 Basic and petrochemical end-products production

The developing ESCAP region's capacity to produce basic as well as main petrochemical end-products is presented in table 4.

The country breakdown of the developing ESCAP region's basic and main petrochemical end-products production capacity is given in table A.5.

Table 4. Basic and main petrochemical end-products production capacity in the developing ESCAP region[a/], 1977, 1979, 1980
(thousand metric tons)

	1977	1979	1980
Olefins (ethylene + propylene + Butadiene)	508	710	1,253
Aromatics (benzene + xylenes) + Methanol	609	790	835
Plastics (5 thermo-plastics)	641	1,193	1,570
Synthetic fibres (polyester, polyamide and acrylic)	625	848	901
Synthetic rubber (SBR and polybutadiene)	100	120	180

a/ Data sources specified in table A.5.

Since relevant statistics are not available the capacity figures have been given only for 1977 to 1980. Most of the existing petrochemical production capacity has been installed during the last decade. As can be seen from the above table, olefins capacity increased 2.5 times during the period 1977 to 1980. Among olefins ethylene has the major share followed by propylene. Aromatics and methanol production increased from 600,000 tons in 1977 to 800,000 tons in 1980.

Among petrochemical end-products the capacity of the five leading thermo-plastics increased 2.5 times. The synthetic fibres production capacity increased from 600,000 metric tons to nearly 1 million metric tons. This increase has been primarily due to the addition of basic polyester manufacturing plants. The synthetic rubber production capacity during the years 1977 to 1980 increased from 100,000 metric tons to 180,000 metric tons.

The basic petrochemical production capacity of the region is restricted to the Republic of Korea and India with the recent addition of Singapore. In the remaining region no significant production capability exists. India's petrochemical industry is the oldest in the region. The Republic of Korea is a new entrant and currently it enjoys a major share in the region's industry. In fact, the increase in the region's production capacity (both basic and

petrochemical end-products) during 1977 to 1980 is due to the operation of the Republic of Korea's yeoch-chon complex. Singapore's petrochemical facilities which started operation in early 1984 consist of a central naphtha cracking complex, capable of producing ethylene, propylene, butadiene and aromatics, with downstream facilities of LDPE, HDPE, polypropylene and ethylene glycol. Iran's basic and petrochemical end-products production facilities which are partially constructed are expected to be operational some time during the late 1980s.

As far as the main petrochemical end-products production capability is concerned, plastics as a group are one product which is quite widespread among the countries of the region. In the case of PVC, 9 out of 15 countries in the region have production capability. Among the plastics the leading materials are polyvinyle chloride (PVC) and polyethylene. The major proportion of capacity is still in the Republic of Korea followed by India. It is interesting to note that large variations exist in the capacities of various countries in the region, for example in the case of PVC the Republic of Korea's capacity is around 300,000 metric tons followed by India with 130,000 metric tons as compared to a capacity of 5,000 metric tons in Pakistan.

The petrochemical production from the facilities located in the region is presented in table 5.

The actual production of basic and main petrochemical end-products by country is given in table A.6.

The capacity utilization of basic petrochemicals in 1980 was in the range of 60-70 per cent. Among end-products the highest capacity utilization rate of around 80 per cent was observed for synthetic fibres followed by synthetic rubber (75 per cent) and plastics (70 per cent). Separate data about the production of the individual basic as well as petrochemical end-products are very scanty. The main reason for this is the integrated nature of the petrochemical industry. Most of the plants are composite having ethylene, polyethylene, aromatics as well as fibre intermediate production facilities. In all these plants separate statistics for the production of basic as well as intermediate products are not kept accurately. In certain cases the PVC

production facilities also have pipe or other products fabrication facilities. Normally these plants report PVC production for sale while records on quantity of PVC utilized internally for the production of pipes etc. are not available.

Table 5. Actual production of basic and main petrochemical end-products in the developing ESCAP region (1975-1980) (thousand metric tons)

	1975	1977	1979	1980
Olefins (ethylene + propylene + butadiene)	255	256	489	805
Aromatics (benzene + xylene + methanol)	242	624	616	579
Plastics a/	370	578	863	1.083
Synthetic fibres b/	354	575	687	753
Synthetic rubber c/	57	86	105	135

a/ Includes major thermoplastics i.e. LDPE, HDPE, PVC and PP.

b/ Includes major synthetic fibres i.e. polyester, polyamide and acrylic.

c/ Includes major synthetic rubbers i.e. styrene butadiene rubber (SBR) and polybutadiene rubber (PBR).

Data sources are specified in table A.6.

5.3 Consumption trends in petrochemical end-products

Historically, consumption of petrochemical end-products in the developing ESCAP region has grown from the low level during the mid-1960s. The low levels of consumption during the mid-1960s as well as the increasing substitution process which took place during the intervening period resulted in an impressive growth during the last two decades.

The consumption figures for main petrochemical end-products for the period 1965 to 1980 in the ESCAP developing region are presented in table 6.

The consumption of petrochemical end-products by country is given in table A.7.

Table 6. Petrochemical end-products consumption in the developing ESCAP region[a/], (1965-1980)
(thousand metric tons)

	1965	1970	1975	1980
Plastics	289	765	1.279	1.909
Synthetic fibres	67	228	460	845
Synthetic rubber	52	102	201	225

a/ The consumption data (1965-75) of individual product groups include all categories of products. The data for 1980 covers major products e.g. in case of plastics only thermoplastics are included.

The review of the above figures reveals that plastics as a group are the major tonnage item among the petrochemical end-products. This pattern is in line with the world consumption pattern. The region's plastics consumption during 1965 to 1975 increased at an annual compound growth rate of 16 per cent which is considerably higher than the growth in world consumption, 11 per cent per annum, for the corresponding period. In view of the non-availability of plastics consumption data (all types), the 1980 figures pertain to five leading thermoplastics. The consumption of these thermoplastics increased at a rate of 20 per cent per annum during 1975 to 1980 which is an unprecedently high growth. These thermoplastics have dominated current as well as past plastics consumption. Among the thermoplastics polyethylene enjoyed the leading share followed by polyvinyle chloride.

The growth of synthetic fibres consumption during the period under consideration was also quite high, this was primarily due to polyester which was introduced during the 1960s. Synthetic fibres consumption of the region during 1970 to 1975 increased at an annual compound growth rate of 13 per cent. The three leading fibres which dominate the total consumption achieved a growth rate of around 10 per cent per annum during 1975 to 1979.

Synthetic rubber consumption increased at 14.5 per cent per annum during 1965 to 1975.

It is interesting to note that although in almost all the petrochemical end-products the growth in consumption has been quite impressive and has not been affected by the events of 1970s, the per capita consumption of the region is still the lowest in the world. For example the developed region average per capita consumption of five leading thermoplastics ranged between 20-45 kg in 1980, while the developing ESCAP region had an average per capita thermoplastics consumption of 2 kg. Among the countries of the region, wide variations in per capita petrochemicals consumption were noticed. For example the Republic of Korea and India which are considered to be leaders of the region in the petrochemical industry had a per capita thermoplastics consumption of 15.4 kg and 0.4 kg, respectively. The low level of per capita consumption in countries of the region itself shows the petrochemical industry's potential.

6. DISCUSSION ON THE PETROCHEMICAL INDUSTRY IN SELECTED COUNTRIES OF THE DEVELOPING ESCAP REGION

6.1 General

The discussion on past developments of the petrochemical industry in selected countries of the developing ESCAP region is presented in the following paragraphs. The discussion pertains to Pakistan, India, Republic of Korea, Iran, Indonesia and Thailand. For each country topics such as economic profile and progress, development of the petrochemical industry, the petrochemical market and the available basic and downstream facilities have been dealt with.

6.2 Pakistan

Agriculture is the largest single sector of Pakistan's economy accounting for 31 per cent of the GDP. It employs 55 per cent of the labour force and its share in export earnings amounts to about 40 per cent. The share of agriculture in GDP has declined over the years, due to an expansion in the industrial and services sectors.[4/]

The industrial sector, including large and small scale manufacturing, is currently contributing around 25 per cent of the GDP with an industrial labour force estimated to be 3.5 million. The industrial sector's growth since 1947 has been highly impressive. Starting with virtually no worthwhile industry in the territories of the present Pakistan the country had developed a substantial industrial base by the end of the 1960s. Despite severe setbacks, the industrial base has continued to expand. The industrial sector during the 1960s recorded an annual growth rate of 10 per cent, which declined to about 6 per cent per annum during 1970 to 1982. The manufacturing value added was estimated to be US$ 2,500 million in 1981. Food and agriculture have the major share of manufacturing value added followed by chemicals and other

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4/ The Sixth Five Year Plan 1983-88, Planning Commission, Government of Pakistan.

manufacturing and textiles. The major large-scale industries are textile, food processing, steel, fertilizer, paper and board, general chemicals and petroleum refining. The sector's growth has been primarily due to expansion in large-scale industries. The small-scale sector comprises industries like clothmaking, sports equipment, carpets and surgical instruments. Pakistan's exports, estimated to be US$ 2,403 million in 1982, were dominated by primary commodities i.e. agriculture and textiles. The import bill in 1982 was estimated to be US$ 5,400 million with the major share taken up by fuels, machinery and transport equipment and other manufactures.

(a) The chemical industry

Pakistan's chemical industry, excluding fertilizer, is still in the developing stage. The production capacity of the chemical industry can meet only 10 per cent of the country's requirement. The fertilizer industry has shown an unprecedented expansion, specifically in nitrogenous fertilizer, with the result that currently the country has a surplus of urea fertilizer which is being exported.

The present chemical industry consists of basic chemicals, pharmaceuticals and synthetic fibres.

(b) Existing petrochemical production facilities

No production facilities for building block petrochemicals e.g. ethylene exist. The bulk of the petrochemical requirements of the country are being met through imports involving a considerable amount of foreign exchange when at the same time the country has the required feedstocks i.e. naphtha, associated gases and molasses. The possibility of setting-up basic petrochemical production facilities has been studied from time to time by various agencies. Recently, the State Petroleum Refining and Petrochemical Corporation (PERAC) initiated a phased study programme which is currently under implementation. In the Sixth Five Year Plan (1983-1988) an allocation of about US$ 5 million has been made for a feasibility study on setting-up petrochemical production facilities utilizing one of the locally available

feedstocks. Depending upon the techno-economic feasibility the project can be implemented during the next plan period.[5/] In the following paragraphs a brief sketch of the existing petrochemical and associated industry is given:

(i) Plastic materials

Currently, one small plant capable of producing about 5,000 metric tons of polyvinyle chloride, known as Pakistan PVC Ltd., is in operation. The PVC resin production of the plant is based on acetylene and HCL, the acetylene being obtained from calcium carbide. The PVC resin production of the plant during the last five years has been in the range of 2,000-4,000 metric tons per annum. A major proportion of the plant's resin production has been utilized internally for the production of PVC pipes.

Another plant, Synthetic Chemicals Ltd., having the manufacturing capability of LDPE (5,000 metric tons) formaldehyde resins and hexamine (7,000 metric tons) and methanol (3,000 metric tons) was operational till the mid-1970s. The plant was based on the utilization of molasses and natural gas as feedstock. The plant was closed down due to the unfavourable economics of the production of ethylene from molasses and heavy financial burdens.

(ii) Plastics processing industry

Despite the constraints in import of raw material and processing equipment, Pakistan's plastic processing industry has developed over the years. Currently, the industry is capable of producing various types of plastic products ranging from sophisticated items like pipes, wire and cables, to household items, footwear and packing materials. The country's annual processing capacity, consisting of more than 2,000 processors is estimated to be around 80,000 metric tons with a major share of extrusion process followed by injection moulding.

5/ The Sixth Five Year Plan (1983-88), Planning Commission, Government of Pakistan.

(iii) Synthetic fibres

The local production of synthetic fibres is limited to polyamides and polyester fibres and yarn.

(iv) Polyamide (Nylon)

In total there are three plants for the manufacture of polyamide fibre and yarn with a total capacity of about 3,000 metric tons. All these plants are based on imported caprolactum and the production of these plants during recent years has been in the vicinity of 2,000 metric tons per annum.

(v) Polyester

Until 1980, no facilities for the manufacture of polyester fibre and yarn existed and the requirement was being met through imports. In 1982 two plants for polyester fibre/yarn namely National Fibres Limited (a public sector project) and ICI (a transnational corporation) started their commercial production. These two plants have the capacity to produce 24,000 metric tons of fibre and 3,000 metric tons of yarn. These plants are utilizing imported DMT/TPA and ethylene glycol as basic feedstock. Additionally, eight polyester yarn manufacturing plants based on imported polyester chips are in operation with a total capacity estimated to be 10,000 metric tons per annum.

(vi) Aromatics (BTX)

In 1979 National Refinery Limited in 1979 established the production facilities of BTX. These are capable of producing 25,500 metric tons of BTX, out of which benzene is 5,000 metric tons, toluene 9,000 metric tons and xylenes 11,500 metric tons. The plant is catering to local and export markets. In the initial years of operation the unit's production remained in the range of 10,000-13,000 metric tons. Recently, the production has declined considerably because of limited domestic and non-availability of export markets.

(c) The petrochemical end-products market

Despite constraints, the bulk of petrochemicals are imported, there are higher rates of duties and taxes on imports and restrictive import policies, Pakistan in the past has expanded its petrochemical end-products market. For example, in the case of plastic material the duty/tax rate is about 200 per cent of the C & F value. The petrochemical products being consumed include plastic materials, synthetic fibres, synthetic rubber and detergents.

(i) Plastics

The plastic market consists of resins, sheets and finished products. The plastic resin market (i.e. thermo-plastics) was estimated in 1983 to be in the vicinity of 65,000 metric tons. PVC was the leading material with an estimated quantity of 30,000 metric tons. Polyethylene (LDPE & HDPE) was next with an estimated tonnage of 26,000. Poly-propylene (PP) requirements were estimated to be around 9,000 metric tons.

(ii) Synthetic fibres

The synthetic fibres market comprises polyester, nylon, viscose and acrylic. Polyester fibre and yarn have a dominating share of about 70 per cent in the total synthetic fibres market. Polyester fibre/yarn requirements for the year 1983 were estimated at around 75,000 metric tons, with a major share of texturized/filament yarn (i.e. 70 per cent).

(iii) Synthetic rubber

The market size of synthetic rubber is comparatively very small in view of the small local tyre and rubber product industry. The leading synthetic rubber is styrene butadiene rubber (SBR). The present consumption of SBR is estimated to be 5,000 metric tons per annum.

(iv) Synthetic detergents

With the increase in the standard of living and the higher rate of urbanization the detergents market has consistently expanded. The current market size of synthetic detergents used for cleaning, washing and bleaching purposes in the household sector is in the vicinity of 20,000 metric tons.

(v) Thermo-plastics resin prices

The bulk of Pakistan's thermo-plastics resin requirements is imported. The imports originate from a number of countries, such as the United States of America, Western Europe, United Kingdom, Japan, People's Republic of China and Qatar. PVC imports are mainly from the People's Republic of China, the Republic of Korea and East European countries because of the relatively lower prices. The import prices of petrochemicals are linked to international market prices. Table A.8 gives historical import prices of major thermo-plastic resins i.e. LDPE, HDPE, PVC and PP. It can be seen that there were considerable fluctuations during the 1977 to 1984 period. For example the LDPE import price increased from US$ 600 per metric ton in 1977 to about US$ 1,200 per metric ton in 1979, the price dropped to US$ 750 per metric ton in 1982, while during 1983 to 1984 an upward trend in prices was observed. Similar fluctuations were seen for other resins. Prices also varied according to grades and origin of imports. The local prices of resins are determined by adding a mark-up on C & F price plus import duty, surcharge and other related charges. The imports of thermo-plastic resins in Pakistan are subjected to import duty, surcharge and sales tax. Currently, import duty is levied at the rate of Rs. 13/Kg. The import surcharge is levied at the rate of 5 per cent. The variation in local prices is attributed to fluctuations in C & F prices as well as variations in import duty and taxes being levied. The local prices of major thermo-plastics during the 1977-1984 period are also given in table A.8. During the 1977-1980 period local prices remained almost double those of import prices. In subsequent years due to an upward revision of duty rates and the rupee to US$ exchange rate the local price

were in some cases almost 400 per cent higher than import prices. However, in dollar terms the local market prices showed a declining trend owing to the higher rupee to dollar exchange rate.

6.3 India

India is the most populous country of the developing ESCAP region with a predominantly agrarian economy. The agricultural sector contributed 33 per cent in 1982 to the country's GDP, as compared to 50 per cent in 1960. India possesses a fairly developed and diversified industrial base. In 1982 the industry's share in GDP was estimated to be 26 per cent while the manufacturing sector's contribution to GDP was around 18 per cent.

India's industrial sector showed an annual growth of 5.4 per cent during 1960 to 1970, the growth declined to 4.3 per cent during the 1970 to 1982 period. The manufacturing value added increased from US$ 10,232 million in 1970 to US$ 16,190 million in 1981. The leading sectors contributing to the country's manufacturing value added were machinery and transport equipment, textiles, chemicals and other manufacturing. The exports in 1982 were estimated to be US$ 8,446 million, consisting of primary commodities, textiles and other manufactures. The import bill for the year 1982 was around US$ 14,088 million. The fuel sector had a dominating share in imports followed by other manufactures and machinery items.

(a) The petrochemical industry

Among the ESCAP developing countries India is one of the leading producers of petrochemicals in particular and chemicals in general. Until the late 1950s India had a limited number of plants producing petrochemicals and general chemicals and its petrochemical industry at that time was primarily based on the supply of ethylene and butadiene manufactured from ethyl alcohol derived from coke-oven operations.

The first olefin plants based on naphtha steam cracking were installed in the 1960s. These plants were established by Union Carbide India Limited and

National Organic Chemical Industries. During the late 1970s additional petrochemical capacity became available when the plant of Indian Petrochemical Corporation came onstream.

The existing production capacity of various basic and petrochemical end-products is presented in table 7.

Table 7. Indian petrochemical production capacity in 1983

Products	Thousand metric tons/year
Primary products	
- ethylene	243
- propylene	120
- butadiene	50
- xylenes	40
- benzene	150
- methanol	33
Intermediate products	
- DMT/TPA	60
- styrene	35
- ethylene glycol and oxide	58
- acetone	25
- styrene	35
End-products	
- thermo-plastics	328
- synthetic fibres	116
- synthetic rubber	50

Source: 1. The petrochemical industry in Iran, a paper presented at the Seminar on co-operation among developing countries in petrochemical industries, Vienna, 7-9 March 1983, OPEC/UNIDO/OPEC FUND. 2. Chem System's study.

India's petrochemical industry is based on naphtha, available after processing imported as well as local crude oil. Imported crude oil constitutes about 60 per cent of crude oil processed. Apart from naphtha, ethyl alcohol from locally available molasses and coke oven for aromatics

production are being utilized for the production of petrochemicals. About one-third of the ethyl alcohol produced was utilized for the petrochemical production. Similarly, about 20 per cent of the benzene production was coal based.

The country is nearly self-sufficient in most of the petrochemicals. The capacity utilization specifically in the case of basic petrochemicals is lower probably due to the time lag between the start-up of downstream facilities and the development of the market. The Indian petrochemical and chemical industries, including petroleum refineries, contributed around US$ 2.6 billion to GDP in 1978. The plastic products' contribution was around US$ 740 million. The industry employed 632,000 personnel. The mean size of establishment in the case of refineries was 300 and in the case of chemicals and plastics 100. The industry consists of public and private enterprises. The public enterprises are active in petroleum refining and the production of basic petrochemicals. The downstream production of chemicals and petrochemicals is in most cases the domain of private enterprises.

The planned petrochemical facilities include the proposed project of Assam and Haldia at West Bengal. Recently, the Indian government approved the construction of a petrochemical complex at Nagothane in the Konkan region of Maharashtra. The complex will use ethane and propane fractions from Bombay High and South Bassien offshore oil and gas fields. The complex will produce 300,000 tons/year of ethylene. Downstream facilities will consist of LDPE (80,000 tons/year), HDPE (135,000 tons/year) PP (60,000 tons/year) ethylene glycol (50,000 tons/year). The complex is expected to be commissioned before the end of 1989.

(a) <u>The petrochemical end-products market</u>

The consumption in India of petrochemical end-products i.e. plastics, synthetic fibres and synthetic rubber has constantly increased during the last two decades. The thermo-plastics consumption which was about 55,000 metric tons in 1965 has increased to about 252,000 metric tons in 1980. Synthetic fibres consumption was low during the 1970s. The current synthetic fibres consumption is estimated to be 88,000 metric tons with polyester as the

leading fibre. The styrene butadiene rubber consumption has gradually increased, in 1980 SBR consumption was estimated to be 50,000 metric tons. Despite the growth in consumption and local production of almost all the basic and petrochemical end-products, India's per capita consumption is one of the lowest in the ESCAP developing region. For example in the case of thermo-plastics India's per capita consumption in 1981 was less than 0.5 kilogram compared to the world average of 9 kilograms. The low per capita consumption is primarily due to the low standard of living of the major proportion of country's population and the fact that the consumer product market is restricted to the urban areas of the country.

(b) Import and export of petrochemicals

India's petrochemical industry is primarily geared to the domestic market, however, exports of various products have been undertaken in the past. India's chemical and petrochemical industry's imports for the year 1979 were estimated at US$ 2 billion as compared to exports of US$ 23.6 million. The export of plastic resins and articles were around US$ 1.5 million, the bulk of which were exported to the developing ESCAP countries.

6.4 The Republic of Korea

The Republic of Korea has a population of about 39.3 million with a GDP per capita of US$ 1,741 in 1982. The Korean economy, considered to be a model developing economy, has grown rapidly in recent years first through the development of an export-oriented textile industry and later through shipbuilding, construction and other heavy industries. The economy during the last two decades showed a considerable shift from an agriculture base to an industrial base. In the 1960s the agricultural sector's share in total GDP was around 37 per cent which declined to 16 per cent in 1982, while the industrial sector's share increased from 20 per cent in 1960 to 39 per cent in 1982.

The Republic of Korea's industrial sector growth during 1960 to 1970 was around 17 per cent per annum which was the highest among the ESCAP region. This growth declined to about 14 per cent per annum during 1970-1982. The

manufacturing value added increased from US$ 2,346 million in 1970 to US$ 10,542 million in 1981. The main contributors to manufacturing value added were textiles, machinery, chemicals and other manufactures.

The Republic of Korea's exports which in 1982 were estimated at US$ 21,853 million increased at an average annual growth rate of 35 per cent during 1960 to 1970 and 20 per cent during the 1970-1982 period. The exports were dominated by textiles, machinery, chemicals and other manufactures. The chemical industry's exports in 1980 were estimated to be US$ 673 million, about 30 per cent of chemical exports were directed to the developing ESCAP region. In 1982, the country's total imports were in the order of US$ 24,251 million. Fuels, machinery and transport equipment and other manufactures were prominent among the imported goods.

(a) The petrochemical industry

The Republic of Korea has no hydrocarbon reserves, although off shore exploration is planned. At present there are six operational refineries with a crude oil through-put capacity of 607 thousand bbls/day. The crude oil requirements of the country are being met by imports primarily from OPEC countries.

The Korean petrochemical industry dates back to the end of the 1960s when the nation began co-ordinated efforts to develop the industry. During the two successive Five Year Economic Plan periods, the development of the industry was given special attention as one of the major thrusts of the plan. The Republic of Korea has at present two petrochemical complexes. The first one is the Ulsan Petrochemical Complex located in the Ulsan Industrial Zone. The Ulsan Complex, jointly owned by the Republic of Korea Oil Government Bank, Korea Public Company and Gulf Oil, consists of a naphtha cracking ethylene plant of 155,000 metric tons per year and 20 downstream plants all of which have been operational since 1973.

The second is the Yeochon Petrochemical Complex located in the Yeochon Industrial Zone. This complex houses a naphtha cracker capable of producing 350,000 metric tons of ethylene a year and 16 downstream plants. Dow Chemical

and Mitsui are involved in the downstream facilities of the complex. Data on the Korean petrochemical production capacity is presented in table 8.

Table 8. Korean petrochemical production capacity in 1984

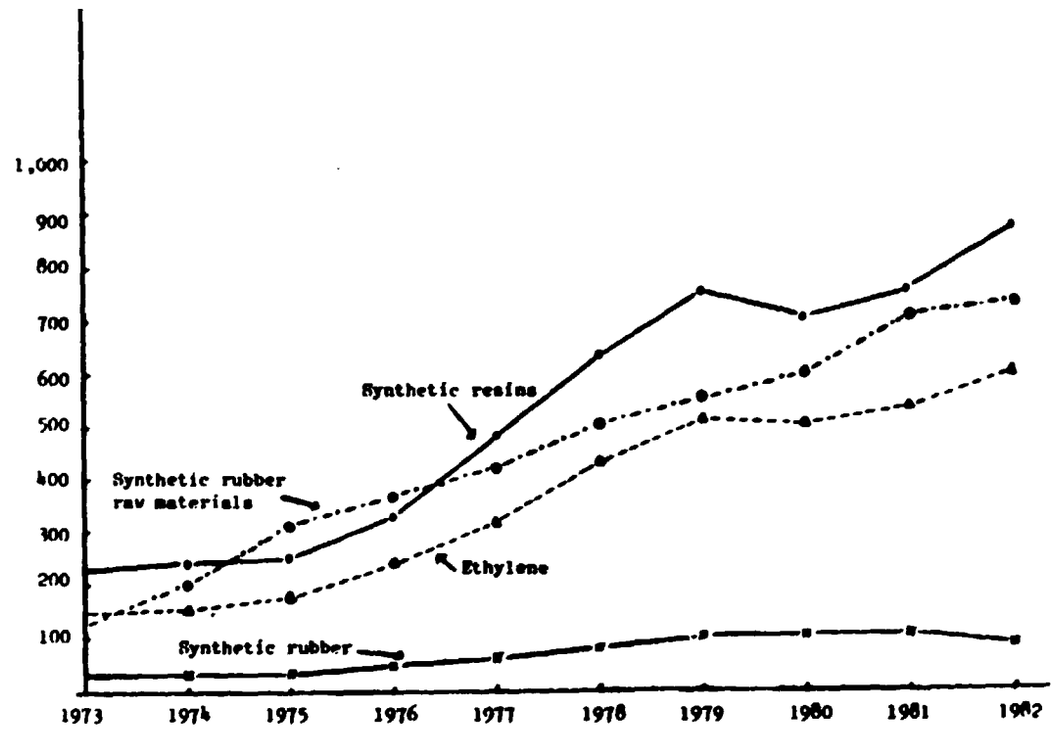
Products		Thousand metric tons/year
Primary products		
- ethylene		505
- propylene		268
- butadiene		25
- xylene		88
- benzene		155
- methanol		390
- toulene		116
Intermediate products		
- DMT/TPA		160
- styrene		80
- ethylene glycol		80
- caprolactom		80
- acrylonitrile		77
End-products		
- thermo-plastics		
LDPE	150	
HDPE	140	
PP	185	996
PVC	355	
PS	166	
- synthetic fibres		445
- synthetic rubber		130

Source: Ministry of Trade and Industry, Republic of Korea.

The Korean petrochemical industry is currently meeting the bulk of the country's requirements. Before the operation of the Yeochon complex in 1979 the industry was operating at about 90 per cent of the rated capacity and

in 1981 the capacity utilization rate dropped to 73 per cent. As a result, the industry recorded an unprecedented negative growth which was attributed to a rise in domestic raw material prices, dwindling international competitiveness and inflows of low priced foreign products. The industry showed slight improvements during 1982-1983. However, this seems to be short-lived as the Republic of Korea is going to further lose its competitiveness on the international market (owing its high feed stock cost, as the complexes are based on naphtha feed) once the Saudi Arabian complexes are in operation. The growth in the petrochemical industry of the Republic of Korea during the 1973 to 1982 period is shown in figure 1 below:

Figure 1. Production growth trend of the petrochemical industry in the Republic of Korea



Source: Petrochemical Industry in Korea (1983) published by Korea Petrochemical Industry Association.

(b) The petrochemicals market

The petrochemical end-product market has expanded with the continued expansion in the country's industrial base, specifically, the industry utilizing petrochemical end-products. The demand for petrochemical products in the Republic of Korea during the 1973 to 1979 period increased at an annual growth rate of around 20 per cent which was twice as much as the GDP growth achieved during the same period. Demand experienced a slow down in 1979 and suffered a serious setback in 1980/82 recording an unprecedented negative growth. During 1982 to 1983, the demand started showing a positive growth.

During the 1973 to 1982 period the demand for synthetic resins showed the highest increase, viz. about 400 per cent. The resins demand was dominated by major thermoplastics. The consumption of sy..thetic fibres consumption increased about 3 times. The leading fibres being consumed are polyester, polyamide and acrylics. The synthetic rubber consumption is 127,000 metric tons with styrene butadiene rubber having a dominant share .

(c) Import and export of petrochemicals

During 1980 the Republic of Korea imported chemicals/petrochemicals worth US$ 2.5 billion as compared to exports of about US$ 1 billion. Among the petrochemical exports thermo-plastics, resins and plastic articles were significant.

(d) Future prospects

The petrochemical industry in the Republic of Korea has played an important role as a highly capable supplier of basic industrial materials for the major export industries. The prevailing international market situation does not present a conducive atmosphere for the Korean petrochemical industry, owing to its disadvantageous position in terms of international competitiveness. As such it is predicted that the severe market conditions now prevailing in the Korean petrochemical industry will continue. It is also

estimated that the Republic of Korea's self-sufficiency rate in terms of major petrochemicals which in 1980 stood at around 77 per cent will decline to 55 per cent in 1985 given no further expansion in production capacity.

The Republic of Korea earlier had plans for the construction of a third integrated complex (as per the projection for fourth Five Year Economic Development Plan). However, owing to the prevailing situation it seems that the plan has been dropped and the industry's further expansion will be limited to capacity increases in the existing units of two complexes.

6.5 Iran

The Iranian economy is predominantly an oil economy since approximately 50 per cent of GDP is contributed by the oil sector. The country's economic growth in the past has been unprecedentedly high primarily due to frequent oil price increases. The country's GDP increased consistently at 26 per cent per annum during 1973 to 1978.

Iran's proven reserves of oil are estimated to be around 60 billion bbls. (1980) with 547 producing wells. The proven reserves of gas are estimated to be 485,000 billion cubic feet. The oil production during 1980 was 1.67 billion b/d. There are six refineries having a crude oil through-put of 1.21 million b/d.

(a) The petrochemical industry

The development of the petrochemical industry in Iran dates back to 1961 when the first petrochemical plant, a fertilizer complex was established at Shiraz. In 1965 the state owned National Petrochemical Company (NPC) was set up to plan and develop the country's petrochemical industry. Since its incorporation, NPC has been actively involved in setting up various projects. The existing petrochemical industry consists of:[6/]

6/ The Petrochemical Industry in Iran, a paper presented at the seminar on co-operation among developing countries in petrochemical industries, Vienna, 7-9 March 1983. OPEC/UNIDO/OPEC FUND.

(i) Abadan Petrochemical Company. The company is a joint venture of NPC and BF Goodrich. The company's facilities are located adjacent to the Abadab refinery. The facilities are based on 25,000 metric tons per annum naphtha cracker with downstream facilities of PVC, DDB, caustic soda and chlorine. The PVC plant has an annual capacity of around 60,000 metric tons.

(ii) Iran-Nippon Petrochemical. The facilities started operation in 1972. The plant is capable of producing dioctyl-phthalate (DOP) and phthalic anhydride. The production capacity of the DOP plant is 40,000 metric tons per annum.

(iii) Polikan Company. This plant has facilities for the manufacture of various types of PVC pipes and fittings. The PVC products of Abadan Petrochemical Company are used as raw material.

(iv) Iran-Japan Petrochemical Project. The project was set up at Bandar Shahpur by the Iran-Japan Petrochemical Company, it is a joint venture of NPC and a consortium of Japanese companies. The project consists of three key units i.e. chloralkali, olefins and aromatics. The production profile of the project is given in table 9.

Table 9. Bandar Shahpur projected capacities

	Capacity[a/] (metric tons per annum)
- Ethylene	540,000
- EDC	300,000
- VCM	150,000
- LDPE	100,000
- HDPE	60,000
- PP	50,000
- SBR	40,000
- Propylene	30,000
- Benzene	360,000
- Xylenes	120,000

a/ The Petrochemical Industry in Iran, a paper presented at the seminar on co-operation among developing countries in petrochemical industries, Vienna, 7-9 March 1983. OPEC/UNIDO/OPEC FUND.

The construction of the project started in 1977 and almost 80 per cent of the work was completed in 1979 when the work was suspended.

6.6 Indonesia

Indonesia is the second most populous country of the region. Oil and/or gas are dominating in the economy, generating over 50 per cent of government income and around 70 per cent of total export earnings. During the last two decades the country's economy has progressed considerably. Agriculture, which in 1960 was dominating the Indonesian economy with a 54 per cent share in GDP became the lowest contributing sector with 26 per cent share in GDP in 1982. During this period the maximum expansion took place in the industrial sector. Major industries include oil exploration, mining, fisheries, forestry and textiles. The industrial sector's share in GDP rose from 14 per cent in 1960 to 39 per cent in 1982. The industrial sector showed a growth of 5 per cent in 1960 to 1970 which increased to about 11 per cent in the period 1970-1982. This high growth was primarily due to the operation or expansion of oil and/or gas based production and refining facilities.

Indonesia's oil reserves are estimated to be about 10 billion barrels and are the second largest oil reserves of the region. Oil production in 1982 averaged 1.45 million b/d, in 1983 the production dropped to 1.3 million b/d (quota fixed by OPEC). Oil refining is being done by nine refineries with a total crude refining capacity of 0.6 million b/cd. In 1982 crude oil refined for domestic consumption amounted to 181.2 million barrels, of which 98.4 million barrels were processed by domestic refineries and the remaining 82.8 million barrels were refined in Singapore.

Indonesia's natural gas reserves are estimated to be 24 trillion cubic feet, another 5 trillion cubic feet of associated gases are also available. The country's two LNG liquefication plants have an annual capacity of about 8 million tons. The oil/gas based industry has extensive plans for the addition of new and expansion of existing facilities. The oil refining capacity will further increase after the expansion of two additional projects

in Balik Papan, east Kalimantan and Dumai (Riau province, Sumatra), are completed. In the case of LNG Indonesia is expected to become the world largest exporter.

The country's exports during 1982 were estimated at around US$ 22,300 million, of which more than 80 per cent was contributed by fuel and minerals and the remainder by other primary commodities. The imports were estimated to be in the vicinity of US$ 17,000 million during the year 1982. Machinery and other manufactures have a high share of the imported goods.

The Third Five Year Plan (Repelitia - III, 1979 to 1984) which recently terminated gave priority to economic development. Its specific objectives included expansion of the economy by an average of 6.5 per cent a year; the creation of new and diversified job opportunities and promotion of development throughout the country. The current plan, Repelitia - IV (1984 to 1989) continues these objectives although the target of annual growth in real gross domestic product (at 1973 prices) is fixed at 5 per cent. The plan gives priority to the development of the mining, forestry and agriculture sectors.[7/]

(a) The petrochemical industry

Indonesia's petrochemical industry is currently limited to downstream facilities of thermoplastics and synthetic fibres. In thermoplastics the country has two plants, one capable of producing 54,000 metric tons of PVC resin and the other 37,000 metric tons of polypropylene. In addition the country has a polyester manufacturing capability of about 60,000 metric tons per annum. Indonesia holds a quite significant position with respect to the petrochemical end-products market. In 1980 thermoplastics consumption was estimated at around 300,000 metric tons. The consumption of synthetic fibres during the same period was 90,000 metric tons. The synthetic rubber consumption in 1980 was estimated at 15,000 metric tons. The petrochemical

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7/ The Hong Kong and Shanghai Banking Corporation, Business profile series Indonesia, Third Edition, 1984.

industry imports in Indonesia in 1980 were valued at US$ 1.06 billion as compared to exports of US$ 4.07 billion the major proportion of which was taken up by petroleum products. The chemical industry on the other hand was a net importer as in 1980 its imports were about US$ 1.00 billion as compared to about US$ 1 million of exports.

Indonesia's plans for the establishment of basic petrochemical facilities have been active for quite some time. The planned ethylene facilities are being set up under a joint-venture arrangement of Petramina and Exxon Chemicals. The facilities will have a production capacity of ethylene (350,000 metric tons) and downstream plants of LDPE (180,000 metric tons), HDPE (60,000 metric tons) and PVC (150,000 metric tons). These facilities are expected to be operational in the late 1980s. Aromatic facilities are also being planned. The planned facilities will have a production capacity of benzene of 370,000 metric tons and xylenes of 240,000 metric tons. The country also plans to have a methanol production capacity of 330,000 metric tons together with aromatic facilities which are expected to be operational in 1990.

The latest news reports have indicated that the Indonesian[8/] government has temporarily suspended the plans for setting up ethylene facilities, the work on which was expected to start shortly. The suspension move of the government is part of the programme to reduce public expenditure due to a decline in revenues from oil and mineral exports. In all 47 major public sectors investment projects involving large amounts of imported capital goods have been rephased. The largest four rephased projects are aromatics, a chemical project in Sumatra, the Musi river refinery project in Sumatra, an olefin complex in Aceh and the Bintan alumina plant in the Riau province.[9/]

8/ European Chemical News ECN issue dated 30 May 1983.

9/ The Hong Kong and Shanghai Banking Corporation, Business profile series, Indonesia Third Edition, 1984.

6.7 Thailand

Thailand has a population of 48.5 million with a GDP per capita of US$ 786. Thailand's economy in the past has been dominated by the agriculture and services sectors. During the last two decades major industrialization has taken place in sectors having strong linkages with agriculture e.g. the rice milling and sugar industry. The country's GDP increased at the rate of 8.4 per cent per annum during 1960-1970 and 7.1 per cent per annum during the 1970 to 1982 period. Agriculture was the leading sector in 1960 but in 1982 it became the least contributing sector. The service sector improved its position and in 1982 was the leading sector. The industrial sector's share in GDP increased from 19 per cent in 1960 to 28 per cent in 1982. During the 1960 to 1982 period the industrial sector achieved the highest growth with an annual growth rate ranging between 9 and 12 per cent. The manufacturing value added which stood at US$ 1,675 million in 1970 achieved a level of US$ 4,636 million in 1981. The main contribution came from food and agriculture, textiles and other manufactures. The exports during 1982 were estimated to be US$ 6,945 million. Primary commodities i.e. agriculture dominated the total exports. The total imports during 1982 were in the vicinity of US$ 8,548 million and the main categories of imports included fuels, machinery and other manufactures.

Thailand's proven oil reserves are currently estimated to be around 103 million barrels. The country has three refineries with a capacity to refine 176,000 b/cd of crude oil. The natural gas reserves are about 6 trillion cubic feet.

(a) The petrochemical industry

Thailand's petrochemical industry is limited to thermoplastics and fibres production facilities. There are two plants for thermoplastics i.e. PVC and PP with a capacity of 20,000 and 15,000 metric tons per annum. Among fibres, the polyester production capacity is quite significant i.e. 90,000 metric tons per annum, as compared to 10,000 metric tons capacity of polyamide. The country has a sizeable market of petrochemical end-products. The thermoplastics consumption in [illegible] was in the region of 100,000 metric tons.

The major proportion of this was imported. The fibres consumption was almost equal to the available capacity. Thailand's petrochemicals market is expected to expand considerably during the current decade and the thermoplastics market would be in the range of 240,000 metric tons as compared to a synthetic fibres market of 160,000 metric tons.

Thailand has been actively pursuing the establishment of a petrochemical industry. Based on the current development plans it is expected that the olefin facilities will be operational in 1990. The planned olefin complex will consist of a cracking plant with downstream facilities to produce LDPE (75,000 metric tons), PVC (50,000 metric tons), PP (70,000 metric tons) and ethylene glycol (50,000 metric tons). The investment cost for the olefin complex is estimated to be US$ 850 million. The feedstock for the complex will be gas available from offshore gas fields. All of the downstream projects in the olefins complex are expected to be undertaken by private investors. The government is providing incentives with the objective to create conditions which will provide both attractive investment opportunities and faster growth in the petrochemical demand. The following are the incentives being provided by the government:

- Exemption from custom duties and business taxes on equipment and machinery;

- Tax holidays;

- Protection against new competition;

- Repatriation of earnings; and

- Tariff protection from imports.

7. BASIC PROBLEMS AND ISSUES

The basic petrochemical production facilities of the region are currently limited to the Republic of Korea, India and Singapore. In the case of Iran the facilities have been partially constructed, however, work is suspended. The region also has a fairly developed oil/gas based industry which is quite similar to the petrochemical industry with respect to technology operation and management. Another significant aspect of the petrochemical industry development in the region is that two countries which now possess a sizeable capacity are net energy importers and the major proportion of capacity is based on naphtha feed. In the coming years, these countries are expected to face problems in exporting their products, as the international market will be highly price competitive. The situation of Singapore is slightly different as it is an export refining base, and the petrochemical facilities are a joint arrangement of international companies. These facilities are expected to utilize a blend of naphtha, gas oil, LPG and refinery gases as feed.

Many countries of the region, including Indonesia, Thailand, the Philippines, the area of Hong Kong and Pakistan have been actively pursuing the establishment of a petrochemical industry in their respective countries. Indonesian plans which had been finalized earlier have been temporarily suspended. The facilities were being set up under a joint venture arrangement with Exxon Chemicals. Thailand's plans are also being finalized. The remaining countries like the Philippines, Pakistan and the area of Hong Kong have not been able to implement their plans primarily due to international economic conditions, market size limitations, as well as resource and feedstock availability constraints.

In Pakistan the plans for setting up basic petrochemical facilities have been active since the mid-1960s, the time when the country's major industrial development took place. Subsequently the project has been included in almost all the development plans. Initially, the planned facilities were based on naphtha feed. Later discoveries of associated gases suggested a shift to gas feedstock and another indigenous feedstock i.e. molasses has also been under consideration. Apart from the uncertainity of feedstock, the market limitations and resource constraints, the factors which have been responsible

for non-implementation of plans are listed below. These factors are equally applicable to countries like the Philippines and the area of Hong Kong. These factors are:

- International market conditions;

- Continuous inflation resulting in an increase in capital outlay;

- Lack of interest of potential sponsors i.e. transnational companies because of expected excess capacity in the developed regions;

- Shifting of priorities to other important sectors by governments of the respective countries.

7.1 Economics

(a) Policy implications

The establishment of a petrochemical industry in a particular country first requires a basic policy decision at the highest level accepting the need for the industry's establishment and its economic contributions. Once this is done, a series of policy decisions as well as institutional measures have to be taken for making the industry's establishment and operation a success. These decisions and measures include:

- allocation of special funds for the industry's development;
- import duty concessions;
- tariffs and other types of protection;
- tax incentives;
- promotion of investments in downstream industries;
- assistance in manpower training;
- encouragement of local demand;
- support services.

Two countries of the region i.e. the Republic of Korea and India which have ventured into the manufacture of basic petrochemicals in the past have done this with consistent government support. For example, in the Republic of Korea the industry received special attention in three successive five year economic development plans, as a result the current ethylene capacity of the industry is around 500 thousand metric tons. India in this respect has followed a consistent policy of self-sufficiency and all development plans of the industry are geared to cater for the domestic market.

(b) Import substitution

In any developing country, with the exception of oil-exporting countries, the petrochemical industry is at least considered as import substitution. Hence, the decision on deploying funds for the petrochemical industry is in most cases based on the magnitude of foreign exchange savings generated, apart from the financial returns. While assessing the foreign exchange savings the inputs are normally taken at their opportunity costs and outputs at their current import costs.

In view of the prevailing depressed market conditions in the petrochemical industry, no new investment specifically in non oil exporting developing countries can be justified based on this criterion, since currently severe price competition is in force. The producers from Western European countries are interested in disposing of their products at a price level at which they can cover part of their fixed costs. The fixed cost element is lower than that of a plant in a developing country, as these plants have been established years ago. On the other hand the producers of centrally planned economies due to their foreign exchange requirement export also at these prices.

An important aspect which decision makers normally do not take into consideration while evaluating the proposals for the establishment of a petrochemical industry is that, apart from the utilization of the domestically available raw materials a broader and rapidly growing industrial base results which will have a positive impact on the country's GDP, employment and technical know-how situation.

(c) Domestic market

The existence of an effective and potential demand for petrochemicals is considered to be a primary condition for the establishment of a petrochemical industry. Both developed and developing countries which now possess basic and downstream petrochemical production facilities initially established these facilities based on their domestic markets. Recently, a new situation has occurred when oil producing countries with quite small domestic markets have started setting up basic petrochemical facilities. The facilities being planned are purely export oriented. This has been possible due to the availability of cheap raw material like gas flared before and thus wasted and joint venture arrangements with international companies who have taken the responsibility of marketing the products.

The developing countries generally have a small market size as compared to their counterparts in the developed regions. The difference in per capita petrochemical consumption of developed and developing region's is the magnitude. For example, in 1981 the developing region's thermoplastics per capita consumption ranged between 2 and 6 kg.[10/] as compared to the developed region's per capita consumption of between 20 and 45 kg. This situation exists since most developing countries:

- are at the initial stage of development;
- have a low per capita GDP with a low standard of living;
- have natural materials easily available;
- have strong consumer resistance to switch over to synthetics (petrochemicals)
- have markets restricted to urban areas;
- have intentionally restricted the growth of petrochemicals (in view of the necessary imports in feedstock primary product, intermediates and/or products) through high rate of duties and taxes and restrictive import policies.

10/ Opportunities for co-operation among the developing countries to the establishment of the petrochemical industry, paper presented by the UNIDO secretariat at the Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemical Industries, Vienna, 7-9 March 1983.

The small domestic market size of developing countries and their inability to realistically assess the magnitude of potential demand has acted as an obstacle in the establishment of a petrochemical industry in these countries. However, a considerable potential market for various petrochemicals exists, which can be captured once the production facilities are set up. It is an admitted fact that local production of basic petrochemicals accelerates the demand not only in existing consuming sectors but also in new sectors where other natural materials are being used. As such a considerable increase in per capita consumption takes place with the establishment of a basic petrochemical industry. Turkey had a thermoplastics per capita consumption of 1.5 kg per annum before the start of production facilities and in about five years consumption reached a per capita level of 4 kg per annum.11/

(d) Export market

The petrochemical production in a developing country is normally started on the basis of domestic market demand. In most of the developing countries, the domestic market size is small compared to the available economic size plants. Because of the economy of scale the developing countries are compelled to install large size plants. Exports are considered as a stop gap arrangement in view of the available excess capacity.

In the past the developing countries have not been successful in exporting their products even to developing countries with whom they have geographical proximity. This has been due to the fact that historically, the petrochemical trade has been dominated by international companies from the developed regions, with world-wide distribution networks and an effective technical back-up. These companies have established markets in developing countries, providing tough competition to new entrants. The difficulties faced by developing countries in exports of petrochemicals can partly be attributed to the fact that petrochemical trade requires a large supporting organization to maintain the required link between producer and consumer. The developing countries are not able to develop such a support especially during

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11/ Market study of petrochemicals, ENAR Petrotech Services Ltd., Karachi, Pakistan (1980).

the initial years. At the same time, developing countries have limited technical back-up with practically no experience of export markets. The developing countries are also at a disadvantage due to the disparity between the size of domestic manufacturers and their international competitors.

Recently, severe price competition has been noticed in the international trade of petrochemicals. The prices of petrochemicals in export markets in the past have been set at levels at which exporters have been willing to ship materials, and these levels have been subject to wide fluctuations. At times when a high level of domestic demand existed in exporting countries, the export prices were higher as producers gave preference to their domestic customers. However, when substantial over-capacity exists, which is the case at present, the producers export materials at marginal prices just to provide some extra loading on their plants. In comparison the developing countries producers who have comparatively new plants with high fixed cost element are unsuccessful in disposing of their products abroad. In the coming years the international market is expected to be highly competitive with respect to both price and technology. Among the countries of the region, the Republic of Korea is expected to face severe problems in the export markets. This situation discourages the producers and planners of developing countries in expanding the industry's role as existing capacity is being under-utilized.

(e) Upstream and downstream linkage

As explained earlier, the petrochemical industry provides an excellent example of upstream and downstream linkages. The upstream linkage is achieved by utilizing the available oil/gas resources, the downstream linkage is achieved by developing a series of industries e.g. plastic processing and textile and rubber processing. In the past, the developing countries which have ventured into the basic petrochemical industry have not been successful in fully achieving the downstream linkage which has ultimately affected the future development of the industry.

The developing countries establishing a petrochemical industry in some cases have undervalued the importance of downstream industries, and considerable difficulties were faced in product marketing, such as adapting

the downstream industries to products being locally manufactured. All these factors resulted in delays in operating the facilities at the desired capacity levels and caused additional costs.

The developing country entering the petrochemical industry has to take stock of existing processing capability, with respect to available capacity, machinery and processes being employed and products currently being handled. Once this is done, efforts have to be made to bring the industry to the required level before the operation of the planned facilities is started. This can ideally be done during the construction phase, as the construction period normally extends from four to six years depending upon the size and magnitude of the planned facilities. In this respect the government of the respective country has to take various institutional measures encouraging the establishment of these industries based on imported material for the interim period. These measure have to be supported through a liberal import policy with regard to those petrochemicals planned to local production. However, it should be ensured that the specifications of imported materials match the products planned for production.

The country should also take measures to develop these industries specifically required for downstream facilities. These can range from engineering back-up for plant construction to manufacture of machinery for the processing of petrochemicals. This will help in the development of local technical know-how, savings in foreign exchange along with savings due to lower local costs.

(f) Specialization

The past developments with respect to the petrochemical industry have made it clear that specialization will have to be introduced for a successful operation of existing and planned facilities. Specialization will help in co-ordination and will activate the process of regional co-operation.

The review of the developing countries' plan for the development of the petrochemical industry reveals that every country intends to produce a whole range of petrochemical products. Indonesia, Thailand, the Philippines and

Pakistan are all planning to set-up ethylene derivative production facilities. This situation, if implemented, is expected to lead to conflicts and the building up of over-capacities affecting the economic viability of available facilities. Petrochemicals cover a wide range of products, the country venturing into the industry should study the available market, technical know-how and downstream industry in its own country as well as of those countries in the same region. The decision to set up production facilities for a specific range of products should be taken, if possible, in consultation with those countries which can be a potential market. In order to ensure the availability of a market a joint venture arrangement can be made. A typical example can be that of the area of Hong Kong, which has a sizeable market of polystrene as compared to Pakistan which has a very small market of this product. An arrangement could be made whereby Pakistan meets its requirements from the production facilities of the area of Hong Kong. Specialization will also act as a catalyst for the development of technical know-how which is required for engineering back-up and machinery manufacturing capability.

(g) The size and the scale of economics

The petrochemical industry is known for large size plants particularly in the case of basic products requiring substantial investments. The size of the facilities becomes smaller and smaller as one moves further downstream to end products. The scaling-up of plant capacities has been one of the essential features of the petrochemical industry. This is substantiated by the fact that during 1955 to 1976 the typical size of ethylene facilities increased more than twenty times. In 1955 the typical size of ethylene facilities was 20,000 metric tons, in 1976 the size was around 500,000 metric tons. Similarly, the size of downstream units which in 1955 for LDPE was 10,000 metric tons increased to 100,000 metric tons in 1976.

The scaling-up of plant capacities resulted in a reduction of unit capital and production costs. The impact of this reduction varied from product to product.

The developing countries historically have opted for small size plants in view of limited capital resources and domestic market size. This situation resulted in an inability on the part of the developing countries to compete in international markets with similar products originating from developed countries which have the advantage of economies of scale. Consequently, developing countries lost their competitiveness in international markets and also faced difficulties in domestic markets. To overcome this problem these countries provided protection to their local industry. The degree of protection varied from country to country and product to product. This in turn has resulted in the development of an inefficient industry in many developing countries, as no incentive for cost effectiveness exists for the producer. This aspect will become more important as the international market is expected to be highly price competitive once facilities of oil exporting countries are operational.

This problem can to some extent be overcome if developing countries rather than opting for technologies applicable for world scale plants can utilize technologies developed specifically for small size plants.

(h) Infrastructure

Existence of infrastructure facilities is considered to be an essential prerequisite for setting up and satisfactorily operate any industrial plant. The infrastructure requirements of the petrochemical industry are more pronounced because of its size and complexity. The developing countries generally lack the requisite facilities, and as such these have to be constructed along with production facilities. This leads to a considerable increase in capital costs as in some locations the cost of infrastructure can equate the cost of petrochemical production facilities. The increase in capital costs results in high financial charges associated with it. The entrepreneur of a developed country is in a more advantageous position as a highly developed and reliable infrastructure is available at no extra cost. In developing countries the infrastructure facilities are not always reliable and e.g. power interruption/fluctuations are quite common, which further burdens the producer of the developing country.

(i) Capacity utilization

The capacity utilization of petrochemical facilities throughout the world is currently at a low level due to the prevailing economic conditions and the availability of excess capacity. In developing countries the capacity utilization generally is low also for reasons other than the economic conditions and market limitations. These are:

- lack of training and experience of operating personnel;
- low level of technical know-how;
- dependence on developed countries for technical back-up;
- non-availability of equipment spares and delay in procurement.

(j) Financing

The petrochemical industry is highly capital intensive requiring huge amounts of capital outlay. The aspect of the industry's financing is crucial as developing countries have limited capital resources. In developing countries investments in petrochemicals compete with other priority areas, like provision of basic needs to the majority of the population and the development of infrastructure.

The bulk of the investment requirements for petrochemical plants in developing countries is in foreign exchange in view of nominal local input, and the major proportion of financing has to be arranged from outside sources. The developing countries have in the past relied on traditional sources of financing which include Suppliers Credit Loan financing through the World Bank and the Regional Development Banks, etc. Lately, co-financing of projects through joint venture agreements have been common, examples of these are facilities established in Singapore and Saudi Arabia.

Incapability on the part of developing countries to arrange financing of this magnitude in the past has acted as hindrance for the industry's development and many projects have been shelved due to non-availability of funds. This is due to the financial position of international companies,

world economic conditions, stringent criteria of international financing agencies with respect to a project's viability and the country's economic progress and financial standing etc.

7.2 Technological issues

The petrochemical industry involves the application of complex technology, both for chemical processes and for many technical alternatives offered concerning products, processes and raw material. The spectacular development of the petrochemical industry has been possible only through continuous perfection and improvement in the field of technology. The development and adoption of new technologies in the industry has been necessitated, amongst others, by:

- availability of low cost feedstocks;
- development of new products in order to expand the industry's role;
- improvement in product characteristics for better marketability; and
- increase in the industry's productivity and efficiency with respect to feedstock/energy consumption.

Much of the technological development in the industry took place during the 1950s to the 1960s, when most of the existing petrochemical processes and products were developed and marketed. Traditionally, major technological developments in the industry have been undertaken by chemical companies having their own production facilities. The developing countries are fully dependent with regard to technology, construction and in some cases operation of petrochemical plants. The pace of technological development with respect to processes and products poses a continuous threat to developing countries with limited resources at their disposal.

Technology has been a prime mover of the petrochemical industry. The industry by now has achieved a high degree of maturity and in the medium term no new major breakthrough in products or processes is expected. The technological development in the remainder of the current decade is expected to be directed towards the improvement of processes and operation with a view to improve the yields, reduce feedstock and energy consumption, use new

feedstocks and arrive at flexibility of feedstock usage in existing and new plants. Most promising is the development of methanol as feedstock for the production of olefins: ethylene and propylene. Technological developments in these areas seem to be imminent as producers in developed countries will use technological advancements to their advantage in order to remain competitive with producers of oil-exporting countries. The oil-exporting countries on the other hand have the advantage of low cost feed.

This situation makes a very careful approach on the part of developing countries necessary and requires co-operation among developing countries themselves, especially between developing countries which have already established a petrochemical industry and new entrants. The following paragraphs deal with some of the important aspects of the problem.

(a) Types of technologies used

All available technologies for the production of various petrochemicals have originated and been developed by industrialized countries to suit their own conditions. The developing countries in the process of industrialization have no other choice than to procure these technologies from developed countries. The technology transfer has been through the normal commercial means as well as through international co-operation.

The developing countries, even those which by now have been able to achieve significant industrialization, have faced numerous problems with respect to procurement and adaptation of technology for a particular industry. The right type of technology to be used for any industrial plant is vital for its success, this aspect is more prominent in the case of the petrochemical industry which is highly complex, capital intensive and technology oriented.

The continuous technological developments in the developed world have made the acquisition of the right type of technology more difficult. The pace of technological development is such that in certain cases developing countries plants have become obsolete in just a few years after being in operation. This situation has resulted because of the low level of technical

know-how available in developing countries, their inability to evaluate various aspects of technology being sought, and uncertainties as to future developments. Many developing countries with limited resources at their disposal have been burdened due to the selection of the wrong technology and technological innovation. An example in the case of Pakistan is that of the polyethylene and PVC plants. The technology used by these plants has become obsolete.

For countries of the developing ESCAP region, this problem is of relatively less importance. Many countries of the region, excluding those having basic petrochemical facilities, have a petroleum refining industry, the technology of which is quite similar in nature to the petrochemical industry. At the same time, these countries have sizeable downstream processing industries.

(b) Degree of adaption

The developing countries, while choosing a particular type of technology, should thoroughly assess local conditions and their consequences on the selected technology. The technology should be one to which the country has some exposure and is easily adaptable. This will help to reduce reliance on technology suppliers of developed countries. The adaptation can be with respect to utilization of local feedstock, type of products and plant size. In some cases developing countries have established plants based on new technologies with high capital costs. Subsequently, frequent shut-downs in these plants have occurred due to operating and maintenance shortcomings. The developing countries which are successfully operating a petrochemical industry have an important role to play. These countries should share their experiences with new entrants from developing countries and wherever possible help them in acquiring and adapting the technology and to develop technology suited to the circumstances of the developing countries.

(c) Technological back-up services

The developing countries generally lack the required technical back-up services. These services relate to the operation and maintenance of petrochemical facilities (both basic and downstream) as well as marketing of

the final products. The technical and after sale service for newly established petrochemical facilities in a developing country is of paramount importance for the correct and rapid development of the market. Technical services to be provided by the petrochemical-end products producer include advice on the adjustment of processing machines, and instructions on new end uses, etc. The developing countries in many cases have undervalued this important aspect of the industry which resulted in interruptions in plant operations and difficulties in expanding the petrochemical market to the desired levels.

(d, Local manufacturing of equipment

In general a limited capability of manufacturing equipment required in petrochemical plants exists in developing countries. At present the major proportion of equipment needs are met by imports from developed countries resulting in high costs and considerable time lag.

The local manufacturing of equipment entails acquisition of technical know-how and the development of a series of industries. The newly industrialized countries e.g. the Republic of Korea and India have been able to acquire capability in some areas. However, the expansion in this respect is restricted due to the limitation of market size and the inability of these countries to compete with comparable products from developed countries.

Since manufacturing of equipment is highly specialized and advantages of economies of scale are quite pronounced, there is a need to provide assistance to existing facilities in countries of the region. This type of regional co-operation will enhance the quality of equipment, improve their competitiveness and reduce the develo[illegible]ies' dependence on the developed world.

(e) Environmental problems

The petrochemical industry, in view of the nature of its raw material, processes and products is quite prone to health and environmental hazards. Most of the processes employed by the industry operate at high temperatures

and/or pressures and deal with catalytically activated inflammable toxic or corrosive materials. The effluents produced can bring harmful effects to human, animal and plant life, adversely affecting the environment. The main environmental problems caused by the petrochemical industry are air and water pollution apart from the disposal of solid wastes.

Air pollution emitted by the petrochemical industry include the following: hydrocarbons, mostly paraffins, olefins, nitriles, chlorinated hydrocarbons, carbon monoxide, oxides of nitrogen, particularly hydrochloric acid, sulphur dioxide. Air pollution can be reduced by process changes; incineration of waste stream for heat value; flares; scrubber condensers; carbon absorption; bag filters and cyclones.

The waste stream generated by petrochemical plants is quite complex. The principal contaminants in the waste waters include oils, organic chemicals, suspended solids, acidity, heavy metals and other toxic materials: colour, taste and odour-producing compounds.

In the past it has been observed that generally consideration to environmental hazards is not given in developing countries during a project's construction phase. Once again this is due to limitation of capital resource, as inclusion of these facilities increases the capital cost of the plant, lack of experience and realization of environmental hazards. In most developing countries no regulations with respect to environmental hazards exist. There is a need to enforce regulations controlling the environmental hazards and such regulations are being strictly enforced in almost all of the developed countries.

(f) Constraints of skills, education and training

In view of the technological complexity and capital intensiveness of the petrochemical industry and the adverse effects of unscheduled stoppages on profits, the operation of production facilities is entrusted to highly qualified and skilled personnel. In developing countries the non-availability of skilled manpower in the required number has acted as a constraint for the establishment and rapid expansion of the petrochemical industry.

These constraints of skills and education in developing countries exist as:

- Most of the countries are in the initial stages of industrial development and exposure to industry, particularly petrochemicals, is very recent;

- Lack of technological infrastructure and background;

- Disproportions between available graduates and demand due to lack of sufficient specialization of chemical and mechanical engineers as well as graduates of institutes. These disproportions have resulted in a shortage of technicians, engineers, supervisors and all kinds of skilled manpower;

- The curriculum of engineering and technical colleges is to a large extent patterned after that of colleges of highly developed countries. The curriculum is academic rather than practice oriented and thus fails to take into account local industry and its problems;

- Non-availability of vocational training schools in required numbers to prepare operators and technicians;

- Lack of qualified trainers, laboratory equipment and other facilities required to provide practical training. This is more common in technical and vocational schools;

- Limited interaction between technical educational institutions and industry.

In this situation the main responsibility for training falls on the industry. In many developing countries, specifically in the initial years of the industry, the operation of plants is undertaken by expatriate personnel who at the same time train the local manpower. In many cases the manpower is trained abroad in facilities owned by the contractor/multinational companies involved in the project. The severity of this problem in the developing ESCAP

region is relatively low. During the last two decades in many countries of the region significant work has been done to remove the constraints of skills and education. The number of vocational and technical institutions have increased considerably, the curriculum has been altered and interaction between educational institutions and industry has also increased.

The exodus of manpower from many countries of the region to the Middle East has reactivated this problem. The policies which could be helpful to meet the growing manpower requirements of the petrochemical industry in the developing countries are:

- Manpower planning;

- Co-operation and co-ordination of activities between the petrochemical industry and educational institutions;

- Training policies and the development of institutional training;

- Co-operation among developing countries in the manpower field;

- Assistance of the developed countries and international agencies in the manpower field.

(g) Research activities

The continuous development and expansion of the petrochemical industry has been the result of intensive research carried out by various companies in the developed world involving huge capital and technological resources. In developing countries research development activities are almost non-existent due to constraints in the availability of specialized manpower, capital and technological resources. R & D activities in developing countries are necessary in view of the rapid pace of technological development. Mere transfer of technology from industrialized countries will not be sufficient to sustain the durable development of the latter unless it is backed by sufficient research and development of their own. The R & D activities of developing countries must be geared to their specific conditions and needs

with greater emphasis on the use of local resources. The developing countries while negotiating a technology transfer agreement, should provide for the legal basis for its repeated usage and for the further development locally. India in this respect has successfully acquired technical know-how for fertilizer technology. Another example is Turkey which has undertaken work locally on the country's second petrochemical complex.

8. TRENDS IN PETROCHEMICAL PRICES

The petrochemical prices prior to 1973 varied through time, with a general trend towards decreasing. This was mainly due to availability of cheap feedstock, technological improvements, strong competition and increases in plant capacities and their subsequent effect on units produced. The price/cost relationship for petrochemical products in these years was quite high as compared to other industrial products.

The consistent increases in crude oil and energy prices after 1973, changed the situation upsetting the previously established balance. A new price/cost relationship with significantly reduced ratios of product prices of feedstock was introduced. Ethylene prices showed a consistent increase till 1981, however, in the subsequent period, the prices have been declining. In most of the petrochemical end products prices, trends similar to that of ethylene have been observed. The petrochemical prices during 1981-1984 with the prevailing economic recession and the availability of excess production capacity have in some cases been lower than the production costs. In future, however, should the excess capacity problem be overcome, the petrochemical price will increase with the expected cost increase of raw material and energy as well as the increase in investment outlays.

9. WORLD PETROCHEMICALS DEMAND: FUTURE OUTLOOK

The world petrochemical industry is now in a transition stage, as rationalization and restructuring is taking place. The industry's future outlook is not expected to be as impressive as it has been during the last two decades. The growth in world petrochemical demand has been dictated by developments in the industrialized countries in view of their dominance in demand as well as production. This situation is expected to remain unchanged at least during the foreseeable future. The petrochemical demand of the developed countries is expected to show a slow growth during the current decade. The developing countries with a relatively small share in world demand are still expected to achieve higher growth. The world economic conditions will also affect demand growth in the developing world. The factors considered to be responsible for a slow-down in the world petrochemical industry's growth are:

(a) General economic conditions specifically those of the developed countries which have a dominant share in the world market;

(b) Exhaustion of substitution opportunities in the consumption of developed countries markets;

(c) Restructure of industry with respect to feedstock pattern, cost structure and technological innovation;

(d) Diversification of the industry's base from consumption areas to oil rich developing countries, i.e. producers who have low production cost advantages over existing producers.

At present, two sets of forecasts of world demand for petrochemical products are available. The first forecast, forecast-I, was developed in 1981 by a working group on world supply and demand for petrochemicals. The working group was established by UNIDO on the recommendations of the First Consultation on the Petrochemical Industry.

The second forecast, forecast-II, was developed by UNIDO in 1983 with the help of the UNITAD model. The following paragraphs contain a discussion of the methodology and results of the two forecasts. Both forecasts have been included in the discussion since forecast-I covers all the three final product groups (i.e. thermoplastics, synthetic fibres and synthetic rubbers), while forecast-II is recent and more comprehensive as far as the methodology is concerned.

9.1 Forecast-I (second world-wide study on petrochemical industry, 1981)

In this exercise demand estimates were developed for the 1984-1990 period and covered 7 basic petrochemicals and 9 final products. Data input was provided by members of a working group. Since most members submitted forecasts of demand up to the year 1984, UNIDO developed forecasts for the period 1984-1990 based on certain assumptions. For example, for industrialized countries, the same rate of growth as for 1979-1984 was applied for the period 1984-1990. The resulting world petrochemical end-product demand by major product groups for developing and developed regions of the world is summarized in table 10.

Table 10. World petrochemical end-products demand (forecast-I) (1985-1990) (thousand metric tons)

	1985	1987	1990
Plastics (thermoplastics)	58,485	65,578	80,000
Synthetic fibres	12,752	13,704	15,115
Synthetic rubber	8,308	8,903	9,950

Source: Second world-wide study on petrochemical industry. Process of restructuring ID/WG.336, 3 May 1981.

The world petrochemical end-products demand (as per the above demand forecast) is expected to show an annual compound growth rate of 6 per cent during the 1985 to 1990 period.

Compared to this, during the 1960 to 1975 period world petrochemical end-products consumption showed a growth rate of 12 per cent per annum. The consumption of the major petrochemical end-products, thermoplastics, main synthetic fibres and rubber increased during 1975-1979 at an annual compound growth rate of 14 per cent.

Plastics are expected to remain dominant on the market for world petrochemical-end products. During 1985 to 1990 thermoplastics are expected to achieve an annual growth rate of 6.5 per cent, as compared to an annual growth rate of 13 per cent during the 1975-1979 period.

The demand growth of synthetic fibre and rubber during 1985-1990 is expected to be around 4 per cent per annum.

The petrochemical industry's growth during the 1985-1990 period, in both developed and developing regions of the world, is expected to be lower than the growth achieved during the 1975-1979 period. However, in the case of the developing region the reductions in growth will be marginal. For example, the developing region's plastics consumption, primarily thermoplastics, during 1975 to 1979 increased at an annual compound growth rate of 12 per cent, while during the 1985 to 1990 period the demand is expected to increase at an annual compound growth rate of 11 per cent. The growth in demand for synthetic fibres and rubbers of the developing region during the 1985-1990 period is expected to be in the vicinity of 6 per cent per annum as compared to a growth of 8 per cent per annum during the 1975 to 1979 period.

9.2 Forecast-II (based on UNITAD model)

In this forecast a general model of regional demand for each of the 24 petrochemical products was specified and estimated over the period 1974 to 1981. The basic structure of the model followed closely the basic structure of the petrochemical industry. The estimates were then used to forecast demands for these products at five year intervals starting with 1985 up to the year 2000. In all, two structures were employed to generate the demand forecasts for 1985, 1990, 1995 and 2000, one exclusive of prices and one including price variables in the four industrialized regions of the world. The

products covered included basic intermediate and final petrochemicals. Table 11 gives the demand forecast (1985-1995) of a number of selected products.

Table 11. World petrochemical end-products demand (forecast-II) (1985-1995) (thousand metric tons)

	1985	1990	1995
Ethylene	39,806	48,598	59,321
HDPE	6,903	9,865	13,008
LDPE	14,080	17,856	22,663
PVC	13,261	16,712	21,148
PP	6,233	8,901	12,336
PS	6,891	9,049	12,020
SBR	6,357	7,903	9,875

Source: World demand for petrochemical products and the emergence of new producers form the hydro carbon rich developing countries, UNIDO/IS.427, 19 December 1983.

World demand for ethylene is projected to increase at an average yearly growth rate of 4.1 per cent during 1985 to 1995. Thermoplastics' demand during 1985 to 1995 is expected to achieve an average yearly growth rate of 6 per cent. The demand for SBR during 1985 to 1995 has been predicted to increase at an average yearly growth rate of 4.5 per cent.

10. THE DEVELOPING ESCAP REGION PETROCHEMICAL DEMAND: FUTURE OUTLOOK

The developing ESCAP region has a considerable potential for petrochemicals, in view of its large population and existence of a fairly well developed processing industry such as plastics and fibres. The demand growth for petrochemical end-products in the past has been quite high as compared to other developing regions of the world. The demand growth during the current decade will still remain highest among the developing world despite the less bright economic prospects of the countries of the region. However, the region's petrochemical demand growth will be far lower than historical growth. The demand growth prospects could improve, if all countries planning to establish a petrochemical industry will implement their plants, since local production of petrochemicals accelerates the requirements of existing and helps in creating demand for new consuming sectors.

The development of a petrochemical demand forecast for the ESCAP region has been difficult in view of the non-availability of country-wide future petrochemicals demand estimates. The demand pattern of petrochemicals in the coming years is expected to vary from country to country. The demand projections were available for Asia only (second world-wide study demand forecast based on UNITAD model). One alternative was to assume that Asia's growth rate of petrochemical demand would be applicable to the developing ESCAP region and then calculate the demand for each country based on their existing share in regional demand. This approach was not considered to be realistic, as the growth rates for each product are expected to be different for each country, depending upon the development with respect to the general economy and the petrochemical industry.

The petrochemical end-products demand projections (1980-1990) of countries in the developing ESCAP region were developed with the help of growth rates. For each country and individual product, different growth rates were applied using 1980 consumption data (given in table A.7) as base figures. The growth rates for each country have been selected considering the past demand growth and development with respect to the general economy, the growth in major consuming areas and expansion/establishment of basic petrochemical production facilities. Generally, higher growth rates have been

used for countries which still have a low penetration of petrochemicals and where basic or even downstream production facilities have been recently established or are expected to be operational during the current decade. For example in the ASEAN countries, the growth rate is expected to be high due to aggressive marketing efforts of international companies involved in Singapore facilities which will further increase when the Indonesian facilities are also operational.

In the case of the Republic of Korea the demand growth is expected to be lower than the historically high growth, since significant market penetration has been achieved during the previous years and there will be less export opportunities. On the other hand India is expected to maintain the growth achieved during the past. However, India's per capita consumption is expected to remain low in view of the extremely big population and the economic difficulties.

In Iran it is expected that petrochemical facilities will be operational latest by the late 1980s. In view of fewer export opportunities the domestic market will see considerable expansion. Countries like Pakistan, the Philippines and Thailand, even if they are not successful in implementing their plans of establishing basic petrochemical production, will show a high growth which will be dictated by an improvement in standard of living, marketing efforts by international companies involved in petrochemical complexes of the Middle and Far Eastern region. Bangladesh, Sri Lanka and Burma are expected to remain small petrochemical markets.

The growth rates applied for each country and product are detailed in table A.9. The growth rates for thermoplastics ranged between 5 and 12 per cent per annum. The growth rate for synthetic fibres varied between 4 and 9 per cent. Synthetic rubber growth rates were between 2 and 6 per cent. The resulting demand projections of thermoplastics, synthetic fibres and rubber in the developing ESCAP region are presented in table A.10. A summary is given in table 12.

Table 12. Projected petrochemicals demand (end-products), 1985-1990
(thousand metric tons)

	1985	1987	1990
Thermoplastics (a)	3,050	3,610	4,664
Synthetic fibres (b)	1,170	1,309	1,558
Synthetic rubber (c)	339	369	419

Source: (a) Includes LDPE, HDPE, PP, PS.
(b) Includes acrylic, polyamide, polyester.
(c) Includes SBR, PBR.

During the 1985-1990 period the demand for petrochemical end-products in the ESCAP developing region is expected to increase at an annual compound growth rate of 8 per cent. The demand projections given below are conservative. In the second world-wide study on petrochemicals (ID/WG.336/3) the developing countries' petrochemical demand (during 1985 to 1990) was projected to increase at an annual compound growth rate of 12 per cent. Developing Asia's petrochemical demand was projected to increase at an annual compound growth rate of 13 per cent.

For South Asia and South-East Asia the petrochemical demand during 1985 to 1990 has been projected to increase at a yearly average growth rate of 6.5 per cent and 10.9 per cent respectively (as per demand forecast based on the UNITAD model).

10.1 Product pattern

(a) Thermoplastics

Thermoplastics will remain the dominant petrochemical end-product group. Thermoplastics demand is projected to increase at an annual compound growth rate of 9 per cent during the 1985-1990 period as compared to a projected growth rate of 12 per cent per annum in developing Asia, given in the second

world-wide study on petrochemicals. The demand forecast, based on the UNITAD model, has predicted a growth in thermoplastics demand of 6 per cent per annum for South Asia and 10 per cent per annum for South-East Asia.

Among thermoplastics, the major share will be taken up by LDPE and PVC. The region during the past has seen considerable penetration of thermoplastics in the natural materials market. With the expected improvement of the standard of living the penetration is expected to further increase as per capita consumption is still far lower than that of the developed regions. The penetration is high in countries like the Republic of Korea, the area of Hong Kong and Singapore. In countries like India, Pakistan, Thailand and the Philippines a significant potential for these materials exist, as market penetration is low and is restricted to urban areas.

(b) Synthetic fibres

The demand for synthetic fibres of the region is expected to increase at an annual compound growth rate of 6 per cent during 1985 to 1990. The slow growth in the demand for synthetic fibres is due to the significant penetration in markets of ASEAN countries, which have a dominant share in the region's demand, the declining trend of polymide for wearing apparel and the availability of natural fibres, e.g. cotton in countries like India and Pakistan. Among synthetic fibres, polyester will remain dominant followed by acrylic.

(c) Synthetic rubbers

The synthetic rubber market is expected to remain small because of the availability of natural rubber and the limited expansion in its outlets, specifically the automobile tyre industry. The demand for synthetic rubber of the region during 1985 to 1990 is expected to increase at an annual compound growth rate of 4 per cent. SBR will maintain its dominance in the synthetic rubber market of the region.

10.2 Market distribution

The Republic of Korea is expected to maintain its position as a major market for petrochemicals in the region. Indonesia will be the second largest market with a significant increase in per capita consumption specifically thermoplastics and rubber. India is also expected to maintain its current position with low per capita consumption of petrochemical end-products. By the end of the current decade a significant market expansion will take place in countries like Iran, Malaysia and the area of Hong Kong. The remaining market areas will also expand with the Philippines, Thailand and Pakistan in leading positions.

11. THE DEVELOPING ESCAP REGION: PETROCHEMICAL FEEDSTOCK: FUTURE OUTLOOK

The existing petrochemical industry is predominantly petroleum-based. The facilities in the Republic of Korea and the major proportion of Indian facilities are based on naphtha. In India a limited quantity of petrochemicals is also being produced from biomass (molasses - ethyl alcohol - ethylene) and coal. Singapore's facilities are flexible and use naphtha, LPG and gasoil. Iran's facilities will be the first gas based petrochemical venture of the region. The future of the region's petrochemial industry will be primarily governed by hydrocarbon availability and markets. Hydrocarbon is expected to remain a prime feedstock for the bulk of the region's petrochemical production. Among the hydrocarbons, natural gas (both associated and non-associated) will have a significant advantage over petroleum in view of high yield, local availability and the uncertainty about crude oil supply and prices. The use of biomass and synthesis gas as feedstock is not expected to be significant in the region due to technological and economic reasons.

The following paragraphs contain a discussion with respect to the future outlook of these feedstocks for petrochemical production in the region.

(a) Petroleum feed

(i) Crude oil production

The ESCAP region has crude oil reserves of approximately 72 billion barrels. Iran has 80 per cent of the total reserves followed by Indonesia, Malaysia and India. Other countries which have significant oil reserves are Pakistan and Thailand. In 1982 the ESCAP region crude oil production was around 4 million bbls/day. The bulk of production was shared by Iran (1.9 million bbls/day) and Indonesia (1.3 million bbls/day). The remaining production was taken up by India, Malaysia etc.

(ii) Refining capacity

The developing ESCAP region crude oil refining capacity (52 refineries) is currently estimated to be 4.35 million b/cd. The major proportion of refining capacity is currently being shared by countries such as Singapore (an export refining base), India, the Republic of Korea, Iran and Indonesia.

(b) Naphtha

It is very difficult to give an indication about quantities of petroleum feed (naphtha, gasoil, LPG and refinery gases) expected to be available during the coming years, due to the non-availability of relevant data. In case of naphtha country-wide data about surplus/exports is not available as petroleum end-products exports are categorized into heavy, middle and light. The naphtha production in the region is estimated to be 2 million metric tons.

The major proportion of total naphtha production is taken up by Singapore, the Republic of Korea and India. These countries with a petrochemical industry are consuming their own naphtha which in some cases is supplemented with imports from various sources within and outside the region.

The availability position of naphtha will improve as many countries of the region have firm plans for expanding their refining capacity. Currently significant naphtha exports are originating from countries like Pakistan, Bangladesh, Sri Lanka, etc.

(c) Natural gas

The developing ESCAP region has the largest concentration of natural gas reserves among the five regions of developing countries. The region's total proven reserves of natural gases are estimated to be around 600 trillion cubic feet. The bulk of the region's natural gas reserves are located in Iran (about 86 cent) and the remainder is divided in eight countries among

which Indonesia, Malaysia and Pakistan are significant. The region has also an estimated availability of associated gases of approximately 37 billion cubic feet. Associated gas resources of the region are also concentrated in Iran. Other countries with significant reserves are Indonesia and Malaysia. Among the countries where there are no natural gas reserves are the Republic of Korea, Singapore and Sri Lanka. The potential ethylene production from natural gas (both associated and non-associated) is estimated to be around 1 billion metric tons. As such the current natural gas availability can feed an ethylene production capacity of 30 million tons for a period of about 30 years.

(d) Biomass

Biomass might be able to replace a significant quantity of petroleum derived chemical feedstocks at the turn of this century. Biomass is currently being used in very limited quantities for petrochemicals and pharmaceuticals. The major use of biomass in more recent years is as automotive fuel, substituting petroleum. Since petrochemicals are higher valued products than fuels, some countries are considering utilization of biomass for petrochemical production. The utilization of biomass for petrochemical production is quite advantageous for countries which are deficient in oil/gas but have a surplus of biomass. These countries are facing consistent balance of payment problems and are not in a position to afford foreign exchange for imports of petrochemicals, while at the same time an indigeneous renewable resource which can be converted into petrochemicals is available.

The factors which have restricted the utilization of biomass as petrochemical feedstock include:

- Obsolete technology;
- Limited ethylene production;
- Uncertainities about availability of molasses (since crop production in developing countries fluctuates significantly);

- Problems related to collection of molasses/alcohol, as sugar mills/distilleries are located at various places in the region;

- Economics of ethylene production from biomass molasses or corn. Based on molasses, ethylene production cost is almost double that from naphtha.

In the ESCAP region only three countries Pakistan, the Philippines and Thailand have surplus biomass (molasses) which can be effectively utilized for the production of petrochemicals. India is already using molasses as feed for petrochemical production. However, the potential of ethylene production from this feed source is quite limited. For example the surplus quantity of molasses from three countries is currently estimated to be 1.3 million metric tons. From this only 160,000 metric tons of ethylene can be produced.

(e) Coal

Coal once again is being considered as petrochemical feed. The ESCAP region has limited coal resources restricted to India, the Republic of Korea and Pakistan. In case of coal the cost of mining, transportation and environmental investments are still high enough to block its use for the industry on a competitive basis against petroleum feed. Furthermore, synthesis gas which has been utilized for the production of a number of petrochemicals is not so economical.

12. THE DEVELOPING ESCAP REGION: FUTURE SUPPLY/DEMAND GAP

With rapid industrialization in the region, the emphasis on the development of the petrochemical industry has increased. Many countries of the region, realizing the capability of the petrochemical industry to accelerate the pace of industrialization, have prepared ambitious plans for the development of the industry. This not only relates to the developing ESCAP region but also to developing countries generally, among which Latin American and Middle Eastern countries are prominent. In the following sections the petrochemical supply/demand gap in the region is examined. The outline of proposed facilities which can be set up based on regional co-operation has also been indicated.

12.1 Production capacity

An enormous expansion in basic and downstream petrochemical facilities is expected for the period 1985 to 1990. Currently, basic petrochemical facilities are available in three countries of the region. Iran's facilities which are partially constructed are expected to be operational by the late 1980s. Possible additions to existing petrochemical producers are Indonesia, Thailand, the Philippines and Pakistan. By 1990 only Indonesia's and Thailand's facilities are expected to be operational. The planned facilities of the Philippines and Pakistan, if implemented, will be operational some time during the early 1990s. The region's basic and petrochemical end-products capacity, expected to be operational in 1990, has been estimated based on the following assumptions.

(a) India will keep on expanding its production capacities in view of increase in local demand. However, implementation of available plans to increase the ethylene capacity from 250,000 metric tons to 920,000 metric tons seems unlikely.

(b) Iran's facilities will be fully operational by 1990.

(c) The Republic of Korea's third complex will be operational by 1990. This however seems unlikely, as the Republic of Korea's high production cost (utilizing imported crude oil and naphtha) will undermine the competitiveness, which is expected to prevail on the international market.

(d) The facilities of Indonesia and Thailand will be operational in 1990.

The developing ESCAP region's petrochemical production capacity for basic and petrochemical end-products is given in table 13. The table also gives comparative figures for 1980.

Table 13. Production capacities of basic and main petrochemical end-products in the developing ESCAP region
(thousand metric tons)

	1980	1990
Basic products		
Ethylene	775	3,220
Propylene	403	1,140
Butadiene	75	270
Xylenes	105	960
Benzene	315	1,280
Methanol	423	1,210
End-products		
Thermoplastics	1,489	2,948
Synthetic fibres	959	1,182
Synthetic rubbers	180	240

Source: Based on the Second world-wide study on the petrochemical industry: Process of restructuring, ID/WG.336/3, 19 May 1981.

Among the basic petrochemicals the maximum tonnage increase will be in ethylene followed by xylenes and methanol. Among petrochemical end-products the maximum production capacity increase will be in thermoplastics. Thermoplastics production capacity is expected to increase to about 3 million metric tons in 1990 which will be almost double the capacity available in

1980. The synthetic fibre capacity in 1990 is expected to be around 1.2 million metric tons as compared to about 1 million metric ton in 1980. A marginal increase in the production capacity of synthetic rubbers is expected to take place by 1990.

12.2 Supply/demand gap

For calculating the region's petrochemicals supply/demand gap, the demand projections arrived at earlier have been used. The supply has been taken as 90 per cent of the production capacity available in 1990. In view of the fact that the region's petrochemical demand is made up of ethylene/propylene derivatives, the demand/supply has been calculated only for these products. The basic petrochemical production facilities normally corresponding to the size of planned downstream facilities and therefore the supply/demand gap, has been calculated only for petrochemical end-products.

The future supply/demand position of the region is given in table A.11 and summarized in table 14.

Table 14. Future petrochemical end-products supply/demand gap (thousand metric tons)

Product	1990
Thermoplastics	
LDPE	337
PVC	495
HDPE	386
PP	511
PS	280
Synthetic fibres	
Polyester	128
Acrylic	80
Polyamide	54
Synthetic rubbers	
SBR	200
PBR	3

The maximum deficits of the region will be in thermoplastics. Among thermoplastics, PVC will be leading followed by HDPE and LDPE. Among synthetic fibres the maximum deficits will be in polyester which is the highest tonnage material among the petrochemical end-products being considered.

From the above it is evident that based on firm plans the region will have deficits of main petrochemicals despite the considerable increase in production capability. The deficits are expected to remain unchanged even if the facilities of the Philippines and Pakistan will be operational in 1990.

At the same time, the deficits can be higher than indicated if India's and the Republic of Korea's plans are not implemented. The projected gap in supply and demand is expected to be met from supplies outside the region, more specifically from facilities of the Middle East oil-exporting countries.

This situation calls for highly activated regional co-operation with respect to the establishment/expansion of the petrochemical industry. This type of co-operation will guarantee to some extent the successful operation of existing as well as planned petrochemical facilities of the region. In the subsequent section the configuration of proposed petrochemical production facilities based on possible regional co-operation is given. The arrangement as to partners for each individual facility has not been indicated as it seems to be too premature since finalization of these proposals will require exhaustive studies and will be dictated by feedstock availability and various other factors. However, based on an analysis of feedstock, infrastructure and availability and other factors the region can be divided into zones whereby each facility takes care of the market in its own zone.

The existing organizations involved in technical/economic co-operation among developing countries can provide an infrastructural base for regional/sub-regional co-operation in the petrochemical industry. ASEAN which is currently in the process of forming industrial joint ventures can provide support to Indonesia's and Thailand's petrochemical projects as well as new projects. The recently formed South Asian Regional Co-operation (SARC) comprising India, Pakistan, Bangladesh, Nepal, Bhutan, Maldives and Sri Lanka can also provide support for a joint venture in setting up petrochemical

facilities in any of these countries. A similar co-operation arrangement can be finalized between two countries like Iran and Pakistan which already have economic co-operation arrangements. In this case downstream facilities of petrochemicals can be established in Pakistan based on ethylene available from Iranian facilities.

12.3 Potential petrochemical projects

Based on the calculated supply/demand gaps ethylene/propylene requirements were worked out. These requirements indicate that four sizeable petrochemical facilities can easily be established based on regional co-operation. The number can be reduced to two if world scale plants, as planned in Saudi Arabia, are installed. The configuration of proposed petrochemical complexes, based on the premise that four such complexes are installed in the region, along with capital costs (highly indicative) is given in table 15. The downstream facilities have not been exactly matched with the gap in supply/demand. In certain cases the gap is higher than the indicated capacity and in some cases capacity is more than the deficits.

The total ethylene production capacity of the proposed four petrochemical complexes will be of the magnitude of 1,200 million metric tons per annum. The feedstock requirements in terms of naphtha would approximately be about 3.5 million metric tons. The total capital cost of these complexes will be US$ 6 billion (in 1980 prices). The proposed facilities will not include polyester fibre plants as well as T.P.A. production facilities (an input for polyester manufacture). The ethylene glycol, another input for polyester manufacture, has been included in the proposed complex. The region's deficits in polyester fibre/yarn are expected to be in the vicinity of 1 million metric ton. To meet these deficits about 20 plants of 50,000 metric tons capacity each will be needed. The capital cost of these plants will be in the order of US$ 5 billion (in 1980 prices).[12/] The T.P.A. requirements for these plants would be of the same magnitude as polyester i.e. 1 million metric tons. The T.P.A. facilities have to be installed or polyester plants have to be

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12/ Opportunities for co-operation among the developing countries for the establishment of petrochemicals industry, UNIDO/IS.376, 16 March 1983.

dependent on T.P.A. facilities outside the region. For this tonnage of T.P.A. approximately 0.70 million metric tons of para-xylenes will be needed. This tonnage of para-xylenes can be supplied from a huge aromatic complex the possibility of which has not been considered in the study.

Table 15. Configuration of proposed petrochemical complex

Facilities	Capacity[a] (thousand metric tons)	Capital cost[b] (million US$ 1980 prices)
Ethylene	300	630
Propylene	150	-
LDPE	100	185
HDPE	100	105
PVC	100	225
EG	100	104
PP	160	273
Total	1,010	1,522

a/ The conversion factors (tons of starting material per ton of product) used are as follows:

LDPE	1.05 ethylene	HDPE	1.05 ethylene
PP	1.07 propylene	PVC	1.06 vinylchoride & 0.50 ethylene for vinylchoride.
Ethylen glycol	0.70 ethylene		

b/ Opportunities for co-operation among the developing countries for the establishment of petrochemical industry. UNIDO/IS.376, 16 March 1983.

13. CO-OPERATION IN THE DEVELOPMENT AND OPERATION OF THE PETROCHEMICAL INDUSTRY

Historically, the petrochemical industry has been dominated by major oil and international chemical companies. Subsequent to the early 1970s the industry has undergone major structural changes creating new conditions necessitating the adoption of an approach towards co-operation.

13.1 Global co-operation[13/]

Co-operation in the petrochemical industry prior to 1972 between the developed and developing countries was mainly based on direct investment by the major chemical companies of developed countries in the developing countries. This approach did not result in a significant expansion of the petrochemical industry in the developing region.

Since the increase in oil prices and the tight energy supply of the 1970s, the petrochemical industry has undergone major structural changes. These changes primarily pertained to the position of hydrocarbon producers and major oil/chemical companies. In view of the increasing demand for oil, the oil producing countries (i.e. OPEC) were able to exercise control over the supply and price of hydrocarbons. They consequently became a major factor in the international petrochemical industry. Since feedstock, energy supply and prices are major factors for the successful operation of the industry, the major oil and chemical companies in order to secure their source of supply have made joint venture arrangements with hydrocarbon producers for various petrochemical projects. As such hydrocarbon producers are currently in the process of implementing their plans of valorization of their resources through expansion of refining capacities and establishment of basic and intermediate petrochemical production facilities. At the same time developing countries which have or plan to establish petrochemcial production facilities based on imported hydrocarbon resources are expected to lose their competitiveness coupled with uncertainties as to the feedstock supplies and their prices.

13/ Second world-wide study on petrochemicals industry: Process of restructuring, UNIDO/IS/WG.336/3.Add.1, 29 May 1981.

Additionally, developed countries with a high proportion of outdated petrochemical production capacity needing renewal under conditions of high inflation and economic recession coupled with insecurity of raw materials and energy supply have further compounded the industry's problems.

The problems of the world petrochemical industry created by the current process of restructuring may be brought closer to their solution by considering a global approach on co-operation. The basic elements to be considered in such an approach, are:

(a) Energy and feedstock supply: Long-term arrangements as to price and availability.

(b) Re-deployment of basic and intermediate petrochemical capacities towards the sources of raw materials.

(c) Establishment of production for petrochemical end-products in the developing country/region which are sizeable markets with considerable potential.

(d) Opening of the markets of developed countries to petrochemical products from the developing countries.

(e) Stabilization of petrochemical prices in international market.

(f) Assistance to developing countries (with no or limited hydrocarbon resources) in the development and successful operation of the petrochemical industry.

13.2 Regional co-operation

From the preceding analysis of the international market situation of petrochemicals and the earlier discussion of obstacles in the development of the petrochemical industry in developing countries it is apparent that individually most of the developing countries are not in a position to establish petrochemical plants and successfully operate them as well as face

the competition on international markets. In order to overcome these problems the developing countries (specifically OPEC countries) have entered into joint venture arrangements with international companies. Another possible alternative for co-operation can be in capital, technological, raw material, markets and manpower resources at the regional level for setting up the required facilities. This will help in the development of the industry in the developing countries and reduce the dependence on developed countries.

To date regional and sub-regional co-operation in the petrochemical industry has been mainly in the areas of training and research. Most of the developing ESCAP region's petrochemical facilities have been set up under a joint venture arrangement or solely by transnational companies e.g. the Indian petrochemical facilities were set up by Union Carbide. Singapore's facilities have been set up in joint venture with Japanese companies.

The need for regional co-operation seems to be more pronounced in the developing ESCAP region. The region is expected to face a unique situation; its petrochemical producers, i.e. India, the Republic of Korea and even Singapore are expected to lose competitiveness for export leading to an underutilization of available production capacity in these countries. The region will also be importing considerable quantities of petrochemicals from producers in the developed region and new entrants from the developing world (OPEC countries). On the other hand the plans for a petrochemical industry of countries possessing substantial gas resource e.g. Indonesia are expected to be delayed due to the uncertainty about their competitiveness for export purposes and to some extent capital resource constraints despite a sizeable domestic market and the exposure to similar industries, e.g. petroleum refining and LNG.

Countries such as Pakistan and the Philippines which have limitations of raw material, market, capital and technological resources can also benefit from regional co-operation arrangements in the petrochemical industry whereby downstream units can be installed in these countries based on basic petrochemical facilities located in some other country e.g. Iran and Indonesia. The countries which possess a significant basic petrochemical

industry e.g. India and the Republic of Korea can play an effective role in implementing regional plans for the petrochemical industry by providing necessary machinery and equipment, technical know-how and assistance.

A regional co-operation arrangement would require the utilization of existing organizational infrastructure or the creation of a centralized organization to be responsible for all the aspects involved. These aspects can range from identifying the regional co-operation projects to their implementation and operation and finally to the provision of product marketing and back-up services. Recently, ASEAN Economic Ministers have finalized agreements on industrial joint ventures. In all, twenty projects have so far been identified.[14/] Efforts should be made for the inclusion of various petrochemical industrial projects. Additionally, a regional organization could be established for undertaking research and development in various technological areas related to the petrochemical industry. This organization can develop specific technologies suited to the region's requirements. Similarly, a joint arrangement for manpower training could be organized whereby manpower of member countries can be trained in available facilities of the region.

14/ TCDC News, 1984-No.1, United Nations Development Programme (UNDP).

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Table A.1 World petrochemicals production basic products, by regions and products, selected years (thousand metric tons)

Countries	Ethylene			Propylene			Benzene			Butadiene			Xylenes			Methanol		
	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981
Developed countries																		
- Japan	3,400	4,800	3,644	2,300	3,100	...	1,600	2,000	...	530	670	...	580	860	...	700	900	...
West Europe	7,900	12,350	10,499	4,100	6,500	...	3,130	4,860	...	1,080	1,710	...	960	1,380	...	1,900	3,000	...
- North America	9,700	14,300	14,400	4,400	7,200	...	3,670	6,400	...	1,250	1,750	...	1,450	2,380	...	2,500	3,650	...
- USSR and East Europe	2,000	3,000	3,000	1,200	1,500	...	2,150	2,600	...	300	400	...	600	800	...	2,100	2,800	...
- Other industrialized countries	250	500	700	120	230	...	80	140	...	75	110	...	20	30	...	...	50	...
Total	23,250	34,950	32,243	12,120	18,530	...	10,630	16,000	...	3,235	4,640	...	3,610	5,450	...	7,200	10,400	...
Developing countries																		
- Africa	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
- Middle East - North Africa	...	100	...	...	...	...	...	...	...	...	...	...	...	...	...	...	400	...
- Middle East - West Asia	...	50	210	...	30	...	...	...	...	10	20	...	...	...	...	...	...	...
- Asia	250	900	1,600	200	450	...	180	360	...	80	110	...	30	320	...	90	400	...
- Cuba	300	430	...	70	210	...	200	320	...	40	80	...	...	20	...	140	210	...
- Latin America	600	1,200	1,200	200	500	...	300	500	...	80	210	...	130	320	...	110	310	...
Total	1,150	2,680	3,010	470	1,190	...	680	1,180	..	210	420	. .	160	650	...	340	1,320	...
World Total	24,400	37,630	35,253	12,590	19,720	18,445	11,310	17,180	16,501	3,445	5,060	8,201	3,770	6,110	9,512	7,540	11,720	...
Share of developing countries in world total (per cent)	4.71	7.2	8.54	3.7	6.0	...	6.0	6.9	...	5.8	7.0	...	4.2	10.8	...	4.5	11.3	...

Source: - Annex to Second World-wide Study on the petrochemical industry; Process of restructuring, ID/WG.336/3/Add.1 dated 20 May 1981.

- The development of petrochemical industries in the developing countries, paper presented by UNIDO Secretariat at Joint UNIDO/OPEC/OPEC Fund seminar on petrochemicals, Vienna, 7-9 March 1983.

Hydrocarbon processing, Gulf publishing Co., U.S.A., August 1983.

Table A.2 World petrochemicals production, end products, thermoplastics, selected years, (thousand metric tons)

C O U N T R I E S	T H E R M O - P L A S T I C S																	
	P.V.C.			H.D.P.E.			L.D.P.E.			POLYPRO-PYLENE			POLYS-TYRENE			T O T A L		
	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981
DEVELOPED COUNTRIES																		
- Japan	1130	1590	1151	350	800	670	940	1370	977	590	1020	1018	690	1230	529	3700	6010	4349
- West Europe	3100	4320	3215	1350	1770	1557	3000	4520	3764	650	1530	1655	1300	1800	1220	9400	13940	11411
- North America	1740	2970	2746	1260	2560	2400	2380	3920	3868	900	1850	1884	1270	1940	1753	7550	13240	12651
- USSR and East Europe	850	1500	1300	130	280	370	600	1130	1120	150	180	280	300	450	410	2030	3540	3480
- Other Industrialized Countries	100	250	450	40	100	140	120	210	260	-	60	100	40	70	80	300	690	1030
TOTAL:	6920	10630	8862	3130	5510	5137	7040	11150	9989	2290	4640	4937	3600	5490	3992	22980	37420	32921
DEVELOPING COUNTRIES																		
- Africa	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***	***
- Middle East - North Africa	***	50	100	***	***	***	***	40	180	***	***	***	***	***	10	***	90	290
- Middle East - West Asia	***	40		***	***	***	10	15		***	***	***	***	20		10	75	
- Asia	200	740	1220	50	100	220	100	330	660	50	180	350	50	150	240	450	1500	2690
- China	220	350	***	5	20	***	25	250	***		90	***	***	10	***	250	720	***
- Latin America	250	420	535	30	170	250	320	450	410	***	80	100	140	240	240	740	1360	1535
TOTAL:	670	1600	1855	85	290	47.	455	1085	1250	50	350	450	190	420	490	1450	3745	4515
WORLD TOTAL:	7590	12230	10717	3215	5800	5607	7495	12235	11239	2340	4990	5387	3790	5910	4482	24430	41165	37436
Share of Developing Countries in World Total (%)	8.83	13.08	17.31	2.64	5.0	°.38	6.07	8.87	11.12	2.1	7.0	8.35	5.0	7.1	10.93	5.94	9.10	12.06

SOURCE: - Annex to Second World-wide Study on the Petrochemical Industry: Process of Restructing ID/WG.336/3/Add.1 dated 20th May, 1981.

- The Development of Petrochemical Industries in the Developing Countries, Paper presented by UNIDO Secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals Vienna 7-9 March, 1983.

- Hydrocarbon Processing, Gulf Publishing Co. USA, August, 1983.

*** Denotes data not available.

Table A.2 World petrochemicals production, end products, synthetic fibres and synthetic rubber, selected years, (thousand metric tons)

COUNTRIES	SYNTHETIC-FIBRES												SYNTHETIC-RUBBER								
	ACRYLIC FIBRES			POLYAMIDE (NY) FIBRES			POLYESTER FIBRES			TOTAL			S.B.R.			POLYBUTADIENE			TOTAL		
	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981
DEVELOPED COUNTRIES																					
- Japan	250	360	***	280	310	***	450	630	***	980	1300	1281	500	600	***	150	150	***	650	750	1010
- West Europe	530	750	***	620	720	***	650	800	***	1800	2270	2841	1000	1150	***	250	270	***	1250	1420	1731
- North America	240	350	***	900	1300	***	1400	1950	***	2540	3600	4567	1170	1600	***	350	450	***	1520	2050	2511
- USSR and East Europe	120	150	***	350	450	***	280	400	***	750	1000	1000	1100	1400	***	140	200	***	1240	1600	2519
- Other Industrialized Countries	***	***	***	30	30	***	20	40	***	50	70	70	30	50	***	10	20	***	40	70	80
TOTAL:	1140	1610	***	2180	2810	***	2800	3920	***	6120	8240	9759	3800	4800	***	900	1090	***	4700	5890	7851
DEVELOPING COUNTRIES																					
- Africa	***	***	***	***	15	***	30	35	***	30	50	***	***	***	***	***	***	***	***	***	***
- Middle East - North Africa	***	***	***	10	10	***	10	20	***	20	30	- 80	***	***	***	***	***	***	***	***	20
- Middle East - West Asia	***	***	***	15	30	***	45	60	***	60	90	-	10	20	***	***	***	***	10	20	
- Asia	100	160	***	150	200	***	400	550	***	650	910	1730	80	100	***	30	40	***	110	140	267
- China	10	45	***	***	5	***	5	70	***	15	120	***	30	40	***	***	***	***	30	40	***
- Latin America	60	100	***	130	170	***	210	330	***	400	600	500	150	240	***	40	60	***	190	300	356
TOTAL:	170	305	***	305	430	***	700	1065	***	1175	1800	2310	270	400	***	70	100	***	340	500	643
WORLD TOTAL:	1310	1915	***	2485	3240	***	3500	4885	***	7295	10040	12069	4070	5200	***	970	1190	***	5040	6390	8494
Share of Developing Countries in World Total(%)	12.98	15.93	***	12.27	13.27	***	20.0	21.80	***	16.11	17.93	19.14	6.63	7.69	***	7.22	8.40	***	6.75	7.82	7.57

SOURCE: - Annex.to Second World-wide Study on the Petrochemical Industry: Process of Restructuring ID/WG.336/Add.1 dated 20th May,1983.

- The Development of Petrochemical Industries in the Developing Countries, Paper presented by UNIDO Secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals Vienna 7-9 March,1983.

*** Denotes data not available.

Table A.3 World petrochemicals consumption, end products, thermoplastics, selected years.
(thousand metric tons)

COUNTRIES	P.V.C.			H.D.P.F.			L.D.P.E.			P.P.			P.S.			TOTAL			INCREASE IN THERMO PLASTICS CONSUMPTION PERCENT PER ANNUM	
	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975-79	1979-81
DEVELOPED COUNTRIES																				
- Japan	1000	1520	1110	220	680	523	680	1200	824	440	930	932	600	1130	487	2940	5460	3876	16.6	-14.51
- West Europe	2600	3930	3192	950	1500	1363	2600	4000	3417	600	1300	1403	1250	1700	1095	8200	12430	10470	11.0	- 7.88
- North America	1710	2850	2552	1190	2250	2157	2310	3460	3338	780	1550	1594	1240	1900	1705	7230	12010	11346	13.7	- 2.76
- USSR and East Europe	1000	1430	1150	150	300	350	700	1130	1100	200	280	330	300	450	410	2350	3590	3340	11.2	- 3.48
- Other Industrialized Countries	200	300	430	80	110	170	240	240	260	40	80	120	40	70	80	600	800	1060	7.4	15.00
TOTAL:	6710	10030	8434	2590	4840	4563	6530	10030	8939	2060	4140	4379	3430	5250	3777	21320	34290	30092	12.6.	6.12
DEVELOPING COUNTRIES																				
- Africa	30	50	***	10	10	***	30	50	***	10	20	***	20	20	***	100	150	***	10.7	***
- Middle East - North Africa	70	100	350	20	20	145	70	100	340	10	20	100	20	20	95	190	260	1030	8.2	18.00
- Middle East - West Asia	130	150		40	50		120	180		20	50		40	50		350	480		8.2	
- Asia	360	800	1300	140	400	520	410	900	1220	150	450	600	140	300	320	1200	2850	3560	24.2	11.8
- China	250	360	***	10	50	***	60	260	***	20	90	***	***	40	***	340	800	***	23.7	***
- Latin America	320	650	630	130	310	320	410	720	700	100	220	250	140	270	280	1100	2170	2180	18.6	0.2
TOTAL:	1160	2110	2280	350	840	985	1100	2210	2260	310	850	950	360	700	695	3280	6710	6770	19.6	0.4
WORLD TOTAL:	7870	12140	10714	2940	5680	5548	7630	12270	11199	2370	4990	5329	3790	5950	4472	24600	41000	36862	13.6	- 5.04
Share of Developing Countries in World Total(%)	14.74	17.38	21.28	11.90	14.79	17.75	14.42	18.01	20.18	13.08	17.03	17.83	9.50	11.76	15.54	13.33	16.37	18.37		***

SOURCE: - Annex.to Second World-wide Study on the Petrochemical INdustry: Process of Restructuring ID/WG.336/3/Add.1 20 May,1981.

- The Development of Petrochemical Industries in the Developing Countries, Paper presented by UNIDO Secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemical Vienna 7-9 March,1983.

*** Denotes data not available.

Table A.3 World petrochemicals consumption, end products, synthetic fibres, selected years, (thousand metric tons)

COUNTRIES	SYNTHETIC FIBRES													
	ACRYLIC			POLYAMIDE			POLYESTER			TOTAL			INCREASE IN SYNTHTIC FIBRES CONSUMPTION PERCENT PER ANNUM	
	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975-79	1979-81
DEVELOPED COUNTRIES														
- Japan	150	270	***	210	280	***	280	510	***	640	1060	1315	13.5	11.5
- West Europe	470	650	***	570	690	***	530	760	***	1570	2100	2893	7.5	17.0
- North America	230	280	***	900	1200	***	1350	1750	***	2480	3230	3921	6.8	10 2
- USSR and East Europe	120	180	***	350	450	***	300	400	***	770	1030	1030	7.5	***
- Other Industrialized Countries	20	40	***	30	40	***	30	60	***	80	140	140	15.0	***
TOTAL:	990	1420	***	2060	2660	***	2490	3480	***	5540	7560	9299	8.1	11.0
DEVELOPING COUNTRIES														
- Africa	10	15	***	20	35	***	35	50	***	65	100	***	11.1	***
- Middle East - North Africa	10	15	***	20	30	***	30	40	***	60	85	220	9.0	1.1
- Middle East - West Asia	10	20	***	40	50	***	50	60	***	100	130		6.8	
- Asia	90	150	***	200	300	***	500	700	***	790	1150	1950	9.8	30.0
- China	40	70	***	***	5	***	40	250	***	80	325	***	42.0	***
- Latin America	70	120	***	150	200	***	240	360	***	460	680	600	10.2	-5.88
TOTAL:	230	390	***	430	620	***	895	1460	***	1555	2470	2770	12.4	5.9
WORLD TOTAL:	1220	1810	***	2490	3280	***	3385	4940	***	7095	10030	12069	9.0	9.7
Share of Developing Countries in World Total(%.)	18.85	21.55	***	17.27	18.90	***	26.44	29.55	***	21.92	24.63	22.95	***	***

SOURCE: - Annex.to Second World-wide Study on the Petrochemical Industry: Process of Restructuring ID/WG.336/3/Add.1 dated 20th May,1981.

- The Development of Petrochemical Industries in the Developing Countries, Paper presented by UNIDO Secretariat at Joint UNIDO/ OPEC/OPEC FUND Seminar on Petrochemicals Vienna 7-9 March,1983.

*** Denotes data not available.

Table A.3 World petrochemicals consumption, end products, synthetic rubber, selected years, (thousand metric tons)

C O U N T R I E S	S Y N T H E T I C R U B B E R										
	S.B.R.			POLYBUTADIENE			T O T A L			INCREASE IN SYNTHETIC RUBBER CONSUMPTION PERCENT PER ANNUM.	
	1975	1979	1981	1975	1979	1981	1975	1979	1981	1975-79	1979-81
DEVELOPED COUNTRIES											
- Japan	350	440	****	100	120	****	450	560	851	5.6	23.0
- West Europe	850	870	****	210	240	****	1060	1110	1734	1.2	25.0
- North America	950	1450	****	300	430	****	1250	1880	2232	10.7	9.0
- USSR and East Europe	1250	1610	****	150	200	****	1400	1810	2450	3.1	16.0
- Other Industrialized Countries	60	80	****	10	20	****	70	100	155	9.3	24.8
TOTAL:	3460	4450	****	770	1010	****	4230	5460	7422	6.6	16.6
DEVELOPING COUNTRIES											
- Africa	10	30	****	****	10	****	10	40	****	42.0	****
- Middle East - North Africa	10	20	****	****	10	****	10	30	60	32.0	7.14
- Middle East - West Asia	20	30	****	****	10	****	20	40		19.0	
- Asia	180	290	****	40	50	****	220	340	450	11.5	15.0
- China	30	90	****	****	****	****	30	90	****	32.0	****
- Latin America	200	310	****	50	70	****	250	380	495	11.0	14.8
TOTAL:	450	770	****	90	150	****	540	920	1005	14.4	4.5
WORLD TOTAL:	3910	5220	****	860	1160	****	4770	6380	8427	7.4	15.0
Share of Developing Countries in world Total (%)	11.51	14.75	****	10.47	12.93	****	11.32	14.42	11.93	****	****

SOURCE:- Annex.to Second World-wide Study on the Petrochemical Industry:Process of Resturcturing ID/WG.336/3/Add.1 dated 20th May,1981.

- The Development of Petrochemical Industries in the Developing Countries,Paper presented by UNIDO Secretariat at Joint UNIDO/ OPEC/OPEC FUND Seminar on Petrochemicals Vienna 7-9 March,1983.

**** Denotes data not available.

Table A.4 Characteristics of the petrochemical industry in the developing ESCAP region

Countries	Year	Value added (thousand US$)	Number of employees	Mean size of establishment
Afghanistan				
Industrial chemicals	1980	-	3,830	3,830
Other chemicals	1980	-	402	80
Petroleum refineries	1980	-	-	-
Misc. petr. & coal products	-	-	-	-
Plastic products	1980	-	771	25
Bangladesh				
Industrial chemicals	1979	44,673	5,300	279
Other chemicals	1979	55,166	23,750	67
Petroleum refineries	1979	1,609	450	450
Misc. petr. & coal products	1979	-	-	-
Plastic products	1979	386	640	23
Area of Hong Kong				
Industrial chemicals	1979	34,476	1,500	12
Other chemicals	1979	62,298	5,400	12
Petroleum refineries	-	-	-	-
Misc. petr. & coal products	-	-	-	-
Plastic products	1979	416,532	87,900	19
India				
Industrial chemicals	1978	736,109	165,000	106
Other chemicals	1978	849,799	262,000	79
Petroleum refineries	1978	138,967	10,000	303
Misc. petr. & coal products	1978	103,065	30,000	102
Plastic products	1978	736,109	165,000	106
Indonesia				
Industrial chemicals	1979	129,760	12,700	128
Other chemicals	1979	95,840	38,100	132
Petroleum refineries	-	-	-	-
Misc. petr. & coal products	-	-	-	-
Plastic products	1979	22,240	16,500	76
Iran				
Industrial chemicals	1979	34,340	2,240	172
Other chemicals	1979	186,883	13,970	155
Petroleum refineries	1979	577,251	18,400	1,314
Misc. petr. & coal products	1979	1,135	360	120
Plastic products	1979	112,669	11,710	94
Republic of Korea				
Industrial chemicals	1979	809,666	40,600	57
Other chemicals	1979	913,999	49,400	84
Petroleum refineries	1979	334,279	3,600	82
Misc. petr. & coal products	1979	188,419	12,300	42
Plastic products	1979	435,306	52,300	53

Table A.4 Characteristics of the petrochemical industry in the developing ESCAP region (cont'd)

Countries	Year	Value added (thousand US$)	Number of employees	Mean size of establishment
Malaysia, West				
Industrial chemicals	1978	57,476	3,700	46
Other chemicals	1978	73,034	8,600	63
Petroleum refineries	1978	75,627	500	100
Misc. petr. & coal products	1978	864	100	17
Plastic products	1978	41,487	11,500	73
Pakistan				
Industrial chemicals	1976	54,343	11,400	190
Other chemicals	1976	55,556	40,596	188
Petroleum refineries	1976	171,344	1,000	250
Misc. petr. & coal products	1976	303	125	125
Plastic products	1976	2,222	1,150	44
Phillipines				
Industrial chemicals	1977	49,413	9,400	57
Other chemicals	1977	148,778	23,300	76
Petroleum refineries	1976	171,344	1,000	250
Misc. petr. & coal products	1976	4,834	100	11
Plastic products	1977	31,052	19,200	67
Singapore				
Industrial chemicals	1980	50,935	2,140	48
Other chemicals	1980	142,056	4,270	48
Petroleum refineries	1980	686,916	3,340	334
Misc. petr. & coal products	1980	686,916	3,340	334
Plastic products	1980	81,308	9,150	47
Sri Lanka				
Industrial chemicals	1979	2,377	769	48
Other chemicals	1979	16,058	4,469	26
Petroleum refineries	1979	18,884	4,729	4,729
Misc. petr. & coal products	1979	193	291	291
Plastic products	1979	3,661	1,543	23
Thailand				
Industrial chemicals	1975	119,237	7,979	80
Other chemicals	1975	126,593	25,951	108
Petroleum refineries	1975	352,193	2,266	453
Misc. petr. & coal products	1975	1,415	440	88
Plastic products	1975	23,462	3,821	41

Source: "Asian industry in figures", statistical profile of key sectors in selected ESCAP countries, UNIDO/IS.390, 15 June 1983.

Table A.5 Petrochemicals, existing production capacities (basic product) in the developing ESCAP region (thousand metric tons)

Country	Ethylene			Propylene			Butadiene			Total		
	1977	1979	1980	1977	1979	1980	1977	1979	1980	1977	1979	1980
India	180	240	240	100	120	120	36	50	50	316	410	410
Iran	12	30	30	...	15	15	...	...	...	12	45	45
Republic of Korea	100	150	505	60	80	268	20	25	25	180	255	798
Total	292	420	775	160	215	403	56	75	75	508	710	1,253

	Xylene			Benzene			Methanol			Total		
	1977	1979	1980	1977	1979	1980	1977	1979	1980	1977	1979	1980
India	17	40	40	69	150	150	33	33	33	119	223	223
Republic of Korea	...	50	50	100	110	155	390	390	390	490	550	595
Pakistan	...	12	12	...	5	5	...	...	...	...	17	17
Total	17	102	102	169	265	310	423	423	423	609	790	835

Source: - First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.

Table A.5 Petrochemicals, existing production capacities (end products) in the developing ESCAP region, thermo-plastics
(thousand metric tons)

Country	PVC			Polysterene			LDPE			HDPE			Polypropylene			Total		
	1977	1979	1980	1977	1979	1980	1977	1979	1980	1977	1979	1980	1977	1979	1980	1977	1979	1980
Hong Kong	...	...	...	58	68	68	...	...	...	...	...	...	...	...	...	68	68	68
India	80	132	132	24	24	24	50	112	112	30	30	30		30	30	184	328	328
Indonesia	12	40	40	...	...	...	...	...	...	...	...	...	20	37	37	32	77	77
Iran	60	60	60	...	...	...	...	...	...	...	...	...	...	...	...	60	60	60
Rep. of Korea	50	200	300	3	50	117	50	70	150		70	140	105	125	185	208	515	892
Malaysia	...	25	25	7	7	7	...	...	...	...	...	...	...	...	...	7	32	32
Pakistan	5	5	5	...	...	...	5	...	...	...	...	...	...	...	...	10	5	5
Philippines	29	50	50	13	13	13	...	...	...	...	...	...	...	...	...	42	63	63
Singapore	10	10	10	...	...	...	...	...	...	...	...	...	...	...	...	10	10	10
Thailand	20	20	20	...	15	15	...	...	...	...	...	...	...	...	...	20	35	35
Total	266	542	642	115	177	244	105	182	262	30	100	170	125	192	252	641	1,193	1,570

Source: - First world-wide study on the petrochemical industry 1975 2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.

Table A.5 Petrochemicals, existing production capacities (end products) in the developing ESCAP region, synthetic fibres
(thousand metric tons)

Country	Acrylic			Polyamide			Polyester			Total		
	1977	1979	1980	1977	1979	1980	1977	1979	1980	1977	1979	1980
Hong Kong	...	...	...	6	6	6	...	...	...	6	6	6
India	1	16	16	20	40	40	34	60	60	55	116	116
Indonesia	...	6	6	5	8	8	39	55	55	44	69	69
Iran	...	...	...	10	10	10	...	...	20	10	10	30
Rep. of Korea	100	130	130	80	100	100	171	215	215	351	445	445
Malaysia	...	...	...	...	...	...	8	36	36	8	36	36
Pakistan	...	...	...	3	3	3	...	...	13	3	3	13
Philippines	...	...	...	8	15	15	26	30	50	34	45	65
Singapore	...	...	...	8	8	8	20	20	20	28	28	28
Thailand	...	...	...	10	10	10	77	80	80	87	90	90
Total	101	151	152	149	200	200	375	496	549	625	848	901

Source: - First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.

Table A.5 Petrochemicals, existing production capacities (end products) in the developing ESCAP region, synthetic rubber
(thousand metric tons)

Country	S.B.R.			Poly butadiene			Total		
	1977	1979	1980	1977	1979	1980	1977	1979	1980
India	30	30	30	20	20	20	50	50	50
Republic of Korea	50	70	100	...	...	30	50	70	130
Total	80	100	130	20	20	50	100	120	180

Source: - First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.

Table A.6 Actual petrochemicals production, basic products, in the developing ESCAP region, selected years (thousand metric tons)

Country	Ethylene				Propylene				Butadiene				Total			
	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980
India	47	57	102	102	33	37	58	58	5	6	7	7	85	100	167	167
Republic of Korea	96	87	185	373	59	56	111	208	15	13	26	57	170	156	322	638
Total	143	144	287	475	92	93	169	266	20	19	33	64	255	256	489	805

	Xylene				Benzene				Methanol				Total			
	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980
India	15	15	30	30	56	64	75	75	25	30	30	30	96	109	135	135
Republic of Korea	51	86	99	120	36	56	65	103	59	175	317	212	146	317	481	435
Pakistan	...	...	...	7	...	...	...	2	...	...	...	...	...	...	...	9
Total	66	101	129	157	92	120	140	180	84	205	347	242	242	624	616	579

Source: - First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981 and Annex, ID/WG.336/3/Add.1, 20 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.
- World Petrochemical SRI International.
Market study of petrochemicals, EMAR Petrotech Services Limited (1980), Karachi, Pakistan.

Table A.6 Actual petrochemicals production (end products), thermo-plastics, in the developing ESCAP region, selected years (thousand metric tons)

Country	PVC				PS				LDPE				PP				Total			
	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980
Hong Kong	...	...	...	...	...	40	50	60	...	...	...	...	...	...	...	...	...	40	50	60
India	42	57	59	100	9	15	14	11	51	47	100	98	...	...	20	25	102	119	193	234
Indonesia	8	10	25	25	...	...	...	...	...	...	...	...	...	...	...	...	8	10	25	25
Iran	15	15	20	20	...	...	...	...	...	...	...	...	10	15	20	20	25	30	40	40
Republic of Korea	68	124	225	237	13	33	38	47	64	64	112	201	60	108	100	146	205	329	475	631
Malaysia	...	...	10	15	3	4	5	5	...	...	...	...	...	...	...	...	3	4	15	20
Pakistan	2	3	4	4	...	...	...	...	...	...	...	...	...	...	...	...	2	3	4	4
Philippines	8	12	20	25	7	8	10	11	...	...	...	...	...	...	...	...	15	20	30	36
Singapore	...	8	8	8	...	...	...	...	...	...	...	...	...	...	...	...	...	8	8	8
Thailand	10	15	15	15	...	...	8	10	...	...	...	...	...	...	...	...	10	15	23	25
Total	153	244	386	449	32	100	125	144	115	111	212	299	70	123	140	191	370	578	863	1,083

Source:
- First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981 and Annex, ID/WG.336/3/Add.1, 20 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.
- World Petrochemical SRI International.
- Market study of petrochemicals, EMAR Petrotech Services Limited (1980), Karachi, Pakistan.

Table A.6 Actual petrochemicals production (end products), synthetic fibres, in the developing ESCAP region, selected years (thousand metric tons)

Country	Acrylic				Polyamide				Polyester				Total			
	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980
India	...	...	10	12	13	15	20	30	16	26	40	50	29	41	70	92
Indonesia	...	...	4	4	2	3	5	5	20	30	45	45	22	33	54	54
Iran	...	...	...	...	5	6	8	8	...	...	...	...	5	6	8	8
Republic of Korea	60	90	115	120	59	70	90	90	112	158	180	200	231	318	385	410
Malaysia	...	...	...	...	...	...	...	...	...	5	30	30	...	5	30	30
Pakistan	...	...	...	...	2	2	2	2	...	...	...	8	2	2	2	10
Philippines	...	...	...	...	4	6	9	10	13	20	25	35	17	[illegible]	34	45
Singapore	...	...	...	...	...	6	7	7	10	15	18	18	10	21	25	25
Thailand	...	...	...	...	6	8	9	9	32	65	70	70	38	73	79	79
Total	60	90	129	136	91	116	150	161	203	319	408	456	354	525	687	753

Source:
- First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981 and Annex, ID/WG.336/3/Add.1, 20 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.
- World Petrochemical SRI International.
- Market study of petrochemicals, EMAR Petrotech Services Limited (1980), Karachi, Pakistan.

Table A.6 Actual petrochemicals production (end products), synthetic rubber, in the developing ESCAP region, selected years (thousand metric tons)

Country	S.B.R.				P.B.R.				Total			
	1975	1977	1979	1980	1975	1977	1979	1980	1975	1977	1979	1980
India	23	27	28	28	10	15	15	17	33	42	43	45
Republic of Korea	24	44	62	70	...	...	...	20	24	44	62	90
Total	47	71	90	98	10	15	15	37	57	86	105	135

Source:
- First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981 and Annex, ID/WG.336/3/Add.1, 20 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.
- World Petrochemical SRI International.
- Market study of petrochemicals, EMAR Petrotech Services Limited (1980), Karachi, Pakistan.

Table A.7 Petrochemical consumption (end-products), plastics, in the developing ESCAP region, 1965-1980 (thousand metric tons)

Countries	1965	1970	1975	1980[a/]	Increase in consumption (per cent/annum) 1965-1975	1975-1980
Bangladesh	...	...	...	14	...	...
Area of Hong Kong	75	150	165	193	8.2	3.2
India	55	110	150	252	10.6	10.9
Indonesia	11	65	145	295	29.5	15.2
Iran	50	100	200	141	15.0	-5.9
Republic of Korea	25	100	284	577	27.8	15.2
Malaysia	...	...	...	108	...	...
Pakistan	6	20	60	55	26.0	-1.7
Philippines	37	100	125	93	13.0	-5.1
Singapore	10	25	60	75	19.8	4.6
Sri Lanka	...	...	...	8	...	...
Thailand	20	95	90	98	16.2	1.6
Total	289	765	1,279	1,909	16.1	8.3

a/ 1980 figures pertain to thermo-plastics (PE, PVC, PS and PP).

Source:
- First world-wide study on the petrochemical industry 1975 2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981 and Annex, ID/WG.336/3/Add.1, 20 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.
- World Petrochemical SRI International.
- Market study of petrochemicals, EMAR Petrotech Services Limited (1980), Karachi, Pakistan.

Table A.7 Petrochemicals consumption (end-products), synthetic fibres, in the developing ESCAP region, 1965-1980 (thousand metric tons)

Countries	1965	1970	1975	1980	Increase in consumption (per cent/annum) 1965-1975	1975-1980
Bangladesh	...	...	...	2	...	...
Area of Hong Kong	2	12	25	25	28.8	...
India	9	22	26	88	11.0	28.0
Indonesia	...	12	96	90	...	-1.3
Iran	2	27	55	57	39.5	0.7
Republic of Korea	10	68	90	320	24.8	28.8
Malaysia	...	...	10	40	...	32.0
Pakistan	...	6	22	73	...	27.0
Philippines	7	20	46	54	20.8	3.3
Singapore	30	37	42	7	3.5	-16.7
Thailand	7	24	48	89	21.2	13.0
Total	67	228	460	845	21.2	12.9

Source: - First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981 and Annex, ID/WG.336/3/Add.1, 20 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.
- World Petrochemical SRI International.
- Market study of petrochemicals, EMAR Petrotech Services Limited (1980), Karachi, Pakistan.

Table A.7 Petrochemicals consumption (end-products), synthetic rubber, in the developing ESCAP region, 1965-1980 (thousand metric tons)

Countries	1965	1970	1975	1980	Increase in consumption (per cent/annum) 1965-1975	1975-1980
Bangladesh	...	...	...	0.20	...	...
Area of Hong Kong	4	10	26	13	20.8	-10.0
India	-	...	...	48	...	...
Indonesia	23	35	35	15	4.3	-11.4
Iran	3	8	50	16	32.5	-13.6
Republic of Korea	10	35	60	127	19.8	16.2
Malaysia	...	...	...	6	...	...
Pakistan	...	...	3	5	...	10.8
Philippines	12	14	21	13	5.8	-7.6
Singapore	...	...	...	3	...	...
Thailand	...	...	...	9	...	...
Total	52	102	201	225.20	14.3	2.3

Source:
- First world-wide study on the petrochemical industry 1975-2000, UNIDO/ICIS.83, 12 December 1978.
- Second world wide study on petrochemical industry: process of restructuring, ID/WG.336/3, 19 May 1981 and Annex, ID/WG.336/3/Add.1, 20 May 1981.
- The development of petrochemical industries in the developing countries. Paper presented by UNIDO secretariat at Joint UNIDO/OPEC/OPEC FUND Seminar on Petrochemicals, Vienna, 7 to 9 March 1983.
- World Petrochemical SRI International.
- Market study of petrochemicals, EMAR Petrotech Services Limited (1980), Karachi, Pakistan.

Table A.8 Plastics products, average import/local market prices (in US$ per metric ton)

Year	L.D.P.E.		H.D.P.E.		PVC (resin)		P.P.	
	Import prices	Local market prices	Import prices	Local market prices	Import prices	Local market prices	Import prices	Local market prices
1977	550-600	1,270	600	1,380	500	1,210	610	1,320
1978	600-900	1,710-2,260	750-900	1,760-2,350	490	1,430	600-700	1,710
1979	1,150-1,200	2,320	1,150	2,420	800	1,930	900 1,000	2,090
1980	930	2,540	1,050	2,590	800-600	2,040	800-900	2,420
1981	750-800	2,460	980-1,000	2,530	500	2,090	900	2,590
1982	750	2,590	940	2,760	475	2,090	950	2,870
1983	830-850	2,116	800-910	2,116	650-700	1,852	870-900	2,116
1984								
1st quarter	805-870	1,940	810-880	1,979	590-630	1,633	830-870	1,960
2nd quarter	895-900	1,912	780-900	1,961-2,000	600-625	1,615	830-850	2,001
3rd quarter	700-750	1,691	750-800	1,883	550	1,837	800	1,883
4th quarter	600-650	1,649	680-730	1,874	530-560	1,499	720-780	1,877

Source: Market study of petrochemicals, ENAR Petrotech Services Ltd., Karachi, Pakistan.

Table A.9 Developing ESCAP region, growth rates used for the development of demand projections, 1980-1990 thermo-plastics
(per cent per annum)

COUNTRIES	P.V.C.		H.D.P.E.		L.D.P.E.		P.P		P.S.	
	1980-85	1985-90	1980-85	1985-90	1980-85	1985-90	1980-85	1985-90	1980-85	1985-90
Afghanistan	***	***	***	***	***	***	***	***	***	***
Bangla Desh	8.0	8.0	15.0	10.0	5.0	5.0	***	***	***	***
Burma	***	***	***	***	***	***	***	***	***	***
Hong Kong	10.0	10.0	8.0	8.0	5.0	5.0	8.0	6.0	12.0	10.0
India	10.0	12.0	10.0	7.0	10.0	8.0	12.0	9.0	12.0	10.0
Indonesia	10.0	8.0	10.0	8.0	8.0	8.0	12.0	10.0	12.0	10.0
Iran	7.0	12.0	10.0	15.0	10.0	15.0	8.0	10.0	10.0	8.0
Republic of Korea	8.0	6.0	11.0	8.0	12.0	9.0	9.0	9.0	10.0	8.0
Malaysia	10.0	8.0	10.0	8.0	8.0	8.0	12.0	10.0	12.0	10.0
Nepal	***	***	***	***	***	***	***	***	***	***
Pakistan	11.0	8.0	12.0	15.0	11.0	10.0	10.0	15.0	10.0	8.0
Phillipines	10.0	8.0	10.0	8.0	8.0	8.0	12.0	10.0	12.0	10.0
Singapore	10.0	8.0	10.0	8.0	8.0	8.0	12.0	10.0	12.0	10.0
Srilanka	8.0	8.0	15.0	10.0	5.0	5.0	***	***	***	***
Thailand	10.0	8.0	10.0	8.0	8.0	8.0	12.0	10.0	12.0	10.0

*** Denotes data not available

Table A.9 Developing ESCAP region, growth rates used for the development of demand projections 1980-1990 synthetic fibres and synthetic rubber
(per cent per annum)

COUNTRIES	SYNTHETIC FIBRES						SYNTHETIC RUBBER			
	ACRYLIC		POLYMIDE		POLYESTER		S.B.R.		P.B.R.	
	1980-85	1985-90	1980-85	1985-90	1980-85	1985-90	1980-85	1985-90	1980-85	1985-90
Afghanistan	***	***	***	***	***	***	***	***	***	***
Bangla Desh	***	***	5.0	5.0	8.0	6.0	3.0	2.0	***	***
Burma	***	***	***	***	***	***	***	***	***	***
Hong Kong	5.0	4.0	6.0	4.0	7.0	6.0	6.0	4.0	5.0	4.0
India	8.0	7.0	10.0	8.0	13.0	10.0	5.0	4.0	4.0	3.0
Indonesia	5.0	4.0	6.0	4.0	7.0	6.0	6.0	4.0	5.0	4.0
Iran	6.0	5.0	4.0	3.0	7.0	6.0	5.0	4.0	3.0	2.0
Republic of Korea	5.0	4.0	7.0	5.0	6.0	5.0	7.0	5.0	5.0	4.0
Malaysia	5.0	4.0	6.0	4.0	7.0	6.0	6.0	4.0	5.0	4.0
Nepal	***	***	***	***	***	***	***	***	***	***
Pakistan	6.0	5.0	3.0	2.0	10.0	8.0	5.0	4.0	3.0	2.0
Phillipines	5.0	4.0	6.0	4.0	7.0	6.0	6.0	4.0	5.0	4.0
Singapore	5.0	4.0	6.0	4.0	7.0	6.0	6.0	4.0	5.0	4.0
Srilanka	***	***	***	***	***	***	***	***	***	***
Thailand	5.0	4.0	6.0	4.0	7.0	6.0	6.0	4.0	5.0	4.0

*** Denotes data not available.

Table A.10 Developing ESCAP region, projected petrochemicals demand, end products, thermo-plastics, selected years
(thousand metric tons)

COUNTRY	PVC			HDPE			LDPE			PP			PS			TOTAL			INCREASE IN CONSUMPTION %/ANNUM	
	1985	1987	1990	1985	1987	1990	1985	1987	1990	1985	1987	1990	1985	1987	1990	1985	1987	1990	1985-87	1987-90
Bangla Desh	11.76	13.72	17.29	0.61	0.74	0.98	8.38	7.04	8.15	***	***	***	***	***	***	18.75	21.50	26.42	7.1	7.1
Hong Kong	48.31	58.45	77.80	24.98	29.14	36.71	63.82	70.36	81.45	23.50	26.40	31.44	140.99	170.60	227.07	301.60	354.95	454.47	8.5	8.6
India	132.06	165.66	232.74	101.46	116.16	142.30	119.17	139.00	175.10	35.25	41.88	54.24	22.92	27.73	36.91	410.86	490.43	641.29	9.3	9.3
Indonesia	148.17	172.82	217.71	103.07	120.23	151.46	113.13	131.95	166.22	88.12	106.62	141.91	21.55	25.60	34.08	474.04	557.22	711.38	8.4	8.5
Iran	98.17	123.14	173.01	30.60	40.47	61.55	45.01	59.65	90.72	17.64	21.34	28.40	19.68	22.95	28.91	211.19	267.55	382.59	12.2	12.2
Korea	263.01	295.52	351.97	119.64	139.55	175.75	239.68	284.76	368.78	227.72	270.55	350.73	69.25	80.77	101.75	919.30	1071.15	1348.66	8.0	8.0
Malaysia	35.43	41.32	42.06	33.83	39.64	49.71	44.07	51.41	64.76	42.30	51.18	68.12	19.40	23.47	31.24	175.03	206.84	265.89	8.7	8.7
Pakistan	32.02	37.35	47.06	5.29	6.99	10 64	33.70	40.78	54.29	16.10	21.30	32.41	4.83	5.64	7.11	91.94	112.06	151.51	10.4	10.6
Phillipines	40.27	46.97	59.17	16.10	18.78	23.65	29.40	34.29	43.19	44.05	53.31	70.95	22.92	27.73	36.91	152.74	181.08	233.87	8.9	8.9
Singapore	25.77	30.06	37.86	12.89	15.03	18.93	20.57	24.00	30.23	44.05	53.31	70.95	21.55	25.60	34.08	124.83	148.00	192.05	8.9	9.1
Srilanka	7.34	8.56	10.78	***	***	***	3.87	4.22	4.88	***	***	***	***	***	***	11.17	12.78	15.66	7.0	7.0
Thailand	29.00	33.83	42.62	32.21	33.57	47.34	44.07	51.41	64.76	26.44	31.99	42.58	26.44	31 99	42.58	158.16	186.79	239.88	8.7	8.7
TOTAL:	871.31	1027.40	1320.07	480.68	564.12	719.05	762.92	898.87	1152.53	565.17	677.88	891.37	369.53	442.08	580.64	3049.61	3610.35	4663.67	8.8	8.9

*** Denotes data not available.

Table A. 10 Developing ESCAP region, projected petrochemicals demand, end products, synthetic fibres, selected years
(thousand metric tons)

COUNTRY	ACRYLIC			POLYAMIDE			POLYESTER			T O T A L			INCREASE IN CONSUMPTION % PER ANNUM	
	1985	1987	1990	1985	1987	1990	1985	1987	199	1985	1987	1990	1985-87	1987-90
Afghanistan	***	***	***	***	***	***	***	***	***	***	***	***	***	***
Bangla Desh	***	***	***	1.15	1.19	1.25	1.47	1.65	1.97	2.62	2.84	3.22	4.1	4.8
Burma	***	***	***	***	***	***	***	***	***	***	***	***	***	***
Hong Kong	2.56	2.77	3.12	17.41	18.83	21.17	14.03	15.76	18.77	34.00	37.36	43.06	4.8	4.8
India	14.69	16.82	18.92	16.10	18.78	23.65	101.34	122.62	163.21	132.13	158.22	205.78	9.4	9.4
Indonesia	19.15	20.72	23.31	20.07	21.70	24.41	84.16	94.56	112.61	123.38	136.98	160.33	5.4	5.4
Iran	9.37	10.33	1 .64	18.24	19.35	21.15	49.08	55.14	65.68	76.69	84.82	103.47	5.2	5.8
Rep. of Korea	105.93	114.58	128.89	112.20	123.70	143.20	210.10	231.64	268.23	428.23	469.92	540.24	4.7	4.7
Malaysia	2.32	2.42	2.57	4.01	4.34	4.88	49.08	55.14	65.68	55.41	61.90	73.13	5.7	5.7
Pakistan	13.38	14.75	17.07	9.27	9.65	10.24	88.58	103.32	130.16	111.23	127.72	157.37	7.2	7.2
Phillipines	7.67	8.30	9.34	24.08	26.04	29.29	42.07	47.27	59.48	73.82	81.61	98.11	5.2	6.3
Singapore	1.15	1.19	1.25	1.34	1.45	1.63	7.01	7.88	9.38	9.50	10.52	12.26	5.2	5.2
Thailand	11.49	12.43	13.99	13.38	14.48	16.29	98.17	110.30	130.30	123.04	137.21	160.58	5.6	5.4
TOTAL:	187.71	204.31	235.10	237.25	259.51	297.16	745.09	845.28	1025.39	1170.05	1309.10	1557.65	5.8	5.9

*** Denotes data not available.

Table A.10 Developing ESCAP region, projected petrochemicals demand, end products synthetic rubber, selected years
(thousand metric tons)

COUNTRY	S.B.R.			P.B.R.			T O T A L			INCREASE IN CONSUMPTION % /ANNUM	
	1985	1987	1990	1985	1987	1990	1985	1987	1990	1985-87	1987-90
Afghanistan	***	***	***	***	***	***	***	***	***	***	***
Bangla Desh	0.25	0.27	0.30	***	***	***	0.25	0.27	0.30	4.0	3.6
Burma	***	***	***	***	***	***	***	***	***	***	***
Hong Kong	14.72	15.92	17.91	2.56	2.77	3.12	17.28	18.69	21.03	4.0	4.0
India	44.68	48.33	54.36	15.81	16.77	18.32	60.49	65.10	72.68	3.8	3.8
Indonesia	17.41	18.83	21.17	2.56	2.77	3.12	19.97	21.60	24.29	4.0	4.0
Iran	17.87	19.32	21.73	2.32	2.42	2.57	20.19	21.74	24.30	3.8	3.8
Rep. of Korea	148.57	163.80	189.62	24.26	26.24	29.52	172.83	190.04	219.14	4.9	4.9
Malaysia	6.70	7.25	8.15	1.28	1.38	1.56	7.98	8.63	9.71	4.0	4.0
Nepal	***	***	***	***	***	***	***	***	***	***	***
Pakistan	5.10	5.51	6.20	1.15	1.19	1.25	6.25	6.70	7.45	3.6	3.6
Phillipines	14.72	15.92	17.91	2.56	2.77	3.12	17.28	18.69	21.03	4.0	4.0
Singapore	2.68	2.90	3.27	1.28	1.38	1.56	3.96	4.28	4.83	4.0	4.1
Thailand	10.71	11.59	13.03	1.28	1.38	1.56	11.99	12.97	14.59	4.0	4.0
TOTAL:	283.41	309.64	353.65	55.06	59.07	65.70	338.47	368.71	419.35	4.4	4.4

*** Denotes data not available.

Table A.11 Developing ESCAP region projected petrochemicals demand/supply, end-products, thermoplastics in 1990
(thousand metric tons)

Country	PVC			HDPE			LDPE			PP			PS		
	Supply	Demand	Surplus/ (deficits)	Supply	Demand	Surplus/ (deficits)	Supply	Demand	Surplus/ (deficits)	Supply	Demand	Surplus/ (deficits)	Supply	Demand	Surplus/ (deficits)
Afghanistan	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Bangladesh	...	17.29	(17.29)	...	0.98	(0.98)	...	8.15	(8.15)	...	...	...	...	...	...
Burma	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Hong Kong	...	77.80	(77.80)	...	36.71	(36.71)	...	81.45	(81.45)	...	31.44	(31.44)	60.00	227.07	(167.07)
India	168.30	232.74	(64.44)	27.00	142.30	(115.30)	100.80	175.10	(74.30)	27.00	54.24	(27.24)	21.60	36.91	(15.31)
Indonesia	135.00	217.71	(82.71)	54.00	151.46	(97.46)	162.00	166.22	(4.22)	33.30	141.91	(108.61)	...	34.08	(34.08)
Iran	135.00	173.01	(38.01)	54.00	61.55	(7.55)	90.00	90.72	(0.72)	45.00	28.40	16.60	...	28.91	(28.91)
Rep.of Korea	270.00	351.97	(81.97)	126.00	175.79	(49.79)	288.00	368.78	(80.78)	184.50	350.37	(165.87)	180.00	101.75	78.25
Malaysia	22.50	52.06	(29.56)	...	49.71	(49.71)	...	64.76	(64.76)	...	68.12	(68.12)	6.00	31.24	(25.24)
Nepal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Pakistan	4.00	47.06	(43.06)	...	10.64	(10.64)	...	54.29	(54.29)	...	32.41	(32.41)	...	7.11	(7.11)
Phillipines	45.00	59.17	(14.17)	...	23.65	(23.65)	...	43.19	(43.19)	...	70.95	(70.95)	11.70	36.91	(25.21)
Singapore	...	37.86	(37.86)	72.00	18.92	53.07	108.00	30.23	77.77	90.00	70.95	19.05	...	34.08	(34.08)
Sri Lanka	...	10.78	(10.78)	...	...	...	...	4.88	(4.88)	...	...	...	...	...	...
Thailand	45.00	42.62	2.38	...	47.34	(47.34)	66.60	64.76	1.84	...	42.58	(42.58)	20.70	42.58	(21.88)
Total	824.80	1,320.07	(495.27)	333.00	719.06	(386.06)	815.40	1,152.53	(337.13)	379.80	891.37	(511.57)	300.00	580.64	(280.64)

Table A.11 Developing ESCAP region projected petrochemicals demand/supply, end-products, synthetic fibres in 1990 (thousand metric tons)

Country	Acrylic fibres			Polyamide fibre			Polyester fibre		
	Supply	Demand	Surplus/ (deficits)	Supply	Demand	Surplus/ (deficits)	Supply	Demand	Surplus/ (deficits)
Afghanistan	...	...	...	...	...	...	...	...	...
Bangladesh	...	...	...	...	1.25	(1.25)	...	1.97	(1.97)
Area of Hong Kong	...	3.12	(3.12)	...	21.17	(21.17)	...	18.77	(18.77)
India	14.40	18.92	(4.52)	36.00	23.65	12.35)	134.10	163.21	(29.11)
Indonesia	5.40	23.31	(17.91)	7.20	24.41	(17.21)	100.00	112.61	(12.61)
Iran	18.00	16.64	1.36	14.40	21.15	(6.75)	18.00	65.68	(47.68)
Republic of Korea	117.00	128.89	(11.89)	162.00	143.20	18.80)	225.00	268.15	(43.15)
Malaysia	...	2.57	(2.57)	...	4.88	(4.88)	32.40	65.68	(33.28)
Pakistan	...	17.07	(17.07)	3.00	10.24	(7.24)	36.00	130.16	(94.16)
Phillipines	...	9.34	(9.34)	13.50	29.29	(15.79)	45.00	59.48	(14.48)
Singapore	...	1.25	(1.25)	7.00	1.63	5.37	...	9.38	(9.38)
Thailand	...	13.99	(13.99)	...	16.29	(16.29)	72.00	130.30	(58.30)
Total	154.80	235.10	(80.30)	242.50	297.16	(54.66)	662.50	845.28	(128.78)

Source: For supply figures only
- Based on Second World-wide Study on the Petrochemical Industry: Process of Restructuring, ID/WG.336/3, 19 May 1981.

Table A.11 Developing ESCAP region projected petrochemicals demand/supply, end-products, synthetic rubber in 1990
(thousand metric tons)

Country	S.B.R.			Poly butadiene		
	Supply	Demand	Surplus/ (deficits)	Supply	Demand	Surplus/ (deficits)
Bangladesh	...	0.30	(0.30)	...	...	...
Area of Hong Kong	...	17.91	(17.91)	...	3.12	(3.12)
India	27.00	54.36	(27.36)	18.00	18.32	(0.32)
Indonesia	...	21.17	(21.17)	...	3.12	(3.12)
Iran	36.00	21.73	14.27	...	2.57	(2.57)
Republic of Korea	90.00	189.62	(99.62)	45.00	29.52	15.48
Malaysia	...	8.15	(8.15)	...	1.56	(1.56)
Pakistan	...	6.20	(6.20)	...	1.25	(1.25)
Phillipines	...	17.91	(17.91)	...	3.12	(3.12)
Singapore	...	3.27	(3.27)	...	1.56	(1.56)
Thailand	...	13.03	(13.03)	...	1.56	(1.56)
Total	153.00	353.65	(200.65)	63.00	65.70	(2.70)

Source: For supply figures only
- Based on Second World-wide Study on the Petrochemical Industry: Process of Restructuring, ID/WG.336/3, 19 May 1981.

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The petrochemical industry in the developing ESCAP region: past review and future prospects

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