OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

D00340

United Nations Industrial Development Organization

ID

Distribution
LIMITED

ID/WG.34/10 REV.1
28 APRIL 1970

ORIGINAL: ENGLISH

PET.SYMP. A/8

Interregional Petrochemical Symposium on the Development of the Petrochemical Industries in Developing Countries

Baku, USSR, 21 - 31 October 1969

THE DEVELOPMENT OF PETROCHEMICAL INDUSTRIES IN THE MIDDLE EAST REGION 1/

by

United Nations Economic and Social ~~Affairs~~ Office in Beirut (UNESOB)

id.70-3131

United Nations Industrial Development Organization

Distribution
LIMITED

ID/WG.34/10/REV.1/CORR.1
12 May 1970

ORIGINAL: ENGLISH

International Petrochemical Symposium on the Development of the Petrochemical Industries in Developing Countries

Baku, USSR, 21 - 31 October 1969

PET.SYMP. A/8

THE DEVELOPMENT OF PETROCHEMICAL INDUSTRIES IN THE MIDDLE EAST REGION

Corrigendum

Cover Page: Delete "United Nations Economic and Social Affairs in Beirut (UNESOB)

Substitute "United Nations Economic and Social Office in Beirut (UNESOB)

id.70-2898

United Nations Industrial Development Organization

Distribution
LIMITED

ID/WG.33/10 SUMMARY
23 July 1969

ORIGINAL: ENGLISH

Interregional Petrochemical Symposium on the Development of the Petrochemical Industries in Developing Countries

Baku, USSR, 20 - 31 October 1969

PET.SYMP. A/8

SUMMARY

D00340

THE DEVELOPMENT OF PETROCHEMICAL INDUSTRIES IN THE MIDDLE-EAST REGION [1/]

by

K. Czeija
Vienna Austria

The Middle-East region is one of the richest in world for raw material for petrochemicals, but the market for the latter is only trivial compared with world market.

In the first section of the paper the position in each country in the region is discussed, its petroleum and natural gas resources, its existing petrochemical production, if any, and its plans for the future.

The figures are then drawn together and presented as summaries for the whole region. This section is extended to include transport possibilities, energy availability and the existence of petroleum refineries.

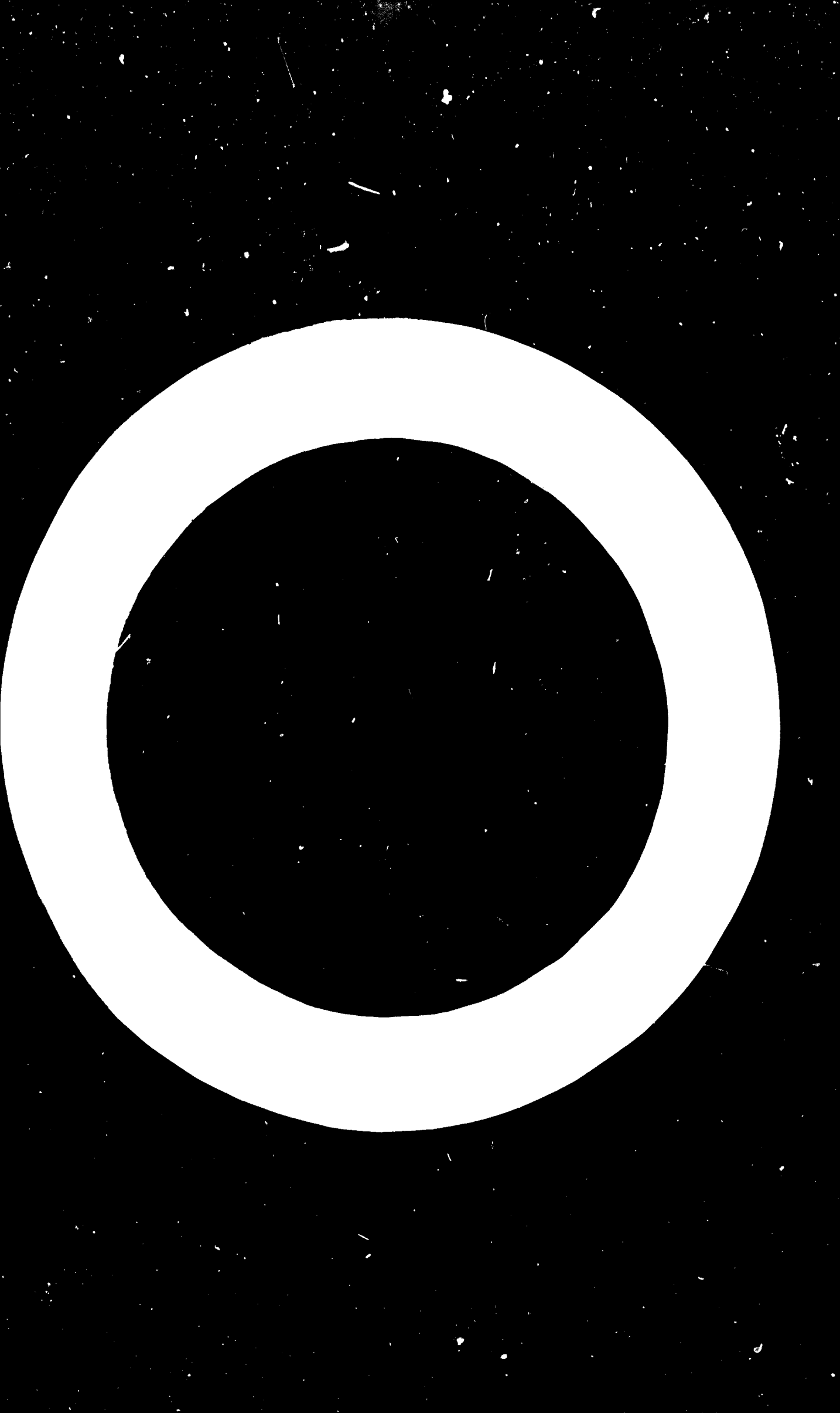
Fertilizers are next discussed, particularly those plants using petrochemical raw materials.

1/ The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

id.69-4385

A scheme is then drawn up showing the ethylene, methanol, benzene, polymers, synthetic fibres and rubbers and other chemicals which the region could reasonably produce by 1975 and by 1980. The current and future markets are forecast, broken down into countries as a whole and for the regions in terms of different plastics, rubbers and fibres. The rubber tyre imports into the different countries are next given as a guide to potential rubber production.

Suggestions are made for action on a national basis e.g. tariff modifications to allow economies of production and standardization of qualities by the various chemical institutes. Action on a regional basis is then dealt with including the [illegible] of scientists, joint planning, regional use of natural gas flaring and the use of LNG in transport e.g. by pipe line. It is estimated that the production of petrochemicals could be raised four [illegible] but the investment of US $ 300 million would be necessary to enable the increased quantity to be produced within the region.



PROVISIONAL

THE DEVELOPMENT OF PETROCHEMICAL INDUSTRIES IN SELECTED COUNTRIES IN THE MIDDLE EAST

A Paper Presented to

The Second Inter-Regional Symposium

on

The Development of Petrochemical Industries in Developing Countries,

Baku, U.S.S.R., 20-31 October 1969

October 1969

For the preparation of this paper, Mr. Karl Czeija served as a consultant to the United Nations Industrial Development Organization (UNIDO) and its outpost in the Middle East, the United Nations Economic and Social Office in Beirut (UNESOB).

CONTENTS

/...

LIST OF TEXT TABLES

/...

LIST OF APPENDIX TABLES

DOLLAR EQUIVALENTS OF LOCAL CURRENCIES

	US dollars
Iraqi Dinar (ID)	2.8
Jordanian Dinar (JD)	2.8
Kuwaiti Dinar (KD)	2.8
Lebanese Pound (LL)	0.22
Saudi Arabia Riyal (SR)	0.22
Syrian Pound (LS)	0.26

/...

I. THE PRESENT SITUATION

A. General background

1. The Middle East is one of the world's richest regions in petroleum resources. Compared to other regions, such as Africa, America, the socialist countries and the remaining parts of the world, the Middle East is the largest producer of crude oil. Its crude oil reserves, amounting to approximately 32 billion tons, or to 60 per cent of the proven world oil reserves, are larger than in any other region of the world. In addition, it is estimated that more than one third of the proven natural gas reserves are located in the Middle East (see appendix table 1).[1/]

2. The utilization of this enormous wealth is, at present, practically confined to extraction and shipping. Whatever chemical conversion exists in most countries in the Middle East, it is restricted to oil refining and to the development of fertilizer industries. Petrochemical industries have not so far been developed in the region; these are still in the planning stage. In order to evaluate existing petrochemical plans with respect to their future realization, it is important to review the present stage of development of the relevant infrastructure in the region, including existing pipelines, refineries, gas processing, and fertilizer and power plants.

3. The refining capacity available in countries covered by this study amounts to less than five per cent of the world's refining capacity. A number of existing refineries could not, however, be regarded as "petrochemical plants" at present[2/].

4. Gas processing plants existing in these countries have been erected mainly for the purpose of purifying gas from sulfur for further use as a source of energy or as a raw material for the production of fertilizers. However, plans exist for the establishment of liquefaction plants for supplying gas in a liquefied form to other regions of the world where industrial facilities for

---

1/ Unless otherwise specified, the countries covered in this study are Bahrain, Iraq, Jordan, Kuwait, Lebanon, Qatar, Saudi Arabia and Syria.

2/ OPEC, Annual Statistical Bulletin, 1967, p. 49.

/...

the utilization of this raw material are available. The cost of transporting liquid gas is being evaluated.

5. In addition to infrastructure, several other factors, such as capital and labour availabilities, industrial ownership, the nature of social relationships and the development of markets for intermediate and end-use products bear heavily on the problems of the development and growth of the petrochemical industries.

6. In the world as a whole, only a small proportion of existing petroleum resources are used for the production of petrochemicals. Roughly, three per cent of world crude oil production and six to seven per cent of natural gas production are used for petrochemicals.3/ In the year 2,000, it is estimated that the use of these two natural resources in the production of petrochemicals will rise to 20 to 30 per cent of total world production.4/

7. If it could be assumed that, during the nineteen seventies, at least twenty different selected intermediate and finished petrochemical products, such as plastics, synthetic rubbers and synthetic fibres, could be developed, the emergence of a common Middle East market in petrochemicals, similar to the one that was achieved twenty years ago by the European Common Market in iron and steel, might become a reality. With this in mind, certain suggestions, which might enable a number of Middle East countries to participate in the development of petrochemical industries in the 1970-1980 period, are presented in this paper.

8. Available data indicate that the world markets for petrochemicals started to develop only around 1950. In 1948, the world production of synthetic polymers was in the range of only one million tons. At present, the world production and sales of petrochemicals, such as plastics, synthetic rubber and synthetic fibres, amounts to approximately 25 million tons per year. This new level of production has been primarily achieved in the industrialized countries where large-scale production techniques result in higher levels of profitability and cheaper prices.

3/ United Nations, Studies in petrochemicals, presented at the United Nations Inter-regional Conference on the Development of Petrochemical Industries in Developing Countries in Teheran 1964, Sales No. 67.II.B.2, p. 218.

4/ 7. Asinger "Was die Petrolchemie vermag" Erdöl, Erdgas Zeitschrift (1963) 6 p 101-110, Urban Verlag, Vienna

/...

In these countries, prices for the main thermoplastics, such as PVC, polyethylene and polystyrene, have been lowered to as low as 25 US cents per kilogramme.

9. The actual market for petrochemicals in the countries reviewed in this paper is at present estimated at 60,000 tons per year, or at approximately 0.24 per cent of total world production. With a population of approximately 30 million, per capita consumption of petrochemicals is, therefore, assumed to be in the neighbourhood of two kilogrammes. The future market for petrochemicals in developing countries may be correlated with the expected growth in industrial development and with population. For example, the building industry, which now consumes in the developed countries 30 per cent of the world production of plastics, should be regarded as one of the main future users of plastics in the Middle East. PVC floor tiles, plastic tubes, polystyrene insulating foams, insulated electric cables and installations are only a few examples of the prospective uses of petrochemical products by the building materials industries in the region. Future consumption of synthetic rubber in the developing countries may also be estimated on the basis of the projected market for tyres and other rubber articles. The use of synthetic fibres by the textile industry is expected to rise above the present level of 15 per cent of world production. Data showing recent rising trends in the import of synthetic fibres may, therefore, be used as a guideline for projecting future production capacities of this commodity.

10. Future prospects for petrochemical developments in the region are explored in the following section on the basis of present and future consumption of raw materials and of existing and future plans for petrochemical production.

B. The present state of the petrochemical industry in individual countries

1. BAHRAIN

11. No petrochemical industry exists in Bahrain. An aluminium smelting project, based on natural gas as a source of energy, has been established for processing aluminium imported from Australia. In the field of petrochemistry, a project for the production of catalysts for refineries is in the planning stage. Once these projects are realized, no other petrochemical projects are expected to be introduced during the nineteen seventies.

/...

. IRAQ

12. Factors favouring the future development of a petrochemical industry in this vast country (445,000 km^2), with its relatively large population (8.5 million), include: a) abundance of natural resources; b) the existence of an adequate infrastructure (transportation and energy), c) the availability of a sizable domestic market for petrochemicals; and, d) the existence of a petrochemical institute.

13. In Iraq, plans for the utilization of natural gas, of which 4.5 billion cubic meters were flared in 1965, have been drawn.[5] These include: a) the erection of a pipeline extending from the natural gas fields in Basra and Kirkuk to Turkey, b) liquefaction of natural gas (in Basra) for shipping to external markets, and, c) the construction of an ethylene plant with a capacity of 20,000 tons, to be followed by the establishment, at a later stage, of plants for the production of PVC and polyethylene.[6]

14. For the future development of petrochemicals in Iraq, several guidelines have been established. These include: a) the erection of capacities capable of satisfying not only the home market but also the markets of all neighbouring Arab countries, b) the production of only such intermediates whose transportation costs are minimal, and, c) the encouragement of joint ventures and public ownerships, with a view to promoting the building of economic links between the Arab countries.

15. Ethylene production facilities are expected to be completed by 1975, to be followed by other projects involving the production of several other petrochemical products. Outlets for C_3 hydrocarbons are also being studied. By 1980, the production of the following products seems feasible:

5/ Federation of Arab Engineers, Eleventh Session, Models of Industrial Co-ordination, March 1969, p. 377.

6/ LPG had been alternatively planned as a possible raw material for ethylene production. However, the studies undertaken so far indicate that the utilization of natural gas, with its high contents of ethane (20 per cent at Kirkuk), may prove to be more profitable than LPG.

Plastics	as Polyethylene	PVC
Synthetic rubbers	as Polybutadiene	
Synthetic fibres	as Acrylonitrile	Polyamides
Solvents	as Methanol	Chlorinated Hydrocarbons

3. JORDAN

16. The consumption of petrochemicals in Jordan is growing in a manner similar to that of other Arab countries in the Middle East. However, the absence of petroleum resources, despite the passing of petroleum pipelines through the country and the availability of a small refinery, are factors which do not favour the development of basic petrochemical industries. Nevertheless, the installation of plastic processing units, e.g., a polystyrene foam production based on finished petrochemical products, might be a very suitable project during the nineteen seventies. Beyond 1975, styrene and other products may become available from other Middle East countries for use as inputs in various profitable processes serving the home market.

4. KUWAIT

17. With a capacity of approximately 12 million tons of natural gas per year, the construction of a plant for the production of ethylene and other higher hydrocarbons in Kuwait seems to be one of the most important projects expected to be completed in Kuwait by 1975.

18. Considering that one of the objectives of Kuwait's development policy is the production of petrochemical intermediates, further processing into finished products, such as plastics, is to be expected. Some consideration has already been given to the production of aromatics at the refinery of Kuwait Oil Company.1/

19. In the field of synthetic rubber, the shipping of butadiene raw material for purposes of producing polybutadiene in satellite plants should also be expected. Similarly, in the field of synthetic fibres, future production of DMT should be considered as a strong possibility with spinning to be carried out in satellite plants abroad. Since detergents are presently produced at a capacity of 2,000

1/ The capacity of this refinery is 250,000 barrels per day.

tons per year, backward integration involving the production of petrochemical raw materials should be expected by the end of the nineteen seventies.

5. LEBANON

20. In Lebanon, no petroleum resources, such as crude oil or natural gas, exist. Considering the network of pipeline which terminates in the country, however, petrochemical plants, based on crude oil and possibly linked to either of the two existing refineries or to a third new one, could be established. The two existing refineries in Tripoli and Sidon have not made plans for the construction of petrochemical projects for the period 1970-1975. Beyond 1975, a change in policy may take place. In any case, plans for the building of a third refinery are closely linked to petrochemical developments. So far no decision has been made for the construction of the proposed third refinery.

21. The plastics processing industry is more highly developed in Lebanon than in other Arab countries in the Middle East. A new modern cable factory [a joint venture between Lebanese capital (55 per cent) and American and French capital (45 per cent)] started production in January 1969 with an output capacity estimated at between 2,000 to 3,000 tons per year. In addition to the facilities which exist for the establishment of a basic petrochemical industry, Lebanon also enjoys a relatively high degree of technical competence for the establishment of a processing industry.

6. QATAR

22. Natural gas, associated with the on-shore oil deposits in Dukhan, is planned to be used near Umm Said as a raw material for a nitrogenous fertilizer (Urea) plant, with a capacity of 900 tons per day. Also planned in the same location is an industrial zone which might stimulate the establishment of other petrochemical industries.

7. SAUDI ARABIA

23. Saudi Arabia, with a sizeable market comprising a population of approximately 7 million[8] and a vast country of 2.25 million square kilometres, seems to be well suited for the development of petrochemical industries, including the

---

8/ United Nations, World Population Prospects As Assessed in 1963, N.Y., 1966, p. 141, Sales No. 66.XIII.2.

manufacturing of such finished petrochemical products as plastics, synthetic rubber and synthetic fibres.

24. On the basis of present plans for the development of gas processing and fertilizers, it seems likely that by 1975 the establishment of an ethylene plant based on natural gas and with a capacity of 200,000 tons per year, would be completed. The planned PVC project, with an annual production capacity of 60,000 tons, is of great importance to the country since this project will be one of the main consumers of ethylene. However, because of the chlorine requirements for PVC production, the project is directly linked to, and depends on, the exploitation of magnesia resources.

25. A large market is expected to develop for hard PVC tubes and, therefore, a plant producing the whole spectrum of tubes, e.g., for irrigation, water conduction and canalization, may be expected to be erected by the end of 1970 in Dhahran. Within five years, domestic requirements in the country may cause production to rise to 6,000 to 10,000 tons per year.

26. In the field of rubber, the possibility of Saudi Arabia coming into an arrangement for a joint venture with external synthetic rubber producers may stimulate not only the production of petrochemicals but also that of carbon black and rubber tyres.

8. THE SYRIAN ARAB REPUBLIC

27. The Homs Refinery seems to constitute an excellent base for petrochemical development. Should plans for the erection of an aromatics plant be realized by 1975, the Syrian Arab Republic would have an excellent base for producing second and third generations of petrochemicals. Ethylene could be produced out of local gas resources or could be provided from one of the three neighbouring oil-producing countries (Saudi Arabia, Iraq and Kuwait) which, because of the availability and composition of natural gas, are more ideally suited for the production of ethylene.

28. The plastics processing plant at Aleppo may be enlarged so as to produce molded products out of polystyrene and ABS materials. The finished products may become available between 1975 and 1980. In the field of synthetic fibres, polyamides could be expected to become available by the end of the nineteen seventies.

/...

A. Crude oil

29. Crude oil production in the countries reviewed in this study amounted in 1968 to approximately 378 million tons, or to 20 per cent of the world production. The type of crude oil produced is relatively rich in light products and has a high sulfur content.

30. Production cost of crude oil in Kuwait is seven US cents per American barrel compared with an average cost of 20 US cents in the Middle East as a whole, 80 US cents in Venezuela and the USSR and 1.75 US dollars in the United States.[9]

31. Approximately 275 million tons of crude oil, or 75 per cent of the total crude oil produced in these countries in 1967, were exported. Assuming an average price of 15 US dollars per tons of crude oil, the value of crude oil exported in 1967 amounted to 4.1 thousand million US dollars. Yearly revenues from oil in the countries reviewed in this study are in the range of two thousand million dollars.[10]

32. If it could be assumed that an amount equal to the worldwide average of approximately 3 per cent of crude oil production is processed into petrochemicals, the future target for these countries would be the utilization of approximately 10 million tons of crude oil as a base for petrochemicals.

33. The value of 60,000 tons of petrochemicals actually imported into the Middle East at present amounts to approximately 15 million US dollars. This estimate is based on an average cost of 25 US cents per kilogramme, as derived from a study undertaken by Professor Horn of Farbwerke Hoechst on the cost of petrochemical production (see table 1).[11]

34. According to these estimates, the average cost of 300,000 tons of petrochemicals, envisaged as the quantity required to satisfy the demand of the countries covered in this study in 1980, amounts to 75 million US dollars.

9/ Helmut Frank, Crude oil prices in the Middle East, a Study in Oligopolistic Price Behaviour, Praeger, 1966, p. 144.

10/ OPEC Annual Stastical Bulletin (1968) Vienna 34, page 15.

11/ F. Asinger "Was die Petrolchemie vermag", Erdöl, Erdgas Zeitschrift (1963) 6, pp 101 - 110, Urban Verlag, Vienna.

Table 1. Average prices of crude oil, natural gas and petrochemical products

Prices (US dollars/kilogramme)	Petrochemical products
0.01-0.02	Crude oil, natural gas
0.05-0.07	Toluene, propylene, ethylene, orthoxylene, benzene
0.15-0.18	Styrene, p-xylene, butadiene
0.20-0.25	PVC, polyethylene (LD), polystyrene, phthalic -anhydride, acrylonitrile
0.30-0.36	Polyethylene (HD), styrene-butadiene-rubber
0.40-0.46	Polypropylene, cis-polybutadiene, polyisoprene, caprolactam

B. Natural gas

35. The production and flaring of natural gas is shown in table 2 below:

Table 2. Production and flaring of natural gas in Selected Countries in the Middle East, 1966, 1975 and 1980

	Per cent flared	Production (thousand million cubic metre) 1967 (actual)	1975 (estimated)	1980 (estimated)
IRAQ	93.0	5.4	9.0	12.0
KUWAIT	64.0	13.5	18.0	20.0
QATAR	85.0	0.5	n.a.	-
SAUDI ARABIA	69.0	15.7	18.0	20.0
SYRIA	n.a.	n.a.	4.0	6.0

36. At present, the total quantity of flared gas amounts to more than 30 billion m^3 per year (see table 2). On the basis of prices prevailing in the European market, i.e., approximately two US cents per m^3, 600 million US dollars worth of natural gas is being flared annually. Since the production of oil is likely to increase in the future, the quantity of flared gas is also likely to increase even more than the present levels if no new outlets are found for the utilization of natural gas during the nineteen seventies.

/...

37. The high contents of ethane (12-22 per cent or approximately three million tons derived from the natural gas produced in these countries) is very favourable for the production of ethylene and other petrochemical products. By converting the ethane contents to ethylene and other derivatives which have, for example, an average price of 25 US cents per kilogramme, the contribution which this conversion makes to the value of petrochemical products might exceed the original value by tenfold. An example for the average composition of natural gas in this region is given in the following:

Average composition of natural gas (total 100 per cent)

nitrogen	0.5 %mol	0.2 %wt	ethane	18.5 %mol	22.0 %wt
carbon dioxide	8.5 %mol	14.0 %wt	propane	9.5 %mol.	15.2 %wt
hydrogen sulphide	1.5 %mol	1.9 %wt	butanes	3.5 %mol	7.3 %wt
methane	55.5 %mol	32.0 %wt	C_5 + C_6's	2.5 %mol	7.4 %wt

38. In the projections of the development of petrochemicals industry attempted in this paper, the establishment of a natural gas cracking plant with a capacity of 150,000 tons of ethylene is envisaged (design study: appendix page 42). On the basis of the calculations made in the previous paragraph, this plant will be capable of producing ethylene valued at approximately 37.5 million US dollars. Several other petrochemical plants based on the use of this extremely cheap raw material as e.g. for methanol production, exist in the region.

39. Besides hydrocarbon, the presence of sulphur in natural gas is of economic importance. Sulphur extracted from natural gas serves as a raw material for the production of sulphuric acid. Saudi Arabia, Kuwait and Iraq have sulphur extraction plants, producing at present approximately 560,000 tons of sulphur, whose value, considering a sulphur price of 45 US dollars per tons, is estimated at 25.3 million US dollars. Should sulphur prices remain constant during the nineteen seventies, additional production capacities may be established in the region.

40. In addition to the loss of energy resulting from the flaring of natural gas, air pollution by SO_2 constitutes a constant danger to health in the region. Studies on transportation and storage of liquid natural gas have been undertaken. In Iraq, for example, a study involving the construction of a pipeline system connecting the oil fields with the sea, two storage and two liquifaction plants, shipping facilities and a network of pipelines for transporting liquid gas to consumers has already been commissioned. It is hoped that the extremely low selling price of natural gas (five US cents for 1000 ft^3) may serve as an incentive for increasing the utilization of this raw material in the region.

3. Transportation (pipelines and shipping)

41. A large network of pipelines exists in the Middle East region. Besides crude and product pipelines, several natural gas pipelines also exist and an additional number is under construction. The following are the major crude

oil pipelines in the region:

the Tapline extending from the large oil fields in Saudi Arabia to Saida, Lebanon (1,213 kilometers);

the IPC pipelines extending from Kirkuk in Iraq to Tripoli, Lebanon (855 kilometers), and to Banias, Syria (870 kilometers);

a pipeline extending from Kirkuk to the Gulf, near Basra; and,

a pipeline extending from the Syrian oilfields to Homs and Tartus on the Mediterranean.

42. In addition, two product pipelines extend from the Homs refinery in Syria to Damascus, and a gasoline pipeline attached to a natural gas pipeline connects the Kirkuk oil fields to the Taji plant in the vicinity of Baghdad. Also envisaged is the construction of a natural gas pipeline extending from Iraq to Turkey.

43. In Saudi Arabia, a 14 inch natural gas pipeline destined to supply the power plant in Riyadh with gas from the East Coast is in the planning stage. Since no pipeline connection exists between the oil fields in the Eastern Province and the Jeddah refinery in Saudi Arabia, ships are being used for transporting crude oil from the East coast to the West coast of the country. For the time being and until such time when the construction of an oil pipeline for the planned refinery in Riyadh is completed, crude and fuel oil are transported by trucks and railcars to the capital of Saudi Arabia.

44. On the whole, these countries may be regarded as being relatively well developed in regard to the existing network of pipelines, these being the cheapest means of transporting large quantities of petrochemical raw materials.

D. Refining

45. Of the total quantity of crude oil produced in 1967, amounting to 363 million tons, 42 million tons, or 11 per cent of total crude oil production, was refined. A total of 18 refineries are located in the region with a capacity of 50 million tons throughput of crude oil. Although no ethylene or aromatics are produced with existing refining facilities, the technical rating of these refineries is nevertheless high.

/...

46. Out of approximately 42 million tons of crude oil throughput, the breakdown of refinery products in 1967 were as follows:

Table 3. Refined petroleum products in Selected Countries in the Middle East, 1967

(thousand tons)

	Production	Exports	Imports	Consumption
Fuel oil	26,000	20,000	-	6,000
Gasoline	4,400	3,800	900	1,500
Kerosene	3,800	3,000	-	800
Gas and diesel oil	9,000	5,000	-	4,000
Lubricating oil	25	9	104	120
Bitumen	345	37	-	308
Total	43,570	31,846	1,004	12,728

47. Future consumption of crude oil is estimated in the table below:

Table 4. Actual consumption for 1965 and estimates of future crude oil consumption in Selected Countries in the Middle East

(millions of tons)

	1965 (actual)	1970	1975 (estimates)	1980
IRAQ	2.80	5.10	6.40	7.70
JORDAN	0.40	0.40	0.50	0.60
KUWAIT	12.80	23.00	29.00	35.00
LEBANON	1.50	1.80	2.30	2.90
QATAR	0.03	0.03	0.04	0.05
SAUDI ARABIA	16.10	18.20	22.80	27.20
SYRIA	1.00	1.10	1.40	1.60
Total	34.03	51.03	63.04	75.05

Source: Federation of Arab Engineers, the Eleventh Session, the Arab Industrial Map, Kuwait, 1969, Part I, p.129.

/...

48. The expected rise in oil consumption during the nineteen seventies indicates not only that new refineries will be built, but that each refinery constructed would be associated with the construction of new petrochemical installations.

E. Energy

49. Considering future developments in petrochemicals in the region, the generation of electric power is important for two reasons: a) as part of the improvement of the overall situation regarding energy resources, and, b) as a source of energy for the operation of petrochemical plants. Thus, electric power is a basic element for the development of an industrial area such as the Shuaiba Industrial Complex in Kuwait.

50. Appendix table III shows that the amount of electric energy produced in these countries is relatively low despite the excellent facilities afforded by the availability of cheap natural resources.

F. Fertilizers

51. The only petrochemical industry which exists in the countries covered in this study is the fertilizer industry. While no attempt is made to analyse the fertilizer industry in detail in this paper, the presentation of some basic figures on production and consumption of fertilizers seems desirable. At this point, it should be stressed that an evaluation of existing plans for petrochemical production in the Middle East shows that, while fertilizers have been given precedence over petrochemicals, the fertilizer industry was inevitably chosen as a first stage in the process of petrochemical development.

52. Considering that world production of fertilizers amounted to 37 million tons in 1965 and that 70 million tons will be needed in 1980, countries in the Middle East should be able to play an important role in the production of fertilizers. Consumption of fertilizers by the developing countries alone is expected to rise between 1960 and 1980 from four million tons to 30 million tons of nitrogenous fertilizers (urea sulfates and nitrates of ammonia). This constitutes roughly 50 per cent of the total world production of fertilizers.

53. Actual production of nitrogenous fertilizers in Iraq, Kuwait, Saudi Arabia and Syria is as follows (see also appendix table II).

/...

Table 5. Present and future production capacity of nitrogenous fertilizers in Selected Countries in the Middle East

(in metric tons)

	Existing	Under construction	Planned for 1970
IRAQ		120,000 $(NH_4)_2SO_4$ 50,000 Urea	
KUWAIT	130,000 NH_3 150,000 $(NH_4)_2SO_4$ 150,000 Urea		250,000 NH_3 445,000 Urea
SAUDI ARABIA		200,000 NH_3 330,000 Urea	
SYRIA		150,000 NH_3 Various mixed fertilizers	

Source: Kuwait Chemical Fertilizers Company; National Development Plans of Kuwait, Iraq, Saudi Arabia and Syria.

54. On the basis of actual consumption of nitrogenous fertilizers, the future needs of the countries enumerated in table 6 are expected to rise to the levels indicated in the same table.

Table 6. Actual and future consumption of nitrogenous fertilizers in Selected Countries in the Middle East

(In metric tons of N.)

	1965 (actual)	1970	1975	1980
IRAQ	2,500	5,000	9,700	25,000
JORDAN	1,800	3,600	7,400	23,000
KUWAIT	-	-	-	-
LEBANON	10,000	20,100	39,000	68,000
SAUDI ARABIA	-	46,000	110,300	176,000
SYRIA	12,800	25,900	52,000	89,000
Total	27,100	100,000	218,400	381,000

Source: Federation of Arab Engineers, Industrial Arab Map and the Possibility of Industrial Coordination, Eleventh Session, Kuwait, 1969, pp.86-87.

/...

55. The production and consumption figures given in tables 5 and 6 above indicate that anticipated future domestic consumption of fertilizers will continue to constitute only a small fraction of the total production planned in these countries. The target for fertilizers is, therefore, primarily an export one. Nevertheless, the process itself, being a first stage in the development of petrochemicals, is likely to make the production of new petrochemical products proceed more smoothly in the future. Furthermore, the use of methane for fertilizers may stimulate the utilization of the ethane fraction of natural gas for petrochemicals.

III. TENTATIVE PROJECTIONS OF THE DEVELOPMENT OF THE PETROCHEMICALS INDUSTRY

A. Markets for petrochemicals

56. Since finished petrochemical products and petrochemical raw materials are not produced in the Arab countries of the Middle East at present, plastics, synthetic rubber and synthetic fibres have to be imported. The market for petrochemicals may, therefore, be characterized by: a) imports of raw materials for the processing industry, b) imports of semi-finished and end-products; and, c) production in the form of processing.

57. Future market developments in the field of petrochemicals depend essentially on three interdependent factors: a) growth in population; b) growth of industries, and, c) future rises in the living standards of the population.

58. The estimated growth rate of the population in a selected number of countries in the Middle East for the period covering the nineteen seventies is given in table 7 below:

Table 7. Actual population figures for 1965 and estimates of population growth for 1970, 1975 and 1980

(Thousands per cent)

	1965 (actual)	1970	Rate of growth	1975	Rate of growth	1980	Rate of growth
IRAQ	8,200	9,700	3.4	11,500	3.5	13,800	3.5
JORDAN	2,000	2,350	3.3	2,800	3.4	3,350	3.5
KUWAIT	474	660	6.8	848	6.0	1,035	5.3
LEBANON	2,050	2,350	2.8	2,700	2.8	3,100	2.8
SAUDI ARABIA	6,750	7,450	2.0	8,350	2.1	9,400	2.2
SYRIA	5,500	6,450	3.2	7,700	3.4	9,250	3.5
Total	24,974	28,960	3.0	33,898	3.1	39,935	3.2

Source: United Nations, World Population Prospects as Assessed in 1963, N.Y., 1966, p.141, Sales No. 66.XIII.2.

/...

59. Based on existing development plans and on projections undertaken by the United Nations Economic and Social Office in Beirut,[12] estimates of future growth in aggregate income and in income generated in each of the oil and manufacturing sectors are given in table 8. Also given in the same table are estimates of the expected rise in the contribution of the oil and manufacturing sectors to national product (see also appendix table IV).

Table 8. Index of growth of national income and of income originating in the oil and manufacturing sectors, 1966-1980, and contribution of oil and manufacturing sectors to national income

(base = 1966, per cent)

	Index			Contribution to income			
	National income	Income originating in		Oil sector		Manufacturing sector	
		oil sector	manufacturing sector	1966	1980	1966	1980
IRAQ	195[a]	261	437	21.8	24.3	10.6	23.6
JORDAN	198[a]	-	264	-	-	10.7	14.4
KUWAIT	241[b]	223	290	68.9	67.0	13.5	17.1
LEBANON	198[b]	-	385	-	-	14.0	27.0
SAUDI ARABIA	317[c]	261	385	55.6	45.5	2.4	2.9
SYRIA	208[d]	-	380	-	-	11.1	21.5

Source: Data compiled and computed by United Nations Economic and Social Office in Beirut.

a/ NNP at factor cost.

b/ GNP at factor cost.

c/ GDP at current prices.

d/ GDP at 1963 prices.

60. The estimated consumption of petrochemicals in 1970, 1975 and 1980 has been based partly on projected growth in population and income and partly on expected expansion in the utilization and application of plastics, synthetic rubber and synthetic fibres. In general, per capita consumption of petrochemicals is expected to rise from its present level of 2 to 3 kilograms to 6 to 10 kilograms by 1980. The assumption made here is that the consumption of petrochemicals will follow the 1950 - 1960 world pattern, i.e. doubling of consumption every five years.

12/ See UNESCO, Studies on Selected Development Problems in Various Countries in the Middle East, 1968 and 1969, Sales No. E.69.II.C.4 and E.69.II.C.5

1. Plastics

61. In the field of thermoplastics, one of the main activities is the processing of PVC into footwear products. PVC is also used in the production of bags, cables, tubes, floor tiles, artificial leather and similar articles. Copolymers are used in the production of phonograph records. Toys are injection molded. Polyethylene is used in the production of bags for which a large market exists for the packaging of fertilizers for export and of films. Fertilizer production involves the use of plastics in packaging, either in the form of plastic bags or in jute bags with inner layers of plastics. Bags containing 50 kilogrammes each are used for fertilizer packaging. The full plastics bag weighs 250 grammes and the polyethylene inner layer bag of the jute combination weighs 90 grammes. Anticipated future packaging of approximately 1,500,000 tons of nitrogenous fertilizer would, therefore, require the following quantities of plastics: 7,500 tons of polyethylene (polypropylene, PVC) in the first case, or 1,500 tons of polyethylene in the second. These figures are based on the assumption that only 60-90 per cent of total expected production of nitrogenous fertilizers will be packaged in plastic bags. Further, the packaging of approximately 80 per cent of other fertilizers (phosphatic) will consume several additional thousands of tons of plastics. Besides the blow molding of bags, the processing of "web bags" made out of monoaxially stretched filament has been started. Moreover, polyethylene foils are used in agriculture. Kitchenware is injection molded and thermoforming is applied for packaging articles, crates, etc.. Polystyrene is extruded in the form of sheets. The sheets are thermoformed by the application of vacuum methods into refrigeration, housings and doors. Several other different articles, e.g. kitchenware, are injection molded in several countries. The construction of polystyrene foam plant is being considered in Jordan. The foam would be used for the packaging of fruits and vegetables for export.

62. In the field of thermosetting resins, a small market exists for phenol-formaldehyde resins. Amine-formaldehyde resins are used as glues and for impregnation. Melamin-formaldehyde resins are molded into tableware. Polyurethane foams produced out of the monomers are used for the manufacturing of mattresses and pillows. Polyester and epoxy resins are used for coatings in the building industry. All types of finished plastics articles and semi-finished formica sheets used by the furniture industry are at present imported.

/...

63. An evaluation should be made of the cost of domestic processing of petrochemical raw materials in relation to the value of imported plastic articles. Such an evaluation is of particular importance since the processing of plastics is at present undertaken in almost all the countries covered in this study, and since a number of new projects exists not only for the molding of thermoplastics but also for the processing of thermosetting resins.

2. Synthetic rubber

64. A few rubber processing small plants exist in some of these countries for the production of various articles, such as tubes, and for tyre remoulding but not for the manufacturing of rubber tyres. The construction of tyre plants is being planned, however, in Iraq, Saudi Arabia and Syria.

65. Table 9 below may give some guidelines for the establishment of tyre factories.

Table 9. Actual imports for 1965 and estimated imports (and consumption) of rubber tyres in Selected Countries in the Middle East[a] for 1970, 1975 and 1980

(metric tons, per cent)

	1965 (actual)	1970	Rate of growth	1975	Rate of growth	1980	Rate of growth
IRAQ	4,600	5,954	5.4	7,857	5.5	10,270	5.5
JORDAN	2,000	2,589	5.3	3,384	5.4	4,465	5.5
KUWAIT	1,100	1,677	8.8	2,375	8.0	3,165	7.3
LEBANON	3,300	4,172	4.8	5,274	4.8	6,667	4.8
SAUDI ARABIA	5,700	6,935	4.0	8,519	4.1	10,566	4.2
SYRIA	3,500	4,510	5.2	5,922	5.4	7,814	5.5
Total	20,200	25,967	5.0	33,331	5.1	42,947	5.2

Source: Data for 1965 obtained from the Federation of Arab Engineers, The Industrial Arab Map and the Possibilities for Industrial Co-ordination among Arab Countries, 1969, p.54.

a/ Estimates of rubber tyre consumption for the period 1970-1980 were calculated on the basis of a constant rise in consumption of two per cent per year in addition to the rate of population growth.

/...

3. Synthetic fibre

66. Imports of woven fabrics of man-made fibres (BTN Classification 51.04) by a selected number of countries in the Middle East for the 1959-1966 period is given in table 10 below:

Table 10. Imports of woven fabrics of man-made fibres by Selected Countries in the Middle East, 1959-1966

Year	IRAQ (1,000m²)	JORDAN	KUWAIT	LEBANON	SAUDI ARABIA	SYRIA[a/]
		(kilogrammes)				
1959	16,616	612,020	32,276	195,137	2,853,832	56,000
1960	23,251	1,632,961	61,034	247,603	3,405,627	15,000
1961	19,741	1,701,338	74,914	304,156	3,516,293	14,000
1962	21,010	1,922,322	125,517	393,253	2,193,805	69,000
1963	15,665	1,823,026	370,886	410,127	3,251,268	17,000
1964	14,851	1,988,289	166,228	382,414	4,774,968	33,000
1965	12,102	2,363,256	92,540	448,408	n.a.	40,000
1966	18,703	2,682,239	184,771	592,112	n.a.	28,000

Source: National Foreign Trade Statistics.

a/ Compared to other countries in the Middle East, Syria's imports of synthetic woven fabrics are extremely low because Syria's textile industry has already achieved a relatively high degree of development.

67. On the basis of these import figures and of past rates of growth in national income, estimates of future consumption of synthetic fabrics were arrived at through regression analysis.

68. For Jordan and Saudi Arabia, the correlation between imports of synthetic woven fabrics (BTN Classification 51.04) and national income is given in the following linear equations:

/...

Jordan[13/] $M_J = -613.4 + 19.9\ Y_J$ $R^2 = 0.78$

Saudi Arabia[14/] $M_{SA} = 122.1 + 0.783\ Y_{SA}$ $R^2 = 0.92$

where:

M_J = imports of synthetic woven fabrics in tons,

Y_J = net national product (at factor cost) in millions of Jordanian dinars,

M_{SA} = imports of synthetic woven fabrics in tons,

Y_{SA} = gross national product in millions of Saudi riyals.

69. The income elasticities of imports (and consumption) of synthetic woven fabrics derived from the historical trend was found to have the following range:

Jordan	1.552	-	1.236	(decreasing over time)
Saudi Arabia	0.960	-	0.970	(increasing over time)

70. In Iraq, the historical data for imports of synthetic woven fabrics are not sufficiently consistent to allow their use for the derivation of the necessary coefficients and elasticities. Instead, a relatively high degree of correlation was found to exist between imports of unornamented nylon textiles (BTN classification 51.04A) and net national product (at factor cost). This correlation is given in the following linear equation:[15/]

$M_I = -541.4 + 2.63\ Y_I$ $R^2 = 0.63$

where:

M_I = imports of unornamented nylon textiles in thousands of square meters,

Y_I = net national product (at factor cost) in millions of Iraqi dinars.

13/ The correlation between imports of synthetic woven fabrics and net national product (at factor cost) for Jordan covers the period 1959-1966.

14/ The correlation for Saudi Arabia covers the period 1379-1384 Hejirah (equivalent to 1959-1964).

15/ The correlation for Iraq covers the period 1956-1966.

/...

71. Accordingly, the income elasticities of Iraq's imports of unornamented nylon textiles derived from the above correlation was found to have values ranging between 2.885 and 1.453 (decreasing over time).

72. On the basis of these results and of projections of future rises in national income,[16] future imports (and consumption) of synthetic woven fabrics in Jordan and Saudi Arabia and of unornamented nylon textiles in Iraq were projected as follows:

Year	JORDAN[a]	SAUDI ARABIA[a]	IRAQ[b]
	(tons)		(1000 m^2)
1966 (actual imports)	2,682	5,281	1,577
1970	3,195	7,299	1,570
1975	4,257	10,963	2,141
1980	5,603	16,499	2,864

a/ Synthetic woven fabrics (BTN Classification 51.04)

b/ Unornamented nylon textiles (BTN Classification 51.04A)

73. It should be emphasized that developments in the petrochemical industry in a number of countries in the Middle East might have the effect of influencing future patterns of consumption, including those of synthetic fibres. A number of factors, such as anticipated changes in the relative prices of synthetic fabrics and their substitutes, government policies with respect to the petrochemical industry and possible future changes in tastes and preferences of consumers, might all exert an upward pressure on the demand for synthetic fabrics. In such a case, the income elasticities might rise to levels higher than those calculated from historical trends.

74. Using the above conclusions for deriving a rough approximation of future rises in the total annual consumption of synthetic woven fabrics in Iraq, Jordan, Kuwait, Lebanon, Saudi Arabia and Syria, total consumption in 1980 may be conservatively estimated at 33,000 tons.

16/ See UNESCWA, Studies on Selected Development Problems in Various Countries in the Middle East, 1968 and 1969, Sales Nos. E.69.II.C.4 and E.69.II.C.5.

75. On the basis of the discussions presented in the previous paragraphs, the total quantities required to satisfy the immediate needs of users of petrochemicals are estimated in Table 11 for the years 1970 1975, and 1980 as follows:

Table 11: Estimated consumption of petrochemicals and their application in selected countries in the Middle East in 1970, 1975 and 1980[a/]

Raw Material	Application	1970	1975 (tons/year)	1980
Plastics				
Polyethylene(low density)	Packaging for fertilizers and other applications	25,000	50,000	75,000
Polyporpylene	Injection molding materials(kitchenware, toys, etc)	5,000	10,000	20,000
PVC	Cables, pipes, tubes floor tiles etc.	15,000	30,000	60,000
Polystyrene and copolymers	Refrigerators, housings, washing machines	5,000	10,000	30,000
Polyurethane	Mattresses & cushions	5,000	10,000	15,000
Phenolformaldehyde resins	Mouldings, impregnation	-	5,000	10,000
Amino-formaldehyde resins	Glueing & moulding	-	10,000	20,000
Unsaturated polyester resins	Construction, transportation, storage tanks		5,000	10,000
Synthetic Rubber				
SBR & polybutadiene	Tyres, technical articles	25,000	40,000	50,000
Synthetic Fibres				
Acrylonitrile	Textile industry	1,000	3,000	7,000
Polyamide		2,000	5,000	15,000
Polyester		2,000	5,000	15,000
		85,000	183,000	327,000

a/ Includes Iraq, Jordan, Kuwait, Lebanon, Saudi Arabia and Syria. It should be related that the estimated present consumption of petrochemicals in these countries is 60,000 tons per year.

b/ The above table includes the consumption of finished goods made from the raw material concerned regardless of whether the raw materials have or have not been processed in the area.

B. Projected developments

76. Based on the previous analysis and on relevant data collected in the countries reviewed, the development of main petrochemical products (at minimum profitable plant capacities) during the nineteen seventies may be projected as follows for these countries:

1970-1975 period:

Suggested new production capacity for petrochemicals:

First generation:

Ethylene	150,000 tons
Methanol	30,000 tons

Second and tertiary generation:

Plastics

Low density polyethylene	75,000 tons
Polypropylene	20,000 tons
PVC	30,000 tons

Polymerization plants

Polyvinyl acetate	10,000 tons
Polystyrene and moulding powder	20,000 tons
Synthetic Rubber 1-4cis polybutadiene	50,000 tons

Synthetic Fibres

Acrylonitrile (monomer)	30,000 tons
Polymerization and spinning plant for polyacrylonitrile fibres	10,000 tons
Polymerization + spinning plant for polyester fibres	15,000 tons
ESTIMATED CAPITAL COSTS	150 million US$

77. In the 1970-1975 period, the production of ethylene based on natural gas is expected to start. At the same time, facilities for production of petrochemicals based on ethylene and higher hydrocarbons should be expected because of higher profitability. The export of ethylene may also become possible during this period.

78. Considering the countries reviewed as a whole, no attempt has been made in this paper to suggest geographical distribution of industrial enterprises and other locational problems. Nevertheless, it should be emphasized that Iraq, Kuwait and Saudi Arabia each produces sufficient quantities of natural gas containing the necessary amount of ethane (12-24 per cent) for the production of ethylene and other unsaturated higher hydrocarbons at a lower cost (60-85 per cent of the costs of producing ethylene out of naphtha) than in Europe and other parts of the world.

1975-1980 period:

Suggested new production capacity for petrochemicals: (tons/year)

First generation:

Ethylene additional	30 - 50.000 tons
Aromatics	120,000 tons
Benzene	
Toluene	
Xylene	

Second and tertiary generations:

Plastics	
Polystyrene	20,000 tons
PVC	30,000 tons
Combined resins production plant	
phenol formaldehyde urea formaldehyde melamine formaldehyde	30,000 tons
Unsaturated polyester resins	10,000 tons
Synthetic Fibres	
D.M.T. (monomer)	28,000 tons
Caprolactam (monomer)	30,000 tons
Polyamide polymerization + spinning plant	15,000 tons
ESTIMATED CAPITAL COSTS	150 million US$

79. On the assumption that in the second period (1975-1980) an ethylene plant and several follow-up products would be established, cross fertilization between intermediates and finished raw materials is likely to take place. Because of this it should become necessary to produce aromatics during this period.

1975-1980 period:

Suggested new production capacity for petrochemicals:

First generation:

Aromatics:	150,000 tons
Benzene	
Styrene	
Xylene	

Second and tertiary generations:

Plastics:	
Formaldehyde	20,000 tons
Phenolar and amino resins	20,000 tons
Unsaturated polyester	10,000 tons
Synthetic rubber	
Polybutadiene	60,000 tons
Synthetic fibres:	
Polyester fibres	15,000 tons
Polyamide fibres	20,000 tons
ESTIMATED CAPITAL COSTS	150 million US $

80. On the assumption that in the second period (1975-1980) an ethylene plant and several follow-up products would be established, cross fertilization between intermediates and finished raw materials is likely to take place. Because of this, it should become necessary to produce aromatics during this period.

/...

IV. SUGGESTIONS FOR POSSIBLE ACTION

A. Action at the national level

81. The guidelines presented in this paper for petrochemical developments in selected countries in the Middle East during the nineteen seventies were framed taking into account the absorptive capacity of the region and the world pattern of industrial development.

82. Should some production of petrochemicals, as suggested in this study, become a reality by 1975, the marketing and distribution of petrochemical products within the countries reviewed could conceivably be based on some type of a customs arrangement.

83. To facilitate the exchange of processed petrochemical products in the region, quality standards, which already exist for some articles, will have to be established. New standards should be established by national institutes having testing facilities; and processing firms should be encouraged to apply the results of the research and testing work of these institutes for optimal quality of production.

84. Scientific and petroleum institutes exist in almost all the countries considered. These institutions should be developed further so that they can become an effective instrument for the promotion of national research and development in the field of petrochemicals.

B. Action at the regional level

85. The projections presented in this paper, for the nineteen seventies (the United Nations Second Development Decade) have been based on the present state of industrial development in these countries and may provide guidelines for the development of a petrochemical policy. The production of ethylene and aromatics, to be established at a suitable time, should provide opportunities for the development of a petrochemical industry. A complex for the production of about 20 intermediates and finished products should be created. Several of these intermediates, such as ethylene, butadiene, vinylchloride, DMT, and caprolactam, could be shipped for marketing abroad.

/...

86. The need for the development of a petrochemical policy was expressed at the Symposium on Industrial Development in the Arab Countries, which was held in Kuwait in March 1966. At this Symposium, it was emphatically stated that "any lapse of time will undoubtedly render the situation more difficult to overcome". The League of Arab States was urged to take, among other things, the necessary steps for the setting up of an "appropriate panel of scientists and technical specialists of recognized standing and experience in various fields".[17]

87. During the nineteen seventies, the flaring of natural gas is expected to be reduced substantially as a result of the anticipated rise in the consumption of gas for petrochemical and fertilizer production, especially in the new ammonia and urea plants in Kuwait and Saudi Arabia, and the expected increase in the shipping of liquefied gas and pipeline transportation of gas.

88. It is important that the project involving the construction of the natural gas pipeline between Iraq and Turkey be realized. The use of natural gas for the generation of power for industrial purposes is conceived on a wider scale so that by 1980 a utilization factor of 60 per cent of the natural gas produced in the countries reviewed could be realized.

89. Investments in the range of 300 million US dollars seems to be necessary for petrochemical developments during the nineteen seventies. By the end of the seventies, the estimated value of the annual output needed to satisfy the growing consumption of petrochemicals in the countries reviewed, is likely to be in the range of 600 to 800 million US dollars.

17/ United Nations, Report of the Symposium on Industrial Development in Arab Countries, Kuwait, 5 to 10 March, 1966, N.Y., 1967, ST/CODF/H.R/4 and UNIDO, Petrochemical Industries Development in the OPEC and other Arab Countries, paper presented to the Kuwait Symposium, 1966, CID.C.KUW/II/OPEC-29.

APPENDIX TABLES

Table I: Reserves, production and consumption of crude oil and natural gas, percentage of gas flared, and number of refineries and their capacities in Selected Countries in the Middle East, 1968

Country	Crude oil[a]		Natural gas[b]				Number of refineries	Capacities (million tons)
	Reserves (million tons)	Production (million tons)	Production	Reserves (thousand billion m^3)	Consumption	Flared (per cent)		
ABU DHABI	2,400	24.0	3.9	2.0	0.4	93		
BAHRAIN	28	3.7	0.20	2.60	n.a.	n.a.	1	10.0
IRAQ	3,700	74.0	5.4	566.3	0.4	93	6[c]	4.0
JORDAN	-	-	-	-	-	-	1[d]	0.4
KUWAIT	9,500	120.0	13.5	1,107	4.8	64	4[e]	18.0
K (neutral zone)	2,190	24.0	n.a.	n.a.	n.a.	n.a.	2	4.0
QATAR	500	16.5	3.5	206.7	0.5	85	1[f]	-
LEBANON	-	-	-	-	-	-	2	1.8
SAUDI ARABIA	10,352	140.0	15.7	1,217.6	4.9	69	2	14.0
SYRIAN ARAB REPUBLIC	200	1.0	n.a.	3.20	-	-	1	2.0

a/ Figures from OPEC (Orgnization of the Petroleum Exporting Countries) Statistics Chart, Vienna, Austria

b/ Figures from B.P. Information Department, Hamburg, FRG

c/ Produces LPG

d/ At Zarqa

e/ Two at Ahmadi with a capacity of 7 million tons (LPG). One at Mina Abdullah with a capacity of 3.5 million tons. One at Shuaiba with a capacity of 3 million tons of hydrogen.

f/ Topping plant.

TABLE II

Proposal for an economic cracking plant based on natural gas

An economic size would be some 1 million tons/annum of natural gas. This will contain:

nitrogen	2,000 tons
carbon dioxide	140,000 tons
sulphur	20,000 tons
methane	304,000 tons
ethane	220,000 tons
propane	150,000 tons
butane	70,000 tons
C_5 and C_6's	74,000 tons
	980,000 tons

On removal of nitrogen, sulphur(as hydrogen sulphide) and carbon dioxide and cracking the following yields are expected:

methane	304,000 tons
ethylene	160,000 tons
propane	150,000 tons
butane	70,000 tons
liquid hydrocarbons C_5+	74,000 tons

The butane fraction can be transformed into 50,000 tons butadiene by catalytic dehydrogenation. The butadiene could be polymerized to 1:4 cis polybutadiene. Alternatively the C_4 and C_5+ fraction could be cracked yielding 90,000 tons of propylene, sufficient for 40,000 tons acrylonitrile and 20,000 tons polypropylene.

The methane, together with some propane if desired, could be used for the production of synthesis gas and hence ammonia (350,000 - 400,000 tons/annum output).

This outlines a petrochemical complex based on natural gas containing a substantial quantity of C_2, C_3 and C_4 etc. hydrocarbon.

The ethylene should be used for polyethylene (75,000 tons), PVC (60,000 tons) and styrene etc. (20,000 tons).

The propane could be liquified and used as natural gas.

Table . Existing and planned sulfur, fertilizer and carbon black plants in Selected Countries in the Middle East

(In tons per year)

Country	Sulfur production		Fertilizer production		Carbon black production
	Existing	Planned	Existing	Under construction	Planned
BAHRAIN					
IRAQ	120,000	+		120,000 $(NH_4)SO_4$ 50,000 Urea	
JORDAN			360,000 Phosphate		
KUWAIT	235,000	+	130,000 NH_3 150,000 $(NH_4)_2SO_4$ 150,000 Urea	250,000 NH_3 445,000 Urea	
QATAR				300,000 NH_3 (Planned)	
LEBANON			13,300 (P_2O_5)		
SAUDI ARABIA	200,000 Natural gas		30,000 ammonium sulfate 22,000 Ammonium and calcium nitrate 83,000 complex fertilizers	200,000 NH_3 330,000 Urea	5,000 Natural gas 1976-1977
SYRIA		At Homs refinery		150,000 NH_3 Various mixed fertilizers	

Table .. . Estimated and projected production of electric power in Selected Countries in the Middle East

Country	Power generated million kkwh 1968	Average per capita consumption kwh/year 1968	Estimated maximum capacity 1968 (mega-watts)	1975	1980	Average annual increase in capacity per cent	Installed capacity in generator stations (mega-watts) Existing	Planned	High voltage of distribution lines (KV) Existing	Planned	Length of distribution lines (km) Existing	Planned
Iraq	1,900	3.4	400	900	1,500	12	560 + (140)	430	132	220	1,640	410
Jordan	200	100	50	130	175	15	60 + (10)	118	-	132	-	300
Kuwait	2,100	4,200	460	2,000	4,000	20-25	1,100 + (100)	4,000	132	-	150	530
Lebanon	1,000	417	210	400	650	10	350	420	66	150	400	150
Syria	700	127	122	300	500	12.5	164 + (90)	910	230/66	-	310	1,000
Total	5,900		1,242	3,730	6,825		2,234 + (340)	5,878	560	502	2,500	2,390

Source: The Federation of Arab Engineers, "Electricity in Arab Countries", Eleventh Session, 19[illegible], page 102.

Table V. National Income and Income Originating in Oil Sector and Manufacturing Sector, and per capita income in Selected Countries in the Middle East

Country	National income[f]		Income originating in				Per capita income	
			Oil sector		Manufacturing sector			
	1966	1980	1966	1980	1966	1980	1966	1980
IRAQ[a]	663	1,295	145	379	70	306	218	263
JORDAN[a]	158	312	-	-	17	45	213	260
KUWAIT[b]	607	1,391	418	932	82	238	3,136	3,763
LEBANON[b]	3,695	7,316	-	-	511	1,965	561	755
SAUDI ARABIA[c]	12,218	38,781	6,794	17,654	296	1,140	390	907
SYRIA[d]	4,042	7,890	-	-	447	1,697	185	222

Source. Data compiled and computed by UNESCOB.

a/ NNP at factor cost.

b/ GNP at factor cost

c/ GNP at current prices.

d/ GDP at 1963 prices.

e/ Converted on the basis of present exchange rate.

f/ In millions of national currencies.

g/ In US dollars.

/...

Table VI. Population, area, energy (maximum capacity) petrochemical imports and water availability in Selected Countries in the Middle East

Country	Population[a] 1966 (thousands)	Area[b] (square kms.)	Energy[c] (maximum capacity, 1968) (mega watts)	Petrochemical imports 1966 (tons)	Water availability[d]
BAHRAIN	193	598	n.a.	n.a.	-
IRAQ	8,478	445,000	400	10,000	Euphrates Tigris
JORDAN	2,066	90,000	50	6,000	Jordan river 450 million m^3
KUWAIT	506	16,000	460	10,000	Distilled water, Brakisk water (import from Iraq)
QATAR	710	22,014	n.a.	n.a.	-
LEBANON	2,107	10,150	210	11,000	Rivers 3,025 million m^3
SAUDI ARABIA	6,885	2,253,000	270	9,000	Artesian fountains
SYRIA	5,676	185,180	122	10,000	Euphrates 26 billion m^3
Total	26,621	3,021,942	1,512	56,000	

Source: a) United Nations, World Population Prospects as Assessed in 1963, N.Y., 1966, p. 141, Sales No. 66.XIII..

b) UNESOB, Studies on Selected Development Problems in Various Countries in the Middle East, 1969, N.Y., 1969, p. 40. Sales No. E.69.II.C.3

c) The Federation of Arab Engineers, Electricity in Arab Countries, Eleventh Session, 1969, page 102.

d) Jordan Information Ministry, Water Resources and Irrigation, 1966, p. 31, Bureau of Reclamation, US Department of Interior, Development Plan for the Litani River Basin, Republic of Lebanon, Denver, June 1954.

/...

SELECTED BIBLIOGRAPHY

IRAQ

1. E.C.S. Paul, "Promotion of Enterpreneurship in Iraq; Small-Scale Industries", Expert Group Meeting on the Development of Small-Scale Industries in Arab Countries in the Middle East, UNESCOB, November 1968.

2. Government Oil Refineries Administration, Doura Refinery, Ministry of Oil, Burhan Printing Press.

3. Iraq Petroleum Company, Annual Reports, (Baghdad).

4. Iraq Petroleum Company, Guide to Iraq Petroleum Company, Kirkuk, 1966.

KUWAIT

1. Central Statistical Office, Statistical Abstract 1966, 1967.

2. General Oil Affairs Department, Ministry of Finance and Industry, The Oil of Kuwait, Facts and Figures, Kuwait, 1965.

3. Fluor Company, Engineers and Constructors, Shuaiba, the World's First All Hydrogen Refinery, Los Angeles, U.S.

4. Kuwait Institute of Scientific Research, Kuwait, published 1969.

5. Mazidi, Faisal, "Natural Gas in Kuwait and its Utilization", Fourth Arab Petroleum Congress, 1963.

6. Mazidi, Faisal, "Kuwait as a Base for Petrochemicals", the Fifth Arab Petroleum Congress, 1963.

7. Mazidi, Faisal, "Fertilizer Needs and Problems Facing It", Conference of Petrochemical Experts, Kuwait, 1967.

8. Planning Board, The First Five Year Development Plans 1967/68-1971/72 Kuwait, 1968.

9. Planning Board, Survey of Economic Conditions of Kuwait 1967, Kuwait, 1968.

LEBANON

1. Lebanese Standards Institution, Lebanese Standards for Petroleum Products, Beirut.

2. "World of Chemistry" published by the Syndicate of Chemists in Lebanon, 1969.

/...

OTHER

1. Arabi, Mohammad El-Amin, "Co-ordinating the Petrochemical Industries in the Arab Countries", Eleventh Session, Models of Industrial Co-ordination, Federation of Arab Engineers, 1969.

2. Halfawy, Mohammad "Prospects of Petrochemical Development in the Arab Countries", Symposium on Industrial Development in the Arab Countries, Conference Document CIDAC.KUW/II/AE 3-24, 1966.

3. Hilmi, Abdul Karim, "Coordination of Petrochemical Industries in the Arab Countries", Eleventh Session, Models of Industrial Coordination, Federation of Arab Engineers, 1969.

4. Iraq Ministry of Industry, "Petrochemical Projects in Iraq", Symposium on Industrial Development in the Arab Countries, Conference Document: CIDAC.KUW/II/IRQ-34, 1966.

5. Mazidi, Feisal, "Petrochemicals: A Practical Start in the Director of Arab Industrial Cooperation", Symposium on Industrial Development in the Arab Countries, Conference Document: CIDAC.KUW/II/KUW-24, 1966.

6. OPEC, "Development of Petrochemical Industries in OPEC and Non-Member Arab Countries", Symposium on Industrial Development in the Arab Countries, Conference Document: CIDAC.KUW/II/OPEC-29, 1966.

7. "Petroleum Press Service" Vol. XXV, 1968, Ludgate Hill, London, E.C.4.

8. UNESOB, "Studies on Selected Development Problems in Various Countries in the Middle East", [illegible], 1967.

24. 1. 72