

UNITED NATIONS
ECONOMIC
AND
SOCIAL COUNCIL



51096

Distr.
LIMITED



E/CN.14/INR/110
11 July 1966

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA
Sub-regional Meeting on Economic
Co-operation in West Africa
Niamey, 10-22 October 1966

THE PETROLEUM INDUSTRY IN THE WEST AFRICAN SUB-REGION

M66-868

CONTENTS

CHAPTER	<u>Paras.</u>
I INTRODUCTION	1 - 4
Scope of the Report	
II WORLD PETROLEUM PROSPECTS	5 -49
A. Petroleum Production and Consumption	10 -23
B. Inter-Regional Trade	24 -36
C. Future Consumption and Reserves Estimates ..	37 -49
III PETROLEUM PRODUCTION AND CONSUMPTION IN THE WEST AFRICAN SUB-REGION (till 1963).....	50 -61
A. Exploration and production	52
B. Refining Capacities	53 -55
C. Consumption of Petroleum Products	56 -61
IV FUTURE DEVELOPMENT OF PETROLEUM INDUSTRY IN THE WEST AFRICAN SUB-REGION (till 1980)	62 -96
A. Consumption Estimates	62 -69
B. Refineries Capacities	70 -78
C. Lubricating Oil Plant	79 -89
D. Bitumen Plants	90 -93
E. Crude Oil Production Estimates	94 -96
V AGGREGATES OF THE ECONOMIC IMPACT	97 -118
A. Investment	97 -98
B. Gross-output and Value-added	99 -101
C. Employment	102 -104
D. Foreign Currency Savings	105 -107
VI SUMMARY	108 -118

ANNEXES

Annex I. Refineries in West Africa

Annex II.	Table 1	Petroleum Consumption in French West Africa 1950-1958				
"	2	"	"	"	Mauritania	1959-1963
"	3	"	"	"	Senegal	1959-1963
"	4	"	"	"	Guinea	1959-1963
"	5	"	"	"	Mali	1959-1963
"	6	"	"	"	Ivory Coast	1959-1963
"	7	"	"	"	Upper Volta	1959-1963
"	8	"	"	"	Dahomey	1959-1963
"	9	"	"	"	Niger	1959-1963
"	10	"	"	"	Gambia	1950-1963
"	11	"	"	"	Sierra Leone	1950-1963
"	12	"	"	"	Liberia	1950-1963
"	13	"	"	"	Ghana	1950-1963
"	14	"	"	"	Togo	1950-1963
"	15	"	"	"	Nigeria	1950-1963

Annex III.	Table 1	Gasoline - Total Consumption in Sub-region					1950-1963
"	2	Kerosene -	"	"	"	"	"
"	3	Fuel Oils -	"	"	"	"	"
"	4	Lubricants -	"	"	"	"	"
"	5	Bitumen -	"	"	"	"	"
"	6	All Products	"	"	"	"	"
"	7	Bunkers -	"	"	"	"	"
"	8	Inland Cons.	"	"	"	"	"

Annex IV. Review of Petroleum Consumption (Past and Future)

Map 1 - Petroleum Refineries in Africa

Map 2 - Concession Map of Nigeria Showing some oil discoveries

Map 3 - Refineries Capacities 1980 and Distribution of Products

Graph 1 - Petroleum Consumption in the West African Sub-region

Graph 2 - Petroleum (Inland) Consumption of West African Countries 1960, 1970, 1980

Graph 3 - Correlation between GDP per capita and Petroleum Consumption per capita

CHAPTER I

INTRODUCTION

Scope of the Report

1. This report constitutes a pre-feasibility study of petroleum industry development in the West African sub-region. It deals with the production of refined petroleum products and with the exploration and production of crude oil and natural gas only insofar as the raw material supply is concerned. The petrochemical industry is included in the pre-feasibility report of the chemical industry.

2. The report examines the situation of the petroleum industry in the world economy in general and in the sub-region's economy in particular. It anticipates the future demand of petroleum products till 1980. On the basis of projected demand it proposes expansion of refining capacities, construction of a lubricating oil plant and blending plants and also bitumen plants which have to serve the whole sub-region. It foresees supply of lubricants for the Central African sub-region.

3. The countries covered by the report are:

1. Dahomey
2. Gambia
3. Ghana
4. Guinea
5. Ivory Coast
6. Liberia
7. Mali
8. Mauritania
9. Niger
10. Nigeria
11. Senegal
12. Sierra Leone
13. Togo
14. Upper Volta

4. Since individual country statistics did not provide consumption of petroleum products by kinds and years it was decided to use:

- (a) "United Nations World Energy Supply" as source for fuels consumption, and
- (b) "Overseas Geological Surveys Statistical Summary of the Mineral Industry (Export and Import)" as the main sources of information.

CHAPTER II

WORLD PETROLEUM PROSPECTS

5. The world's oil requirements are now approximately doubling every ten years. The growth of the petroleum industry, for the world as a whole, has been among the fastest, attaining an average annual rate of growth of about 6 per cent during last 25 years. This rapid growth is to be attributed, in the first place, to the unique characteristics of petroleum and allied products. Their high calorific value (about 10,000 kcal/kg) and easy handling while being transported, have enabled them to replace to a great extent the earlier conventional sources of power, i.e., wood and coal.

6. The increasing share of petroleum (crude oil and natural gas), in the total world energy supply, may be seen from the following data:

TABLE 1

World Primary Energy Supply
(Production - in million tons of coal equiv.)

	Quantity	%
<u>1953</u>		
Coal and lignite	1,669	56.3
Crude petroleum	895	30.2
Natural gas	348	<u>11.7</u>
Hydro and nuclear	52	1.8
Total	<u>2,963</u>	<u>100.0</u>
<u>1958</u>		
Coal and lignite	2,027	53.1
Crude petroleum	1,202	31.5
Natural gas	511	<u>13.4</u>
Hydro and nuclear	76	2.0
Total	<u>3,815</u>	<u>100.0</u>
<u>1963</u>		
Coal and lignite	2,162	45.0
Crude petroleum	1,726	36.1
Natural gas	803	<u>16.8</u>
Hydro and nuclear	101	2.1
Total	<u>4,793</u>	<u>100.0</u>

Source: United Nations World Energy Supply.

7. Besides becoming the main source of energy supply, petroleum crude and natural gas have opened a new era in the chemical industry by direct processing or through the utilization of the by-products obtained from petroleum refining.

8. A third field covered by petroleum is the production of lubricants, which has enabled a rapid progress of mechanization and motorization.

9. And though at present a new form of power, i.e., nuclear, is in sight, petroleum will still remain, in the foreseeable future, the main source of power, while its importance as a raw material for chemicals and lubricants will grow still further.

A. Petroleum Production and Consumption

10. World production of crude oil in 1965 reached the 1,500 million metric tons mark. From 1960, when world production reached 1,000 million metric tons mark, the annual rate of growth averaged 7.8 per cent till 1964, while last year's advance was more moderate, amounting to 6.8 per cent.

11. The expectation now is that, over next few years, output will rise at a rate similar to that in 1965, so that world production by 1970 will be above 2,000 million metric tons. It took about 100 years (from 1859 when the modern history of petroleum began) to reach the first landmark of 1,000 million metric tons (in 1960), while it will take only one decade to reach the second thousand million tons mark.

12. The consumption of petroleum grew not only in absolute terms, but also per head of population. From 1940, when world per capita consumption of petroleum amounted to about 150 kgs, it rose to about 450 kgs in 1965, i.e., per capita consumption increased three-fold in 25 years.

13. The rate of growth of production and consumption of petroleum, however, differs considerably from country to country. The first depending mainly on natural conditions, while the second is predominantly related to the course of general economic progress of a country. (Availability of other kind of fuel or power in some countries also influences the rate of growth).

14. World crude oil production according to regions, has been as follows:

TABLE 2
Crude Oil Production
(in million metric tons)

Region	1960	1963	1965	As per cent of total		Index 1965 (1960=100)
				1960	1965	
1. North America	372.9	406.1	422.5	35.4	28.0	113
2. Caribbean	161.9	185.3	198.6	15.3	13.3	112
3. South America	31.4	39.4	41.0	3.0	2.7	130
4. Middle East	261.7	337.2	414.1	24.8	28.0	158
5. Africa (inc. Egypt)	13.7	56.9	106.1	1.3	6.6	775
6. West Europe	14.9	18.3	20.9	1.4	1.4	140
7. Far East	26.9	28.5	33.2	2.6	2.2	123
8. East. Europe and China		228.7	268.2	16.2	17.8	158
Total	1,053.9	1,300.4	1,504.6	100.0	100.0	143

15. Though USA is still the biggest single producer of crude oil in the world, her rate of growth is among the slowest (about 2 per cent per year). The second biggest producer is USSR, the third Venezuela and the fourth Kuwait. Libya, with her production of 58 million tons held, in 1965, the eighth place.

16. As the leading region in crude production in the 1966 will, most probably, be the Middle East, which in 1965 produced slightly less than the North American region. The fastest progress in crude production, however, has been achieved in the last five years by Africa, where production has increased by almost eight times. Africa's share in world production of crude rose from 1.3 per cent in 1960 to 6.6 per cent in 1965. It is expected that Africa will continue to maintain the highest rate of growth in crude production, at least up to 1970.

17. World oil consumption, in the last two years, was as follows:

TABLE 3
World Oil Consumption
(in million tons)

Country/Area	1965	1964	1965 share of total	Change 1965 over 1964	Annual average 1960/1965
USA	544	522	36 %	+4½ %	+ 3 %
Canada	56	52	4 %	+8 %	+ 6 %
Mexico	18	17	1 %	+5 %	+ 4 %
Caribbean	37	36	2 %	+4 %	+ 4½%
Other	46	43	3 %	+6½ %	+ 6 %
Total Western Hemisphere	701	670	46 %	+5 %	+ 3½%
Benelux	41	37	3 %	+12½ %	+15 %
France	53	47	4 %	+13 %	+14 %
Germany	77	68	5 %	+13 %	+18 %
Italy	52	47	3 %	+11 %	+17 %
UK	73	67	5 %	+ 9½ %	+ 8½%
Scandinavia	33	31	2 %	6 %	+ 9 %
Other	47	42	3 %	+12 %	+14 %
Total Western Europe	376	339	25 %	+11 %	+13½%
Middle East	33	32	2 %	+ 4 %	+ 5 %
Africa	34	31	2 %	+ 9 %	+ 7 %
South Asia	17	16	1 %	+ 7½ %	+ 8 %
South East Asia	24	22	2 %	+10½ %	+10 %
Japan	89	74	6 %	+19 %	+24½%
Australia	20	18	1 %	+11 %	+ 9½%
USSR, East. Europe, China	220	203	15 %	+ 8 %	+ 9 %
Total Eastern Hemisphere	813	735	54 %	+10½ %	+12 %
WORLD	1,514	1,405	100 %	+ 8 %	+ 7½%

Source: Statistical Review of the World Oil Industry, published by the British Petroleum Company Ltd., for 1965.

Note: Differences between production and consumption are accounted for stock changes and unknown military liftings.

18. The biggest single consumer of petroleum is USA followed by USSR, Japan and Germany. The highest rate of growth in petroleum consumption during the last five years has been attained by Japan, followed by the countries of European Common Market.

19. Per capita consumption of petroleum is in general in close correlation with income per capita as may be seen from the following comparative data:

TABLE 4

Country	Petroleum consumption 1963 in kg. per capita	Income US\$ per capita	Year
Austria	550	831	1961
Belgium	1,100	1,198	1961
Italy	730	618	1961
Sweden	2,000	1,592	1961
Bolivia	110	96	1958
Brazil	230	252	1958
Chile	365	352	1958
Paraguay	70	126	1958
Burma	40	55	1961
Ceylon	108	128	1961
India	23	73	1961
Congo	33	87	1958
Sudan	45	94	1961

20. The rate of growth of petroleum consumption per capita, however, as shown in the following countries, is faster than that of income per capita.

TABLE 5

Country	Petroleum 1953	Consumption kg. 1963	Index 1953=100	Income 1953	US\$ 1963	Index
Austria	150	550	367	407	831	204
Belgium	340	1,100	324	903	1,198	133
Italy	145	730	503	353	618	175
Sweden	750	2,000	267	981	1,592	162
West Germany	135	1,000	741	611	1,000	164

21. For the world as a whole the comparative rates of growth of petroleum consumption and of income (GDP) for the period 1950-1960 were as follows:

TABLE 6

World total	Petroleum consumption	Income ^{a/}
Annual rate of growth	6.5 %	3.6 %

^{a/} ECA Tables, East Africa Survey.

22. A further analysis shows that the consumption of petroleum is still more closely correlated with the rate of growth of industrialization of a country. This may be seen by comparing the rate of growth of petrol consumption in the above mentioned countries, between 1950 and 1960, with the rate of growth of their industrial output for the same period as shown below.

TABLE 7

Austria	7.1 %
Belgium	4.1 %
Italy	9.0 %
Sweden	3.3 %
West Germany	10.1 %

23. In addition to the above data, it may be noted that the country (Japan) which attained the highest rate of growth^{1/} of petroleum consumption in the last 5 years, has at the same time attained the highest rate of growth of industrial output (14 per cent).^{2/}

B. Inter-regional Trade

24. As may be observed from the Tables 2 and 3 the production and consumption of petroleum differs considerably according to the regions. Some of the regions have surpluses and other shortages of petroleum (the same is mostly valid for the individual countries). The Middle East, as one of the biggest producers of oil, is at the same time the smallest consumer of the same. On the other hand the smallest producer of petroleum, Europe, is the second biggest consumer of petroleum.

25. The following Table shows the surpluses and shortages on petroleum according to regions:

TABLE 8

in million metric tons

Region	Production 1965	Consumption 1965	+ or -
North America	422.5	600.0	- 177.5
Caribbean	198.6	37.0	+ 161.6
South America	41.0	64.0	- 23.0
Middle East	414.1	33.0	+ 381.1
Africa (incl. Egypt)	106.1	34.0	+ 72.1
West. Europe	20.9	376.0	- 355.1
Far East	33.2	150.0	- 116.8
East. Europe/China	268.2	220.0	+ 48.2

26. Africa, in the year 1965, held the third place according to the quantity exported by the region. Having the highest rate of growth of crude production, in a few years time (perhaps in 1970), Africa may become the second biggest exporter, after the Middle East.

^{1/} See Table 3.

^{2/} Source: United Nations Monthly Bulletin of Statistics.

27. The unequal development of production and consumption per region or country, causes the expansion of inter-regional trade, as it could be seen from the following Table.

TABLE 9
Inter-regional Oil Movements
(thousands of barrels daily)

To	US	Canada	Latin America	West Europe	Africa	Middle East	Far East	Total Export	%
1959, from US	-	67	24	48	6	4	62	211	2.9
Canada	98	-	-	-	-	-	-	98	1.4
Latin America	1,253	2,519	-	566	77	3	27	2,177	30.4
West Europe	6	-	20	-	109	15	11	161	2.3
Africa	1	-	-	72	-	1	-	74	1.1
Middle East	353	106	81	2,422	169	-	864	3,995	55.7
Far East	69	-	4	21	2	9	-	105	1.5
Soviet Bloc	-	-	24	260	37	9	3	333	4.7
Total	1,780	424	153	3,389	400	41	967	7,154	100 %
% of Total	24.9	5.9	2.1	47.4	5.6	0.6	13.5	100 %	
1964, from US	-	21	37	52	5	1	77	193	1.5
Canada	302	-	-	-	-	-	-	303	2.4
Latin America	1,493	319	-	898	88	2	51	2,851	22.7
West Europe	5	1	5	-	68	21	11	111	0.8
Africa	50	1	16	1,498	-	-	6	1,571	12.5
Middle East	317	140	220	3,584	334	-	2,033	6,628	52.7
Far East	62	-	2	21	-	1	-	86	0.7
Soviet Bloc	-	-	115	595	30	2	108	850	6.7
Total	2,229	482	395	6,649	525	27	2,286	12,593	100 %
% of Total	17.7	3.8	3.1	52.8	4.2	0.2	18.2	100%	
1964 Index (1959=100)	125	114	258	196	131	66	237	175	

Source: The International Petroleum Industry: A Review and Forecast published in Petroleum Press Service, June 1965.

28. The world's crude oil production amounted to about 19.5 million barrels daily in 1959. It increased to about 28 million barrels daily in 1964, or by about 43 per cent over period of five years. At the same time (according to Table 9), inter-regional oil movements expanded by 75 per cent.

29. The trends which might bring about a doubling in crude oil production within a decade, may well bring a trebling in inter-regional oil movements. Western Europe's imports virtually doubled over the five years and now account for more than a half of the world's inter-regional trade. This fact is a very important one for Africa due to the proximity to the European market.

30. According to a recent study by Professor M.A. Adelman, professor of economics at the Massachusetts Institute of Technology, the combined production and transport cost of crude oil will play an important role in the international trade of crude oil. Professor Adelman's estimates for crude oil production costs are as follows:

TABLE 1.0
Crude Oil Production Costs

Area and year(s)	Operating Cost (cents per barrel)	Development Investment per Initial Daily Barrel (dollars)	Development Cost (cents per barrel)	Total Cost (cents per barrel)
USA 1961-62				
Texas	18	3,250	138	156
Louisiana	10	2,542	108	118
Total	17	3,155	134	151
Venezuela 1962-64	6.5	863	55	62
Africa:				
Libya 1963-64	2.2	149	13 ^{a/}	15
Algeria 1962-64	3.9	656	42 ^{b/}	46
Nigeria 1964	2.7	590	28	31

TABLE 10 (Cont'd)

Area and year(s)	Operating Cost (cents per barrel)	Development Investment per Initial Daily Barrel (dollars)	Development Cost (cents per barrel)	Total Cost (cents per barrel)
Persian Gulf: 1962-64				
Iran	1.0	130	6 ^{a/}	7
Iraq	1.2	69	3 ^{b/}	4
Kuwait	1.8	167	8	10
Saudi Arabia	1.5	160	8	10

Source: M.A. Adelman: Oil Production Cost in Four Areas, published by American Institute of Mining Engineers.

a/ Including 6 cents pipeline cost.

b/ Including 10.7 cents pipeline cost.

c/ No pipeline allowance since Kirkuk has net transport advantages in pipeline let to East Mediterranean, and cost comparison is on Persian Gulf basis.

31. According to Professor Adelman's analysis, the freight advantages over Persian Gulf shipments in West European markets (he assumes Intascale less 60 per cent), amounts

- for Algerian crude oil to 34 cents a barrel
- for Libyan crude oil to 30 cents a barrel, and
- for Nigerian crude oil to 20 cents a barrel.

Taking into account the transport cost, Professor Adelman comes to the conclusion that Libyan oil has the lowest average cost in the world, and that Algerian is more or less on a par with the Persian Gulf costs. For Nigeria he is of the opinion that production costs will decline because the discoveries are not yet reflected in the production figures. However, he considers that further development might raise more the costs per barrel in the new African fields because known reserves there are very much smaller than those in the Middle East.

32. On the other hand, the exploration in Africa might show, since it is yet at its beginning, that reserves are much higher than presently estimated, and that costs need not rise considerably, i.e., to the extent that they will offset the transport cost advantages over the Persian Gulf (to the European markets).
33. It seems, however, that one cannot come to the right conclusions concerning the economy of crude oil production if the associated product, i.e., natural gas production, is not taken into account. Up to recently, natural gas was commercially used in USA, USSR, and in Europe, but very little in other producing areas. The long-term contracts already concluded by Algeria and Libya (and negotiations are going on for further deliveries) to export natural gas to European countries, will undoubtedly increase the over-all economy of the petroleum industry in these countries, and as a consequence will make them more competitive. Nigeria, though it has a less favourable condition as compared with Algeria and Libya in natural gas exports, has the same transport advantages over the Persian Gulf as shown for crude oil.
34. Refining capacities are mostly installed in the consuming countries as may be seen from the following Table.
35. In 1965 surplus refining capacities, i.e., above requirements existed only in the Caribbean and the Middle East. In the next two years, i.e. at the end of 1967, the refining capacities are expected to increase by about 20 per cent, which means that they grow faster than the consumption. In 1965 refining capacities, for the world as a whole, showed an excess capacity of about 100 million tons, while at the end of 1967, excess capacity will be about 200 million tons.
36. Though it is normal that refining capacity goes ahead of consumption, the increased activity in refinery construction proves a very good prospect for the petroleum industry. The characteristics of these construction activities is the constant gain in new refineries in many smaller and newer countries throughout the world. This may be seen especially in Africa, which in 1967 will equalize refining capacity with the level of consumption. (See also Map 1)

TABLE 11
Petroleum Production, Consumption and Refining
(in million metric tons)

Region	Year 1965			1967 Refining Capacities ^{a/}
	Production	Consumption	Refining	
North America	422.5	600	590	600
Caribbean	198.6	37	118	127
Latin America	41.0	64	67	88
Middle East	414.1	33	93	102
Africa	106.1	34	26	38
West Europe	20.9	376	365	510
Far East	33.2	150	150	192
East Europe/China	268.2	220	201	245
Total	1,504.6	1,514	1,610	1,902

a/ Refining capacities from: World Petroleum Report 1965, p. 22/23.

C. Future Consumption and Reserves Estimates

37. All assumptions of the petroleum experts foresee that average annual rate of growth in total energy consumption will range between 4 and 4½ per cent for the next 20 or 25 years. All of them agree that petroleum industry will have a higher rate of growth since the share of petroleum and particularly that of natural gas in the total energy supply is going to be increased.

38. The shares of crude petroleum and natural gas are estimated to amount, by 1985-1990, to about two-thirds of the total energy supply. (In 1963 the shares of crude oil and natural gas amounted to 36.1 and 16.8 per cent, respectively, i.e., 52.9 per cent totally).

39. Continuing at the same rate of growth as attained in 1965, i.e. 6.8 per cent, total world production of crude oil will reach by 1970

a level of about 2,100 million metric tons per year. Continuing at a slower rate of growth between 1970 and 1980, namely at about 5 per cent per annum, total world production might reach a level of about 3,400 million metric tons.

40. For natural gas a higher rate of growth is expected, namely at about 7 per cent per annum during next 15 years, so that by the year 1980 total world production will amount to about 2,500 million tons of coal equivalent.

41. The question arises whether there are enough reserves to meet requirements during the next 15 years, and well beyond. The proved reserves of crude oil at the end of 1964^{1/} are estimated to be about 46,500 million metric tons while the ultimate reserves are estimated to be at least 500,000 million metric tons (at least 10 and perhaps 40 times as great as proven reserves today).^{2/} As the total requirements on the crude oil, for the world as a whole, amount to about 37,000 million metric tons during the next 15 years, there is no doubt that there are sufficient reserves to cover these requirements.

42. The proven reserves of natural gas are estimated to be about 28,800 million tons of coal equivalent^{3/} while in regard to the ultimate reserves the same could be said as for crude oil, i.e., that they will be at least 10 times higher than present proved reserves. The total requirements on natural gas, for the world as a whole are estimated to amount to about 25,000 million tons of coal equivalent during the next 15 years, which means that, for natural gas also, there are sufficient reserves to cover these requirements.

43. Exploration and drilling techniques will continue to improve, so that average world-wide exploration and development costs will, most probably, remain unchanged. Taxation in producing countries might

^{1/} Petroleum Press Service, May 1965, p.179.

^{2/} J.P. Berkin, CBE, "The Potential Contribution of Oil", published by Shell, London.

^{3/} Source: Petroleum Press Service, October 1965, p.363.

increase, but the over-all cost of oil supplies are not expected to rise appreciably since there is still great scope for technological improvements and automation.

44. New sophisticated techniques of discovery and development are rapidly enlarging the possibilities of future discoveries. There are advances in geophysical and seismic techniques, and today it is possible to drill up to 30,000 feet. Particular progress have been made in the design of offshore drilling equipment. Besides the progress being made in discovering techniques, means have been found which will enable petroleum producers to extract twice as much oil from existing fields as was formerly possible. The application of secondary recovery methods, natural depletion, gas injection, water injection and thermal methods, will make possible a recovery rate of about 60 per cent, which compares with an average of around 30 per cent today on the average. Taking into consideration the fact that an improvement of less than 1 per cent in the recovery rate from the known commercial fields is sufficient to yield an output equal to one year's production at present, one may well judge the significance of these advanced methods.

45. Technological developments in the field of refining have made it possible for petroleum to remain competitive with other energy sources. Technological development has permitted a reduction in the amount of fuel oil produced and a gain in gasoline production. At the same time the yield of all products has increased by 3 per cent as compared with the 1940's. The refined fuel oils, used for energy production, are more and more being substituted by natural gas which is better suited to that purpose. The chemical industry based on refinery products (in particular the olefins obtained as gaseous by-products) and on natural gas is growing rapidly. Lubricants are produced today of much higher quality and for longer use. Pipelines and larger tanker units (probably up to 200,000 and 250,000 dwt) are making the transport of petroleum and natural gas cheaper. All these improvements in the fields of exploration, production, refining and transport are securing steady progress in the petroleum industry and are making petroleum and natural gas increasingly competitive with other sources of energy.

46. Taking all these facts into consideration there seem to be no obstacles in fulfilling the targets envisaged for the next 15 years for the world as a whole. However, any forecast, according to region or country, for the period of 15 years, is bound to be more uncertain, since the factors influencing the development of a particular area are bearing a more direct effect. There are always possible unexpected limitations in the natural conditions of an area or country (characteristic for this industrial-branch). In addition, economic incentives and finally the political situation are factors which comes into play, determining the course of development.

47. The development of petroleum industry on the African continent in the near future is of great interest. As the situation stands today the condition prevailing in Africa is quite satisfactory in comparison with other petroleum regions. Its geographic position, i.e., its proximity to the future main market of petroleum, Western Europe, is a great advantage for this continent. The share of Africa in world crude oil production rose in the five-year period from 1.3 per cent in 1960 to 6.6 per cent in 1965.

48. Having in view the favourable condition of Africa as compared with that of the Persian Gulf, at present the biggest petroleum producer in the world, (see also paragraph 31), one would probably not be wrong in forecasting that Africa's share by 1970 may reach about 10 per cent, and by 1980 about 15 per cent of the total world production of crude oil. As the estimates for world production of crude oil are 2,100 million metric tons for 1970 and 3,400 million metric tons for 1980, this would mean that Africa's production in 1970 would amount to about 210 million metric tons and in 1980 about 500 million metric tons. Though proved reserves of Africa are at present low, due to the relatively short period of exploration, there seems to be no doubt that it could produce the above quantities of crude oil. The offshore production, from which is expected so much in future world's crude and gas production, is only at its beginning in Africa. There are also many new areas, of this vast continent, which are not yet touched with the exploration.

49. Africa's prospects for natural gas development are particularly favourable in comparison with those of the Persian Gulf region. There is a firm opinion that the growth rate for natural gas will be determined largely by transport economics. The high capital costs for pipelines and tankers for gas transport are economical only at a high rate of utilization and this economy diminishes with distance. Therefore, countries closer to the gas markets have obvious advantages. However, it will be extremely risky to make any forecast for the future natural gas production for Africa as region and even more risky for a particular country. In Western Europe, which is a potential importer of natural gas, and has already concluded long-term contracts with Libya and Algeria, the exploration of gas is particularly intensive and there are probabilities that new rich gas fields like those in Groningen (Holland) will be found elsewhere. Exploration in the North Sea has already shown good results and there is a chance of discovering resources which eventually may cover the requirements of England. The same could be the case with other Northern areas. Therefore, it is particularly difficult to forecast the export possibilities for Nigeria, whose natural market is thought to be found in Northern Europe. USA is the biggest consumer of natural gas in the world (accounting for around 30 per cent of her total energy consumption) and it might be that, in the future, her resources will not cover the whole demand, i.e., that USA might become an importer of natural gas which will then give an opportunity for Nigeria to compete with the neighbouring countries of the USA (Canada and the Caribbean).

CHAPTER III

PETROLEUM PRODUCTION AND CONSUMPTION
IN THE WEST-AFRICAN SUB-REGION (till 1963)

50. Development of the petroleum industry in the West African sub-region started only a few years ago. Although exploration, in some countries, has been carried on for a long time (for instance, in Nigeria since 1937), the production of petroleum was first started in 1958. At present Nigeria is the only producing country. The first refinery started to work in September 1963 (in Ghana). Up to the end of 1965 three more refineries had been put into operation (Senegal, Ivory Coast and Nigeria).

51. The situation in the individual countries is as follows:

A. Exploration and Production

52. Licences have been granted almost in all countries, but exploration has varied in duration and intensity from country to country.

- 1) DAHOMEY - Cabol Enterprises Ltd (Canada), Union Oil Co. of California and Dahotex hold the concessions. The search is going on, but no results are yet reported.
- 2) GAMBIA - SPS joint venture of the French State concern BPR and the BP group has concession. Besides a dry well near Bathurst, no other results are known.
- 3) GHANA - A Rumanian team has been exploring there and it has been reported that oil has been discovered. No further data yet available.
- 4) GUINEA - No reports are available concerning exploration.
- 5) IVORY COAST - Concession held by Sté Africaine des Pétroles (SAP) of Dakar, Senegal. It carried on extensive exploration including drilling, but the final results are not yet published.
- 6) LIBERIA - No conclusion of a negotiated concession is reported.

- 7) MALI - SAP, Petropar and Standard Oil hold the concessions, but results of the exploration are not yet known.
- 8) MAURITANIA - No reports on exploration are available.
- 9) NIGER - Petropar obtained concession and has carried on exploration. The results are reported to be negative.
- 10) NIGERIA - The only country, so far, where exploration has been successful.

Exploration was started in 1937 by Shell D'Arcy Exploration Parties. At present there are the following concessionnaires: Shell-BP, Nigerian Gulf Oil Co. Ltd., Nigerian Agip, American Overseas, Tennessee Nigeria, Mobil Exploration Nigeria, Safrap (Nigeria) and Phillips. (See Map 2).

The oil was first discovered by Shell-BP at Oloibiri in 1955 and after this discovery interest in Nigerian oil has grown steadily.^{1/} It has been reported that all the concessionnaires have had greater or smaller successes.

Shell-BP on onshore fields produced in 1965 about 250,000 barrels per day (about 12.5 million tons/year) and is expected to reach 400,000 barrels per day by 1970. From 1965 other companies also started export, although all of them together have not attained as high a production as Shell-BP.

Nigeria's total production of crude oil has been as follows:

1958	=	260	thousand	metric	tons
1959	=	540	"	"	"
1960	=	850	"	"	"
1961	=	2270	"	"	"
1962	=	3330	"	"	"
1963	=	3770	"	"	"
1964	=	5950	"	"	"
1965	=	13000	"	"	"

^{1/} Since 1961 other concessionnaires have joined Shell-BP.

- 11) SENEGAL - Exploration started in 1952. Up to now SAP, SPS, COPETAO and ESSO have undertaken extensive exploration, but so far with very little or no success. The Cie des Pétroles Total will drill for two years off shore, about 250 miles South of Dakar.
- 12) SIERRA LEONE - The concessionnaire Tennessee Gas Transmission Company (Sierra Leone) Inc., carried out the exploration which was successful, and the licence was surrendered.
- 13) TOGO - The California Exploration Co. and Togo-American Oil Co. carried out the exploration, but so far without success.
- 14) UPPER VOLTA - No reports concerning exploration are available. The geologic condition is not promising for oil.

B. Refining Capacities

53. At the beginning of 1966 there were four refineries in operation in the sub-region. At present there are known plans for three additional refineries to be built in the near future. In 1960 only four African countries possessed refineries: Egypt with a capacity of about 80,000 barrels per day, South Africa about 27,500 barrels per day and Morocco and Angola about 3,000 barrels per day each, i.e., totalling about 113,500 barrels per day. At the end of 1965 14 countries had refineries with a total capacity of about 522,000 b/d, i.e., 4.5 times as great. The refineries built by the end of 1965 in the West African sub-region are as follows (see Annex I):

- 1) GHANA - The refinery is built at Tema, near Accra. It has a crude capacity of 25,000 b/d., catalytic reforming 6,500 b/d, hydrodesulfurisation 6,500 barrels/stream day, Merox treating 2,500 b/sd, Howe-Baker treating 3,300 barrels/stream day. Investment amounted to

about US \$ 23 million. It is owned and managed by Ghanaian Italian Petroleum Co. Ltd. (GHAIIP). The operation started in September 1963.

- 2) **IVORY COAST** - The refinery is built at Abidjan-Vridi; it has a crude capacity of 14,000 b/d; platforming of 2,500 b/d and hydrotreating. Investment amounted to about US \$ 16 million. It is owned and managed by Sté Ivoirienne de Raffinage (SIR) - shared by a group of petroleum companies. The operation started in August 1965.
- 3) **NIGERIA** - The refinery is built at Alesa-Elеме (near Port Harcourt); it has a crude capacity of 32,000 b/d; catalytic reforming 4,225 b/d. Investment amounted to US \$ 22 million. It is owned and managed by Nigeria Petroleum Refining Co. Ltd. (shares: 40 per cent Shell and BP; 20 per cent public). The operation started in November 1965.
- 4) **SENEGAL** - The refinery is built at M'Bao, near Dakar; it has a crude capacity of 12,000 b/d and catalytic reforming 1,600 b/d. Investment amounted to US \$ 16 million. It is managed and owned by Sté Africaine de Raffinage (SAR) Dakar which is shared by group of petroleum companies and 10 per cent by Government. The operation started in January 1964.

54. The new refineries to be built are as follows:

- 1) **GUINEA** - A refinery of about 12,000 b/d is planned to be built in order to cover the fuel requirements needed for present and new alumina plants as well as for the country's other requirements. No other data are available.

- 2) **LIBERIA** - The refinery is to be built near Monrovia with a crude capacity of 10,000 b/d with installations for cracking, reforming, sweetening and vis-breaking. Ownership 50 per cent Government, 50 per cent Hydrocarbon Research Inc. It will cost US \$ 14.5 million. The completion of the refinery is forecast for 1968.
- 3) **SIERRA LEONE** - It is reported that agreements were signed with contractors in April 1966 and that under these, the refinery is to be completed and on stream within 30 months. Its capacity is to be 10,000 b/d. The Government is to have full ownership and construction costs are said to be US\$ 5.7 million. (Unfortunately, no authentic data from the Government could be obtained; however, the quoted construction costs seems to be too low, having in view the costs of similar refineries built in the sub-region or elsewhere).

55. The four refineries at present in operation are all constructed for easy extension. Present total capacity of these refineries is 83,000 b/d, or about 4.15 million metric tons per year, which is by about 40 per cent larger than the consumption (present) of these countries. The excess capacity is used partially to supply neighbouring countries and partially to export outside the sub-region. The three new refineries to be built will have a combined capacity of about 32,000 b/d, i.e., about 1.6 million metric tons per year and will also have excess capacity (to be determined at the time of completion). The combined capacity of these seven refineries will be about 5.75 million metric tons per year, while total consumption of all the 14 countries of the sub-region amounted to about 4.0 million tons in 1965.

C. Consumption of Petroleum Products

56. The total consumption of petroleum products (inland plus bunkering) for the African continent as a whole (excluding Spanish territories) has increased from about 11 million metric tons in the year 1950 to about 25 million metric tons in the year 1963, i.e. it has more than doubled, attaining an average annual rate of growth of about 6 per cent.

57. The total consumption of petroleum products (inland plus bunkering) for the 14 countries of the West African sub-region has increased from 1.3 million metric tons in 1950 to about 3.7 million metric tons in 1963, attaining an average annual rate of growth of about 8 per cent. Inland consumption alone (excluding bunkering) has grown even more rapidly, increasing from 0.64 million metric tons in 1950 to 2.52 million metric tons in the year 1963, i.e., quadrupling and attaining an average annual rate of growth of about 11 per cent. The West African sub-region has attained the highest average annual rate of growth in total consumption as well as in inland consumption as compared with other sub-regions, and with countries still under colonial rule. The consumption of petroleum products according to individual countries (years and kind of products) may be seen from Annex II, Tables 1 to 15.

(It is not possible to establish which country has had the highest rate of growth since for eight of them, comprising previous French West Africa, no separate data exist for the period between 1950 and 1958).

(The sources for data were: for gasoline, kerosene and fuel oils - UN World Energy Supply - from the year 1955 in round ten thousand tons figures; for lubricants and asphalt - Overseas Geological Surveys Statistical Summary of the Mineral Industry / Exports and Imports).

(The individual countries' trade statistics do not always provide breakdown according to the kind of products and in addition unexplained discrepancies between quantity and value often appear).

58. Comparative data of GDP per capita and petroleum consumption per capita are given in the following Table.

TABLE 12
GDP and Petroleum Consumption
 (per capita in 1960)

Country	Popul. Mil.	GDP per cap. US \$	Total Petr. Cons.		Per Cap. Cons.	
			Total million	Inland Kgs	Total	Inland Kgs.
1. Dahomey	1.94	72	51	51	26	26
2. Gambia	0.28	71	10	10	37	37
3. Ghana	6.78	197	459	439	69	66
4. Guinea	3.07	67	130	130	43	43
5. Ivory Coast	3.43	172	156	146	46	43
6. Liberia	0.98	176	61	51	62	52
7. Mali	4.10	67	30	30	7.4	7.4
8. Mauritania	0.69	114	10	10	14	14
9. Niger	2.82	72	10	10	3.6	3.6
10. Nigeria	50.00	68	651	641	13	12.8
11. Senegal	3.11	190	1308	188	420	60
12. Sierra Leone	2.45	76	324	74 ^{a/}	133	30
13. Togo	1.44	83	31	31	22	22
14. Upper Volta	4.30	42	20	20	4.6	4.6
Total	85.39	88	3251	1831	38	21.5

^{a/} Import figure (Annex II Table 11) corrected for differences in stock.

The consumption of petroleum products is generally very low (the world average consumption in 1960 was near to 400 kilogrammes per capita). Though such a low level of consumption is more influenced by the particular circumstances in a country (the availability of other sources of energy) there is still a considerable income elasticity of demand for petroleum products.

59. The structure of consumption of petroleum products in the West African sub-region has been as follows: (See Annex III Tables 1 to 8).

TABLE 13

	<u>1950</u>	<u>1963</u>
Gasoline	23 %	19 %
Kerosene	8 %	9 %
Fuel oils	64.5	69 %
Lubricants	3.8 %	1.7 %
Asphalt	<u>0.7 %</u>	<u>1.3 %</u>
Total	<u>100.0 %</u>	<u>100.0 %</u>

The comparative structure for Africa as a whole was as follows:

TABLE 14

	<u>1950</u>	<u>1963</u>
Gasoline	24 %	20.5 %
Kerosene	12 %	11.5 %
Fuel Oils	60 %	64.5 %
Lubricants	2 %	1.8 %
Asphalt	<u>2 %</u>	<u>1.7 %</u>
Total	<u>100 %</u>	<u>100.0 %</u>

For the world as a whole the structure of consumption has been as follows:

Table 15^{a/}

Gasoline	33 %	28 %		
Kerosene	7 %	8 %		
Distillate	20 %	24 %	57 %	62 %
Residual	37 %	38 %		
Lubricants	<u>3 %</u>	<u>2 %</u>		
Total	<u>100 %</u>	<u>100 %</u>		

^{a/} Source: United Nations Statistical Yearbook.

The same tendency may be observed in all three tables, i.e., a relative decline in gasoline and lubricants consumption and an increase in fuel oils consumption (distillate and residual). The increase in the share of kerosene consumption in the West African sub-region is similar to that of the world average. The higher share of gasoline consumption for the world as a whole (33 and 28 per cent, respectively, is due to the high consumption in USA (about 40 per cent of all products) and the high participation of USA in total world petroleum consumption (about 40 per cent in 1963).

60. The consumption of petroleum products in industrialized regions according to so-called "end-consumers" differs quite a lot as may be seen from the following Table.

TABLE 16
The Uses of Petroleum, 1963^{a/}
(percentage)

Uses	USA	West Europe	Japan
Power stations and gasworks	2.9	6.5	14.1
Industry	8.1	28.5	31.9
Space heating	19.5	16.0	1.4
Inland transport	41.5	22.9	24.5
Agriculture	4.0	2.4	4.3
Aviation	6.1	2.8	0.9
Ocean bunkers	1.6	8.4	12.7
Non-energy uses	11.3	6.0	7.5
Refinery fuel and loss	5.0	6.5	2.7
Total	100.0	100.0	100.0

^{a/} Source: Petroleum Press Service, June 1964, page 206.

61. The very low consumption of petroleum in USA by power and industry is due to the very high consumption of natural gas which accounts for around 30 per cent of total energy supply in USA, compared to only about 3 per cent in Europe. In other fields the differences are also high - the refinery fuel and loss for Japan with 2.7 per cent seems to be extremely low. Statistics of West African countries do not follow petroleum consumption according to "end-consumers" and therefore it is difficult to assess it. However, an attempt has been made, in consultation with the petroleum companies, and approximate figures arrived at for some countries are as follows:

TABLE 17
Approximate Uses of Petroleum in West Africa in 1965^{a/}
for Inland Consumption
(percentage)

Uses	Ghana	Nigeria	Senegal
Household uses incl. private cars	15	18	28
Commercial transport	23	18	18
Industry including power plants	40	44	42
Agriculture	9	8	neglig.
Aviation including air-force	13	12	12
Total	100	100	100

^{a/} Excluding ship bunkering, but including aviation bunkering.

Though the differences are not so striking as among the industrialized countries (shown in Table 16) they are still high, especially, in household uses, commercial transport and agriculture. Industrial uses, including power plants, in 1965 were more or less the same, but with the commencement of the Volta hydro plant in Ghana, and later with hydro plants on the Niger in Nigeria the structure will change. In Nigeria one would anticipate a reduction in petroleum consumption for industrial purposes due to the increasing use of natural gas. The structure of uses will change in accordance with the particular development of these three countries, as well as of the rest of the countries for which no data, so far, are recorded.

CHAPTER IV

FUTURE DEVELOPMENT OF PETROLEUM INDUSTRY
IN THE WEST AFRICAN SUB-REGION, TILL 1980

A. Consumption Estimates

62. In the absence of forecasts on petroleum consumption by individual countries and without knowing the requirements of the "end-consumers" of petroleum products or having available projections by economic sectors, estimates of future consumption, till 1980, will be based mainly on the over-all economic rate of growth, i.e., on the rate of growth of GDP. In the previous paragraphs it was established, that there is a correlation between income per capita and petroleum consumption per capita and in addition that the rate of growth of petroleum products in the world as a whole, is faster than that of income. The comparative figures, for the past period, for the world as a whole and for the West African sub-region are as follows:

TABLE 18

	Period	Rate of growth of GDP (at 1960 prices)	Period	Rate of Growth of petroleum consump- tion
World	1950-1960	3.6 %	1950-1960	6.5 %
Sub-region	1960-1965	4.9 %	1959-1963	10.0 % ^{a/}

^{a/} GDP see ECA Tables for sub-region; for petroleum given in land consumption.

63. The period of observation for the sub-region is a very short one and perhaps does not give the exact parametres. However, for petroleum products the rate of growth has been established for a longer period, i.e., from 1950 to 1963, and is above 11 per cent. (The high rate of growth for the sub-region is partly due to the very low starting consumption, in 1950). There is no forecast for the ~~62~~ rate of growth

for the whole world, but for the sub-region it has been forecast at^{1/} 5.9 per cent per annum between 1965 and 1980. This rate of growth of GDP is higher than that estimated for the past period (1960/65), and will call for a higher rate of growth of petroleum consumption as well. Nevertheless, as for the world as a whole, there is envisaged a decline in the future rate of growth, and one of the causes is the level of consumption of petroleum already attained. Having this in view as well as particular requirements of the individual countries, the average rate of growth for the sub-region as a whole is forecast as follows:

TABLE 19

Rate of Growth of Petrol Consumption for Sub-region

a.	realized period 1950-1963	= 11.4 per cent
b.	realized period 1959-1963	= 10.0 per cent
c.	planned period 1963-1970	= 9.0 per cent
d.	planned period 1970-1980	= 7.0 per cent

64. The comparative data for the world as a whole are as follows:

TABLE 20

Rate of Growth of Petrol Consumption in the World

a.	realized period 1960-1965	= 7.5 per cent
b.	planned period 1965-1970	= 6.8 per cent
c.	planned period 1970-1980	= 5.0 per cent

Consequently, for the sub-region is envisaged a higher rate of growth of petroleum consumption than for the world as average. (One of the reason for this is, also, the fact that world consumption contains bunkering, which was excluded from the sub-region consumption. The

^{1/} See the same ECA Tables.

bunkering is first of all influenced by outside factors and only partially by the countries' development, and secondly it has a much lower rate of growth due to increased economy in fuel consumption by newly built ships of greater size). On the basis of the above given rate of growth the total petroleum consumption for the sub-region would be as follows (see also Annex IV and Graph 1):

TABLE 21

Inland Consumption of Petroleum in the Sub-region

a.	realized consumption 1959	= 1,740 thousand metric tons
b.	realized consumption 1963	= 2,527 thousand metric tons
c.	planned consumption 1970	= 4,600 thousand metric tons
d.	planned consumption 1980	= 9,000 thousand metric tons

65. For individual countries the total inland consumption of petroleum would be as follows (see also Annex IV for the annual rates of growth and Graph 2).

TABLE 22

Inland consumption of Petroleum
(in thousand metric tons)

Country	Actual		Estimated	
	1959	1963	1970	1980
1. Dahomey	41	41	80	140
2. Gambia	10	10	16	30
3. Ghana	396	495	764	1430
4. Guinea	50	220	400	700
5. Ivory Coast	176	198	450	1000
6. Liberia	41	93	350	700
7. Mali	30	60	100	180
8. Mauritania	10	20	50	100
9. Niger	10	21	55	120
10. Nigeria	627	835	1580	3150
11. Senegal	236	264	400	750
12. Sierra Leone	63	118	230	450
13. Togo	30	41	75	130
14. Upper Volta	20	31	50	120

For some countries like Guinea and Liberia a higher rate of growth has been envisaged due to the existence or projected existence of certain big direct consumers of petroleum (in Guinea the alumina industry, and in Liberia the steel industry). For other countries such big direct consumers are not yet known. For Ghana and Nigeria, on the other hand, big hydro-plants are reducing petroleum consumption, (power previously generated by thermal plants).

66. The comparative figures for GDP per capita and petroleum consumption (inland) per capita for 1960 and 1980 are as follows (For correlation between per capita income and petroleum consumption per capita see Graph 3):

TABLE 23

Country	GDP per capita in US\$		Petrol.Cons. per capita in kgs.	
	1960	1980	1960	1980
1. Dahomey	72	103	26	42
2. Gambia	71	110	37	60
3. Ghana	197	287	66	120
4. Guinea	67	112	43	140
5. Ivory Coast	172	455	43	185
6. Liberia	176	585	52	600
7. Mali	67	101	7.4	28
8. Mauritania	114	382	14	110
9. Niger	72	152	3.6	25
10. Nigeria	68	110	12.8	35
11. Senegal	190	337	60	160
12. Sierra Leone	76	162	30	123
13. Togo	83	140	22	55
14. Upper Volta	42	103	4.6	19
Average	88	152	21.5	61

The highest consumption per capita, by 1980, is envisaged for Liberia, which at the same time will have the highest GDP per capita. The second

highest in income and petroleum consumption is Ivory Coast. Though the difference in income between these two is not big, the difference in consumption of petroleum is a consequence of the low population in Liberia (envisaged 1.1 per cent population growth between 1965 and 1980) and the expected direct big consumer of petroleum (steel plant). Guinea for similar reasons has a disproportionally high consumption of petroleum per capita as compared with income per capita. Nigeria has a low consumption, using natural gas and coal.

67. Bearing in mind what has already been said about bunkering, the consumption of petroleum for bunkering purposes (aviation and ships), has been envisaged as follows:

TABLE 24

Petroleum Consumption for Bunkering in Sub-region
(in thousand metric tons)

-
- | | |
|----|-----------------------------------|
| a. | realized in the year 1963 = 1,200 |
| b. | planned for the year 1980 = 1,785 |
-

The corresponding annual rates of growth of bunkering consumption in the West African sub-region are as follows:

TABLE 25

-
- | | |
|----|--|
| a. | realized period 1950/1963 = 4.6 per cent ^{a/} |
| b. | planned for period 1963/1980 = 3.0 per cent |
-

a/ See Annex IV.

It is necessary to note that in 1956 bunkering had already reached a higher level than it had in 1963, i.e., it had its ups and downs, but from 1960 on it has shown a permanent decline. However, in the coming years there is expected to be more transport by sea and by air among the countries of sub-region as well as more exchange with other parts of the world. The creation of national or multi-national commercial marine companies is also expected which all together will once more increase the consumption of petroleum for bunkering purposes.

68. For natural gas, as has already been said, the situation is a much more uncertain one. For the time being only Nigeria is producing natural gas. By mid 1965 total potential gas production was exceeding 200 million cubic feet ^{1/} per day of which only a small proportion could be used locally. About 6 million cubic feet a day are supplied to a power station near Port Harcourt, and another 1.3 million to industries around Port Harcourt and Aba. There is a project for liquefaction of gas, costing £18 million and an agreement with England to export 100 million cubic feet a day is being negotiated but, probably because of promising gas discoveries in the North Sea, the agreement is not yet finalized. A survey has recently been carried out by the Canadian Industrial Gas Ltd. on the utilization of gas for the country's requirements and its recommendations are being studied.^{2/} In addition there is a proposal by ECA to construct an ammonia plant in Nigeria, by 1970, which will utilize about 66 million cubic metres of natural gas per year.^{3/} As the extensive reserves of unassociated gas remain unutilized, and a large proportion of the associated gas is flared, there is an urgent need to find ways for utilizing these rich sources.

69. The production of natural gas between 1960 and 1964 was as follows:

TABLE 26
Natural Gas produced in Nigeria^{2/}

1960	=	5,095,278 MCF
1961	=	10,843,331 "
1962	=	17,179,458 "
1963	=	22,104,792 "
1964	=	36,332,862 "

^{1/} Source: Petroleum Press Service, February 1966, page 53.

^{2/} Source: Nigerian Government Report submitted to the Regional Symposium in Cairo (E/CN.14/AS/I/6 of November 26, 1965).

^{3/} See ECA's study on petrochemical industry for West Africa (E/CN.14/INR/109).

B. Refineries Capacities

70. As has been mentioned already, there are four refineries in operation, and three more, according to known plans, are going to be built, probably, by 1969. (See paragraphs 53 and 54). These seven refineries will have a combined capacity of about 5,750 thousand metric tons which, by 1969, will correspond to requirements for inland consumption plus bunkering. By 1970, however, requirements will begin to exceed production and consequently new capacities will have to be constructed. The seven refineries are located each in one country. The sub-region consists of 14 countries, and, of course, there will be a desire on the part of other countries to have refineries as well. However, even by 1980, there is little practical possibility, according to the envisaged level of consumption by that time, for the construction of refineries in other countries (See Table 22 and Annex IV). Of the remaining seven countries, by 1980, Mali will have the highest consumption, about 180,000 tons, but this quantity is also too small for a refinery of economic size. Therefore, the additional requirements for refining capacity are envisaged by an extension of the existing (four) and of the planned (three) refineries. This is at the same time a fortunate situation because extensions are always cheaper (probably by about 30 per cent, especially when earlier construction has taken account of possible extension, as was done with the four existing refineries).

71. The extension of refineries is foreseen as follows (See Map 3):

TABLE 27
Refinery Capacity in West Africa
(in thousand metric tons)

Country	1969	1980
1. Ghana	1,250	1,650
2. Guinea	600	900
3. Ivory Coast	700	1,400
4. Liberia	500	1,000
5. Nigeria	1,600	4,500
6. Senegal	600	1,600
7. Sierra Leone	500	850
Total	5,750	11,900

a/ See also Annex IV.

72. The total requirements of petroleum products for the sub-region, by 1980, will be as follows:

TABLE 28

a. inland consumption including refinery fuels.....	9,000	thous.m.tons
b. bunkers	1,785	" " "
c. petrochemical industry requirement	250	" " "
Total	11,035	thous.m.tons

The balance between the refinery capacity and total requirements will accordingly be as follows:

TABLE 29

a. refinery capacities.....	11,900	thous.tons
b. loss in production	250	thous.tons
c. petrol.products incl.ref.fuel	11,650	thous.tons
d. total requirements	11,035	thous.tons
e. surplus for export outside reg.	615	thous.tons

73. In our calculation we have foreseen the minimum capacities required, which only theoretically would all come into operation by 1980. In practice there will always be some refinery which will just be starting extensions while others will have completed them. It is advisable to proceed with construction, at least some years ahead of consumption, depending on the economy calculation (break-even point of capacity utilization). The enlargement of the capacity in the seven countries could be done in a co-ordinated way, so that there will not be high percentage of unutilized capacity, and at the same time all the requirements be satisfied. In enlarging capacity it will be necessary to take into account the requirements of feedstock for the petrochemical industries, envisaged by ECA, and to install adequate equipment.

74. It would be advisable to create a body to co-ordinate the construction of refineries as well as the production and distribution of petroleum products in the interests of producers as well as consumers. Such co-ordination is indispensable if it is desired that the seven refineries supply 14 countries with petroleum products they require. (Of course, some small quantities of specialized products could always be imported, as well as some small quantities of petroleum products exported outside the sub-region. The higher the degree of co-ordination, the smaller the need for such import-export). In order to demonstrate the possible co-ordination in the distribution of petroleum products, a balance in production and consumption has been elaborated as follows (See Map 3):

TABLE 30
Refinery Capacities and Supply in Sub-region
in the year 1980
(quantities in thousand metric tons)

Refinery located in	Capacity (-loss in prod.)	Supply in the sub-region	Net export	
1. Ghana	1,620	a. Ghana	1,430	
		b. Bunkers	50	
		c. Petrochem.	70	
		d. Upper Volta	70	
			<u>1,620</u>	
2. Guinea	880	a. Guinea	700	
		b. Bunkers	50	
		c. Petrochem.	15	
		d. Mali	115	
			<u>880</u>	
3. Ivory Coast	1,375	a. Ivory Coast	1,000	
		b. Bunkers	50	
		c. Petrochem.	25	
		d. Upper Volta	55	
		e. Senegal bunk.	190	
			<u>1,320</u>	
4. Liberia	875	a. Liberia	700	
		b. Bunkers	150	
		c. Petrochem.	25	
	<u>875</u>			

TABLE 30 (Cont'd.)

Refinery located in	Capacity (-loss in prod.)	Supply in the sub-region		Net export
5. Nigeria	4,400	a. Nigeria	3,150	
		b. Bunkers	100	
		c. Petrochem.	65	
		d. Dahomey	145	
		e. Togo	135	
		f. Niger	125	
		g. Senegal bunk.	180	
			<u>3,900</u>	500
6. Senegal	1,670	a. Senegal	750	
		b. Bunkers	630	
		c. Petrochem.	50	
		d. Gambia	35	
		e. Mauritania	105	
		f. Mali	70	
	<u>1,640</u>	30		
7. Sierra Leone	830	a. Sierra Leone	450	
		b. Bunkers	350	
		<u>800</u>	30	
Grand Total	11,650		11,035	615

75. The table shows one of the possible solutions for distribution of petroleum products in the whole territory of the sub-region. The producing and consuming countries may, of course, find ways more convenient for them. Such arrangements should be made at an early date. The supply of one country by two or three refineries might be sometimes more convenient in order to cover more easily the variety of products required. But on the other hand it may have disadvantages. Senegal has quite a high need of bunkering, which might be difficult to supply from the Dakar refinery alone (mostly fuel oils), therefore, a supply in the above Table has been proposed also from the Abidjan and Port Harcourt refineries.

In this paper the financial and legal arrangements for such a co-ordinated economic activity will not be dealt with since there will be a separate paper dealing with these matters as for all similar integrated activities inside the sub-region. A small surplus for export outside the

sub-region, by 1980, will exist for the Port Harcourt refinery (about 10 per cent of capacity). It is also expected that Nigeria, by that year, will produce crude oil about 20 times above refinery capacity (export includes lubricants).

76. Having for disposal such a large quantity of crude oil, Nigeria should try to find a way to export more refined products instead of crude oil. The Middle East and Caribbean regions - the two biggest crude exporting regions in the world - had, in 1965, refining capacities about three times higher than were their requirements in refined products. The advantages of refining crude oil in the country of origin, besides being in the interest of the country itself, are in avoiding unnecessary transport of refinery fuel and the refinery loss amounting to about 7-8 per cent of the processed quantity - and in creating opportunities for dispatching refined products directly to the consumers. On the other side crude oil can be shipped in bigger volumes which reduces transport cost.

77. Presuming that there will not be radical changes in the utilization of petroleum in general, except in a higher usage for petrochemicals, the consumption according to kind of petroleum products, has been forecast for the West African sub-region as follows:

TABLE 31
Petroleum Products Consumption Structure

Products	1970		1980	
	thous. m.t.	%	thous. m.t.	%
Gasoline	1,080	18	1,985	18
Kerosene	540	9	990	9
Distillate fuels	1,740	29	3,095	28
Residual fuels	2,340	39	4,215	38.2
Lubricants	108	1.8	170	1.55
Bitumen	132	2.2	250	2.25
Other products	60	1.0	330	3.0
Total	6,000	100.0	11,035	100.0

78. Compared with the consumption structure realized in the year 1963, some smaller changes have been foreseen for 1970 and 1980. The reasons for it are as follows:

- gasoline has shown a decline since 1950; it is expected that consumption will stabilize at 18 per cent.
- Kerosene (including jet fuels) is expected to remain on the same level, i.e., at 9 per cent, which would imply that its growth will follow the over-all rate of petroleum products.
- distillate fuels (gas and diesel oils) and
- residual fuels (medium and bunker fuel oils) are estimated separately with 29 and 39 per cent, respectively, for 1970 and with 28 and 38.2 per cent for 1980. The decrease in percentage is only relative, caused by the introduction of "other products".
- lubricants: records for 1950-1963 are not complete; the share of lubricants for 1963 might therefore be about 2 per cent; the improved quality of lubricants, enabling their longer usage, will cause a further reduction in their share, to 1.8 in 1970 and to 1.55 per cent in 1980.
- bitumen (asphalt): records are also not complete for 1950-1963 period; the real share for 1963 could be about 2 per cent; for 1970 and 1980 a ten per cent increase in the share is foreseen due to expected improvements of the roads.
- other products contain also feedstock for petrochemicals and LPG for which the demand is expected to grow faster.

C. Lubricating Oil Plant

79. Lubricants are highly valuable and highly priced petroleum products. No running of engines is possible without lubricants and/or greases. The prices of lubricants are on the average about five times higher than those of petroleum fuels (gasoline, kerosene, gas oil).

80. It is today established that owing to costly machinery and production process, an economic size for a lubricating oil plant is about 100,000 tons capacity per year. The investment cost for such a plant is estimated to amount to about US\$ 16 million. (This investment is equal to the construction cost for a refinery of about 500,000 to 600,000 tons per year

capacity). A lubricating oil plant of half of the above capacity (50,000 tons/year) would cost about US\$ 10 million, while one twice as large i.e., of 200,000 tons/year capacity would cost around US\$ 25 million. This shows that economies of scale in lubricating oil production play a very important role.

81. In the year 1963 actual consumption (corrected for non recorded consumption) amounted to about 70,000 tons for all the 14 countries of the West African sub-region. The biggest consumer was Nigeria with about 23,000 tons. Obviously, no country will find it economical to construct its own lubricating oil plant since all the countries together consumed a quantity below the minimum economic size. However, the consumption is growing, though at a more moderate rate than that of the petroleum fuels, and as a higher level of consumption is attained there will be a chance of constructing a lubricating oil plant for the whole sub-region.

82. While studying the requirements of West African sub-region for lubricants it seems to be proper to take into consideration the other neighbouring sub-region, i.e., Central Africa, which eventually may join the former in order to find out if their combined consumption might offer some better economic solutions for both sub-regions. This way of thinking is justified by the fact that the Central African sub-region has an even lower consumption [about 30,000 tons in 1963; the highest was Congo (Kinshasa) with 15,000 tons], and will not have the chance to construct a lubricating oil plant of an economic size for an even longer period. (At the same time this might be an opportunity for a wider economic co-operation on the African continent to be followed, most probably, by many other industrial projects where economy of scale imposes such requirements).

83. The combined consumption of lubricants for West and Central African sub-region is estimated as follows:

TABLE 32

Lubricants Consumption of West and Central Sub-region
in thousand metric tons

Sub-region	1963	1970	1980
West	70	108	170
Central	30	50	80
	100	158	250

The rate of growth of lubricants consumption for the Central African sub-region is expected to be similar to that of the West African sub-region, i.e., about 6 per cent between 1963 and 1970 and about 5 per cent between 1970 and 1980. (The comparative annual rates of growth for all petroleum products for the West African sub-region amount to 9 and 7 per cent, respectively). By 1970 the consumption of lubricants, for both regions, will amount to about 150,000 tons and ten years later will be increased by an additional 100,000 tons. A capacity of 150,000 tons for lubricants is of an economic size which would mean that by 1970 or immediately afterward there would be justification for the construction of such a plant.

84. The technical possibilities for the production of lubricants should also be examined. Lubricants are produced from the products of vacuum distillation in a refinery, and a refinery having a distillation unit and producing a sufficiently large quantity of residue of appropriate quality might provide an opportunity for establishing lubricating oil plants. The bigger the refinery, the easier it will be to obtain the required residual, but the quality of crude oil plays an important role. There are reports that the crude oil so far obtained from onshore oilfields yields low viscosity index oils. However, the quality of oil varies from oilfield to oilfield. It seems, therefore, that there will not be any technological trouble in producing lubricants somewhere after 1970 when Nigeria might reach crude oil production of about 40 mil. tons since there will then be ample opportunity for selecting suitable oils. However, the refinery should have sufficiently big capacity in order to provide required quantity of feedstock for lubricating oil production.

85. As the situation stands with the refineries in the West African region and with the refineries under construction in the Central African sub-region, all are of too small size except the Port Harcourt refinery after it has been extended to about 2.5 or 3 million tons, which will be required immediately after 1970. From the geographical point of view, the location of a lubricating oil plant at Port Harcourt, which has to serve the West and Central African sub-regions, might be considered as the most convenient one. (See Map 1).

86. It is proposed that the lubricating oil plant will produce basic lub-oil which will be blended in each country where consumption approaches 10,000 tons of lubricants per annum. Each country may then combine the required ingredients of lubricants and pack them into domestically produced containers (of tin or plastic). Through such an arrangement all countries could benefit from lubricants production and distribution.

87. The consumption of lubricants in the West African sub-region, by 1980, is foreseen as follows:

TABLE 33

Lubricants Consumption in West Africa by 1980

Country	Thous.metric tons
1. Dahomey	3
2. Gambia	1
3. Ghana	30
4. Guinea	10
5. Ivory Coast	20
6. Liberia	10
7. Mali	3
8. Mauritania	2
9. Niger	2
10. Nigeria	60
11. Senegal	15
12. Sierra Leone	9
13. Togo	3
14. Upper Volta	2
Total	170

88. Blending plants could be established now in Ghana and Ivory Coast, for these two countries have already passed or are level with 10,000 tons consumption of lubricants. (Nigeria is constructing its fourth lub-oil blending plant at Lagos, expected to be completed this year). By 1970

Senegal might build a blending plant and by 1975, Guinea, Liberia and Sierra Leone.

89. If a lubricating oil plant is built immediately after 1970 with a capacity of about 150,000 tons, there will soon be a need for an extension or for the construction of a new one (See Table 22 which shows that by 1975 consumption in the West and Central sub-regions may reach 200,000 tons and by 1980 is expected to reach 250,000 tons). Though some smaller quantities of highly specialized lubricants (about 10-15 per cent) will, most probably continue to be imported from outside of the sub-regions, after 1975 the situation, in regard to consumption and supply should again be studied in order to ascertain whether the Central African sub-region would benefit most from being supplied by the Port Harcourt plant or from constructing its own when it approaches consumption of 100,000 tons. The extension of Port Harcourt lubricating oil plant would then be dealt with in accordance with the plans of the Central African sub-region.

D. Bitumen plants

90. Similar arrangement could be made in regard to the production of bitumen. However, owing to the much lower investment cost - which allows the construction of bitumen plants with about 40,000 tons capacity per year, four or five bitumen plants could be constructed gradually in order to cover the needs of the West African sub-region. (For the same reason no involvement of the Central African sub-region is suggested, for it may install plants in accordance with requirements inside its own territory).

91. One of the obstacles to installing bitumen plants is that it implies also the construction of vacuum distillation facilities which increases the total investment involved. However, both of these installations are not too costly and production of bitumen might be feasible. Most probably, the most suitable time for the installation of bitumen plants (together with vacuum installation) will be simultaneously with the expected extension of refining capacity expected in 1969 and subsequently.

92. The consumption of bitumen, which is used for road asphaltting and in building construction, is expected to be, by 1980, as follows:

TABLE 34
Bitumen Consumption in West Africa by 1980

Country	Thous. metric tons
1. Dahomey	8
2. Gambia	2
3. Ghana	40
4. Guinea	15
5. Ivory Coast	30
6. Liberia	17
7. Mali	10
8. Mauritania	5
9. Niger	5
10. Nigeria	75
11. Senegal	20
12. Sierra Leone	12
13. Togo	6
14. Upper Volta	5
Total	250

Consequently, bitumen plants could be installed first in Nigeria and Ghana (these two countries are at present also the biggest consumers of bitumen and Ghana has a bitumen blending plant already) to be followed afterwards by Ivory Coast and Senegal. These plants could then serve neighbouring countries whose consumption is too small to allow construction of such a plant. By agreement with the Governments and companies concerned, the locations and capacities of individual plants could be definitely established.

93. The blown asphalt (bitumen) production, usually involves the production of drums which will add to the industrial activity of the countries and sub-region.

E. Crude oil production estimates

94. The requirements of petroleum products for the West African sub-region (including consumption of lubricants for Central African sub-region), are estimated to amount to about 11,115 thousand metric tons by 1980. Our concern is, in the first place, that there should be sufficient raw materials, i.e., crude oil, inside the sub-region to cover requirements.

95. For the time being only Nigeria is producing crude oil. Production (export) started in 1958 with 260,000 tons and reached 13 million tons in 1965. The future fast development of Nigeria's crude oil production is based on the successful exploration of the eight concessionaires who, encouraged by the Shell-BP results, are increasing their activities which surely will result in increased production. It is expected that Nigeria's crude oil production, between 1964 and 1969, will grow at an annual rate of 32.7 per cent^{1/} so that total production by 1969 will reach a level of about 35 million tons. This would imply that Nigeria's production could reach about 40 million tons, by 1970, which would at the same time represent about 20 per cent of the total production of the African continent estimated to amount to about 200 million tons (see para. 48). By maintaining the same percentage after 1970 Nigeria's production, by 1980, might reach about 100 million tons of crude oil.

96. Though it is very risky to make such long-year forecasts in crude oil production, there is obviously a pressing need for such a production in order to satisfy the world's total requirements. And all the signs are that Nigeria's position in over-all crude oil production is a favourable one, though the present crude reserves are estimated at a low figure due to the short period of exploration. In the next 15 years other countries of sub-region (particularly coastal countries) may find crude oil as well.

^{1/} Source: Report of First National City Bank, October 1965.

CHAPTER V.
AGGREGATES OF THE ECONOMIC IMPACT

A. Investment

97. The total investment is estimated to be as follows:

(a)	4 refineries already in operation	4.15 mil.t.	= US\$ 78.00 mill.
(b)	3 refineries to be built by 1969	1.6 " "	" 36.50
(c)	7 refineries extension by 1980	6.15 " "	" 84.00
(d)	5 bitumen plants by	0.285 " "	" 7.50
(e)	1 lubricating oil plant by	0.15 " "	" 21.00
(f)	7 lub-oil blending plants by	0.15 " "	" 3.00
	Total		<u>US\$230.00 mill.</u>

98. The investment costs for the extension of seven refineries has been calculated, on the average, at 30 per cent lower than the primary investment, taking into account previously built premises for that purpose. The bitumen plants include construction cost for the bitumen plant itself with necessary vacuum distillation unit (for Nigeria this is included in the lubricating oil plant) and drum factory. The lub-oil blending plants include in addition plants for production of containers (tin or plastic). All the above investment costs are estimated on the basis of the prices prevailing today on the market. Having in mind the very high increase in the cost of refinery equipment in the past period, one would expect that this trend will continue in the future, so that in the next fifteen years it may be higher by 60 per cent or more than the estimated above.^{1/}

B. Gross-output and value-added

99. The gross-output has been calculated on the basis of the present average C.I.F. import price of the 14 West African countries for all kinds of petroleum products. Due to the small quantities delivered, the transport

^{1/} According to Nelson Refinery Construction Index, cost increased by 102 per cent from 1946 to 1957; see Chemical Engineering Series "Plant Design and Economics for Chemical Engineers" by Peter M.S.; Mc Graw Hill, 1958, page 105.

costs (mostly from the Caribbean) are high, being further increased through land transport costs to the land-locked countries.

100. Through the establishment of refineries, which in the future will have to cover the whole demand of the sub-region, the situation concerning transport costs will be considerably improved, in the first place, through lower transport costs for crude oil and, secondly since the supply will come from nearer sources (Nigeria)^{1/} or other West African countries which by 1980 might produce crude oil. If the production cost of crude oil and refinery processing costs remain the same as today, this might call for a reduction in prices of refined petroleum products, particularly when the refineries attain an economic size capacity (after being further extended, as foreseen). In this way the countries which, due to economic reasons, cannot install their own refineries will also profit and the whole sub-regional integration project will have its full economic justification. However, for purposes of comparability, the prices calculated are left at the present level, i.e. at US\$ 30 per ton average.

101. The gross-output and valued added for the sub-region by 1980, will then be as follows:

(a) gross-output: 11,650 million tons at US\$ 30.0/6on =	US\$ 349.5 million
(b) material costs estimated to amount to	= " 229.5 "
(c) value-added by subtraction	= <u>US\$ 120.0 million</u>

C. Employment

102. Employment, by 1980, is estimated to be as follows:

(a) 4 refineries at present in operation	1,250
(b) 3 new to be constructed by 1969	450
(c) for extensions, bitumen and lub-plants.....	<u>1,750</u>
Total	<u>3,450</u>

^{1/} It is expected that Nigeria alone will produce 10 times the need of the sub-region. Probably, the range in crude oil quality will be sufficiently large to meet specific requirements of the refineries.

103. It is anticipated that employees in general will obtain the high level of training required for running these expensive installations and that their qualification structure will be as follows:

- Senior technician	150
- Junior "	300
- Managers and clerical staff	400
- Skilled workers	600
- Semi-skilled workers	900
- Unskilled workers	<u>1,100</u>
Total	<u><u>3,450</u></u>

104. Indirect employment connected with the operations of the plants could amount to an additional 1,000 people.

D. Foreign currency savings

105. The foreign currency savings are calculated from the point of view of the sub-region, taking into account only transactions with the outside world. It is assumed that investment for plants will come predominantly from foreign sources and will necessitate repayments of loans and part of the profits.

106. The crude oil supply is foreseen to be completely covered from sub-regional sources, while chemicals and maintenance materials predominantly from foreign sources.

Gross-output equal to the c.i.f. value of imported products, at 1980, = about	US\$ 353 million
- repayment of loans and export of profit about	US\$ 40 mil.
- salaries to foreign personnel, chemicals and other..	US\$ 20 mil.
- Crude oil 11.9 mil.t. at 14.0	US\$166.6 mil.
	<u>226.6</u>
Per year savings about	<u>US\$ 122.9 mill.</u>

The above calculation is done on the presumption that all petroleum products are at present imported from outside the region. There are,

however, already four refineries, which are partially supplied with crude oil of sub-region origin (from Nigeria). It is also assumed that exports of petroleum products from the sub-region will compensate the value of imported products.

107. All the above calculations are based only on the activities of the refineries and the plants connected with them (lubricating oil plant, blending plants and bitumen plants including containers) and do not include activities connected with petrochemicals, natural gas and crude oil production.

CHAPTER VI

SUMMARY

108. With the progress and modernization of the economies of the countries of the West African sub-region, the importance of the petroleum industry is increasing.

109. Petroleum industry development in the sub-region started only recently. First Nigeria started the production and export of crude oil in 1958 and the first refinery was constructed in Ghana, in 1963. At the end of 1965 there were already four refineries with a total capacity of 4.15 million tons and there are known plans for three additional refineries of 1.6 million tons capacity. Though these capacities are not fully utilized from the beginning through the increased consumption they will become more economical.

110. The West African sub-region attained for the period 1950-1963 the highest rate of growth of petroleum consumption among the sub-regions. The actual annual rate of growth for 1950-1963 was 11.4 per cent, but for the last few years it has slowed down (1959-1963) to 10.0 per cent. A still slower rate of growth of petroleum consumption, i.e., 9.0 per cent for the period 1963-1970 and 7.0 per cent for the period 1970-1980 is anticipated. (The comparative figures for the world as a whole are: 7.5 for actual period 1960-1965; 6.8 per cent for the period 1965-1970 and about 5.0 per cent for period 1970-1980).

111. Total inland consumption (excluding bunkering) is expected to grow from 2,527 thousand metric tons in 1963 to about 4,600 thousand metric tons in 1970 and about 9,000 thousand metric tons in 1980.

112. Bunkering is expected to grow from 1,200 thousand tons in 1963 to about 1,785 thousand tons in 1980. In addition the petrochemical industry will consume 250 thousand metric tons.

113. To meet these increases in petroleum consumption the construction of new refining capacities is proposed. It has been established that this could best be done through the enlargements of the existing refineries

(four) and of the new ones (three) to be constructed in the near future (by 1969). The extension of the capacity of these seven refineries by 1980 will amount to 6.15 million tons. The total refining capacity will therefore amount to 11,900 thousand metric tons in 1980.

114. In addition to capacity for refining petroleum fuels, it is proposed to construct a lubricating oil plant of 150,000 tons which also will serve the Central African sub-region for a determined period. Lub-oil blending plants are proposed in five countries (Nigeria has one already) of the West African sub-region, and by 1980 five blown asphalt (bitumen) plants with a capacity of 285,000 tons.

115. The new investment required for all these plants amounts to US\$ 152 million which will make the total investment including investment in the four refineries already established by 1980 amount to US\$ 230 million.

116. The gross output for the year 1980 on the basis of today's prevailing prices (based on import c.i.f.) is estimated to amount to about US\$ 349.5 million, and the value added to about US\$ 120 million (35 per cent of gross output).

117. Foreign currency saving (excluding crude oil which will also be supplied from the sub-region) is calculated to amount to about US\$ 122.9 million.

118. The total employment anticipated is 3,450 people directly employed and about 1,000 indirectly employed.

ANNEX I
REFINERIES IN WEST AFRICA

E/CN.14/INR/110
Annex I

Country	Location	Company and address	Capacity b/d			Operation Start	Investment Mil.US\$
			Distillation	Reforming	Other		
A. IN OPERATION							
1. Ghana	Tema	Ghanian, Italian Petroleum Co. (Ltd.) P.O.Box 599, Tema	25000	6500	Mercox Treat 2500 b/sd	Sept. 1963	23.5
2. Ivory Coast	Abidjan	Soc. Ivoirienne de Raffinage B.P. 1269, Abidjan	14000	2500		Aug. 1965	16.5
3. Nigeria	Port Harcourt	The Nigerian Petrol Refining Co. Ltd., P.O.Box 585, Port Harcourt	32000	4225		November 1965	22.0
4. Senegal	Dakar	Soc. Africaine de Raffinage 15 Bld de la République Dakar	12000	1600		Jan. 1964	16.0
B. PLANNED (ALREADY) 1/			Total I		83000		78.0
5. Guinea			12000				12.0 est.
6. Liberia			10000			1968	14.5
7. Sierra Leone			10000				10.0 est
			Total II		32000		36.5
Grand Total			Total		115000		114.5

1/ By countries themselves

ANNEX II

E/CN.14/INR/110
Annex II

TABLE I

Country: French West Africa - Petroleum Products Consumption

(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline	87	115	137	133	142	160	190	200	220							
2. Kerosene	23	23	38	50	50	60	60	70	70							
3. Fuel oils	669	1061	1165	1225	1276	1240	1440	1920	1250							
4. Lubricants	37	24	14	12	10	16	20	13	15							
5. Asphalt	-	-	-	-	-	-	-	-	-							
6. Other	-	-	-	-	-	-	-	-	-							
	816	1223	1354	1408	1480	1476	1710	2203	1555							
B. Burners	618	1005	1095	1110	1132	1120	1300	1780	1100							
C. Inland	198	218	259	298	348	356	410	423	455							

See individual countries

TABLE 3
Country: Senegal - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline									90	80	70	80	70			
2. Kerosene									20	10	10	10	20			
3. Fuel oils									1140	1212	1100	1170	1070			
4. Lubricants									6	8	4	4	4			
5. Asphalt									-	-	-	-	-			
6. Other									-	-	-	-	-			
									1256	1308	1184	1264	1244			
B. Bunkers																
1. Gasoline									-	10	10	-	-			
2. Kerosene									-	-	-	-	-			
3. Fuel oils									-	1110	970	1000	900			
4. Lubricants									-	-	-	-	-			
									1020	1120	980	1000	900			
C. Inland									236	188	204	264	344			

TABLE 4
Country: Guinea - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline										20	20	30	30	30		
2. Kerosene										10	10	10	10	10		
3. Fuel oils										20	100	160	170	180		
4. Lubricants																
5. Asphalt																
6. Other																
										50	130	200	210	220		
B. Bunkers - None																
C. Inland																
										50	130	200	210	220		

TABLE 5

Country: Mali - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline									20	20	20	20	20	30		
2. Kerosene									-	-	-	-	10	10		
3. Fuel oils									10	10	10	20	20	20		
4. Lubricants									-	-	-	-	-	-		
5. Asphalt									-	-	-	-	-	-		
6. Other									-	-	-	-	-	-		
										30	30	40	50	60		
B. Bunkers - Ncne																
C. Inland										30	30	40	50	60		

TABLE 6
 Country: Ivory Coast - Petroleum Products Consumption
 (thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline									100	80	90	90	90	90		
2. Kerosene									30	30	30	30	30	30		
3. Fuel oils									50	40	60	70	80	80		
4. Lubricants									6	6	6	7	8			
5. Asphalt									-	-	-	-	-			
6. Other									-	-	-	-	-			
									186	156	186	197	208			
B. Bunkers																
1. Gasoline																
									10	10	10	10	10	10		
									10	10	10	10	10	10		
C. Inland																
									170	146	176	187	198			

TABLE 7
Country: Upper Volta - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline									10	10	10	10	10	10	10	10
2. Kerosene									-	-	-	10	-	10	-	10
3. Fuel oils									10	10	10	10	10	10	10	10
4. Lubricants									-	-	-	1	1	1	1	1
5. Asphalt									-	-	-	-	-	-	-	-
6. Other									-	-	-	-	-	-	-	-
									20	20	20	31	21	21	31	31
B. Bunkers - None																
C. Inland									20	20	20	31	21	21	31	31

See French West Africa

TABLE 8

Country: Dahomey - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline										20	20	10	10	10		
2. Kerosene										10	20	10	10	10		
3. Fuel oils										10	10	10	20	10		
4. Lubricants										1	1	1	1	1		
5. Asphalt										-	-	-	-	-		
6. Other										41	51	31	41	31		
B. Bunkers - None																
C. Inland										41	51	31	41	31		

1/ In Annex IV corrected because of fluctuations

TABLE 9
Country: Niger - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline				10	10	10	10	10	10	10	10	10	10	10	10	10
2. Kerosene				-	-	-	-	-	-	-	-	-	-	-	-	-
3. Fuel oils				-	-	-	-	-	-	-	-	-	10	10	10	10
4. Lubricants				-	-	-	-	-	-	-	-	-	-	1	1	1
5. Asphalt																
6. Other																
B. Bunkers -- None				10	10	10	10	10	10	10	10	10	21	21	21	21
C. Inland				10	10	10	10	10	10	10	10	10	21	21	21	21

TABLE 11
Country: Sierra Leone - Petroleum Products consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline	6	5	6	7	8	10	20	20	20	20	20	20	20	20	20	20
2. Kerosene	4	1	1	1	2	10	10	10	10	10	10	10	20	20	10	10
3. Fuel oils	8	7	7	8	7	10	80	330	240	270	290	360	340	310	310	310
4. Lubricants	-	1	1	1	1	1	1	1	2	1	2	2	2	2	2	2
5. Asphalt	-	1	-	-	1	1	2	2	4	2	2	3	3	3	6	6
6. Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	18	15	15	17	19	32	113	363	276	303	324	395	385	348	348	348
B. Bunkers																
1. Fuel oils										280	310	280	280	230	230	230
	1	-	-	-	1	-	60	250	220	220	280	310	280	280	230	230
C. Inland																
	17	15	15	17	18	32	53	113	56	83	44	85	105	118	118	118

TABLE 12

Country: Liberia - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline	7	6	7	8	21	10	10	20	20	20	20	30	20	20		
2. Kerosene	3	3	4	3	7	-	-	-	-	10	10	-	10	10		
3. Fuel oils	6	6	6	6	6	10	10	10	20	20	30	30	60	70		
4. Lubricants	-	-	-	1	1	1	1	1	1	1	1	2	4	3		
5. Asphalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
6. Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
B. Bunkers																
	16	15	17	18	35	21	21	31	41	51	61	62	94	103		
C. Inland																
	16	15	17	18	32	21	21	31	31	41	51	52	84	93		

TABLE 14
 Country: Togo - Petroleum Products Consumption
 (thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline	2	4	7	4	4	4	4	4	6	10	10	10	10	10	10	10
2. Kerosene	2	3	5	3	4	3	4	3	3	10	10	10	10	10	10	10
3. Fuel oils	1	1	2	2	3	2	2	2	1	10	10	10	10	10	20	20
4. Lubricants	-	-	-	1	-	1	-	1	1	-	1	1	1	1	1	1
5. Asphalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6. Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	8	14	10	11	10	10	10	11	30	31	31	31	31	41	41
B. Bunkers -- None																
C. Inland	5	8	14	10	11	10	10	10	11	30	31	31	31	31	41	41

TABLE 15
Country: Nigeria - Petroleum Products Consumption
(thousand metric tons)

	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
A. Total																
1. Gasoline	126	94	103	125	136	150	190	200	200	220	230	250	240	260		
2. Kerosene	46	33	45	44	53	60	70	70	70	110	100	130	140	160		
3. Fuel oils	38	37	47	54	56	90	110	130	170	260	260	390	340	410		
4. Lubricants	5	8	11	6	9	11	10	14	11	14	19	18	21	23		
5. Asphalt	7	12	31	11	17	22	13	12	26	33	42	12	19	10		
6. Other	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
	222	184	227	240	271	333	393	426	477	637	651	800	761	865		
B. Bunkers																
3. Fuel oils											10	20	20			
4. Lubricants											10	10	10	10		
	14	10	9	9	7	10	10	10	10	10	10	20	30	30		
C. Inland																
	208	174	218	231	264	323	383	416	467	627	641	780	731	835		

ANNEX III

TABLE 1

Gasoline - Total Consumption
(thousand m. tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Mauritania																
2. Senegal										20	80	70	80	70		
3. Guinea										20	20	30	30	30		
4. Mali	87	115	137	133	142	160	190	200	220	20	20	20	20	30	30	
5. Ivory Coast										100	80	90	90	90	90	
6. Upper volta										10	10	10	10	10	10	
7. Dahomey										20	20	10	10	10	10	
8. Niger										10	10	10	10	10	10	
9. Gambia	2	3	2	1	3	7	10	10	10	10	10	10	10	10	10	
10. Sierra Leone	6	5	6	7	8	10	20	20	20	20	20	20	20	20	20	
11. Liberia	7	6	7	8	21	10	10	20	20	20	20	30	20	20	20	
12. Ghana	72	68	74	88	99	110	120	150	140	140	140	110	140	130		
13. Togo	2	4	7	4	4	4	4	4	6	10	10	10	10	10	10	
14. Nigeria	126	94	103	125	136	150	190	200	200	220	230	250	240	260		
Total	302	293	336	366	413	451	544	604	616	690	670	670	700	710		

TABLE 2

Kerosene - Total consumption
(thousand m. tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Mauritania										-	-	-	-	-	-	-
2. Senegal										20	10	10	10	10	20	
3. Guinea										10	10	10	10	10	10	
4. Mali	23	23	38	38	52	60	60	70	70	-	-	-	10	10	10	
5. Ivory Coast										30	30	30	30	30	30	
6. Upper Volta										-	-	10	-	10	10	
7. Dahomey										10	20	10	10	10	10	
8. Niger										-	-	-	-	-	-	
9. Gambia	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	
10. Sierra Leone	4	1	1	1	2	10	10	10	10	10	10	10	10	10	10	
11. Liberia	3	3	4	3	7	-	-	-	-	10	10	-	10	10	10	
12. Ghana	27	21	24	25	28	40	30	40	40	40	50	40	60	50	50	
13. Togo	2	3	5	3	4	4	4	4	3	10	10	10	10	10	10	
14. Nigeria	46	33	45	44	53	60	70	70	70	110	100	130	140	160		
Total	105	84	118	115	146	174	174	194	193	260	250	260	300	330		

TABLE 3
Distillate and Residual Fuel Oils - Total Consumption
(thousand m. tons.)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Mauritania										10	10	10	10	10	10	10
2. Senegal									1140	1210	1100	1170	1170	1070		
3. Guinea									20	100	160	170	180			
4. Mali	669	1061	1165	1225	1276	1240	1440	1920	1250	10	10	20	20	20	20	20
5. Ivory Coast										50	40	60	70	80		
6. Upper Volta										10	10	10	10	10	10	10
7. Dahomey										10	10	10	20	10	10	10
8. Niger										-	-	-	10	10	10	10
9. Gambia	2	2	1	1	2	-	-	-	-	-	-	-	-	-	-	-
10. Sierra Leone	8	7	7	8	7	10	80	330	240	270	290	360	340	310		
11. Liberia	6	6	6	6	6	10	10	10	20	20	30	30	60	70		
12. Ghana	112	102	104	108	114	160	140	170	190	200	240	260	260	310		
13. Togo	1	1	2	2	3	2	2	2	1	10	10	10	10	20		
14. Nigeria	38	37	47	54	56	90	110	130	170	260	260	390	340	410		
Total	836	1216	1332	1404	1464	1512	1782	2562	1871	2010	2220	2420	2490	2510		

TABLE 4

Lubricants - Total Consumption
(thousand m. tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Mauritania																
2. Senegal										6	8	4	4	4		
3. Guinea																
4. Mali	37	24	14	12	10	16	20	13	15							
5. Ivory Coast										6	6	6	7	8		
6. Upper Volta												1	1	1	1	1
7. Dahomey										1	1	1	1	1	1	1
8. Niger																1
9. Gambia																
10. Sierra Leone		1	1	1	1	1	1	1	2	1	2	2	2	2	2	2
11. Liberia				1	1	1	1	1	1	1	1	1	4	3		
12. Ghana	7	7	8	5	9	12	10	11	10	12	13	13	16	16		
13. Togo				1		1		1	1		1	1	1	1		
14. Nigeria	5	8	11	6	9	11	10	14	11	14	19	18	21	23		
Total	49	40	34	26	30	42	42	41	40	41	51	48	58	60		

TABLE 5

Asphalt - Bitumen - Total Consumption
 (thousand m. tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Sierra Leone	-	1	-	-	1	1	2	2	4	2	2	3	3	3	6	6
2. Ghana	2	9	17	10	11	18	13	18	9	14	16	15	20	28	28	28
3. Nigeria	7	12	21	11	17	22	13	12	26	33	42	12	19	10	10	10
Total	9	22	38	21	29	41	28	32	39	49	60	30	42	44	44	44

TABLE 6
All Petroleum Products - Total Consumption
(thousand m. tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Mauritania										10	10	10	20	20		
2. Senegal										1256	1308	1184	1264	1164		
3. Guinea										50	130	200	210	220		
4. Mali	816	1223	1354	1408	1480	1476	1710	2203	1555	30	30	40	50	60		
5. Ivory Coast										186	156	186	197	208		
6. Upper Volta										20	20	31	21	31		
7. Dahomey										41	51	31	41	31		
8. Niger										10	10	10	21	21		
9. Gambia	4	5	4	3	5	7	10	10	10	10	10	10	10	10		
10. Sierra Leone	18	15	15	17	19	32	113	363	276	303	324	395	385	348		
11. Liberia	16	15	17	18	35	21	21	31	41	51	61	62	94	103		
12. Ghana	220	207	227	236	261	340	313	389	389	416	459	438	416	514		
13. Togo	5	8	14	10	11	10	10	10	11	30	31	31	31	41		
14. Nigeria	222	184	227	240	271	333	393	426	477	637	651	800	761	863		
Total	1301	1657	1858	1932	2082	2219	2570	3432	2759	3050	3251	3428	3521	3654		

TABLE 7

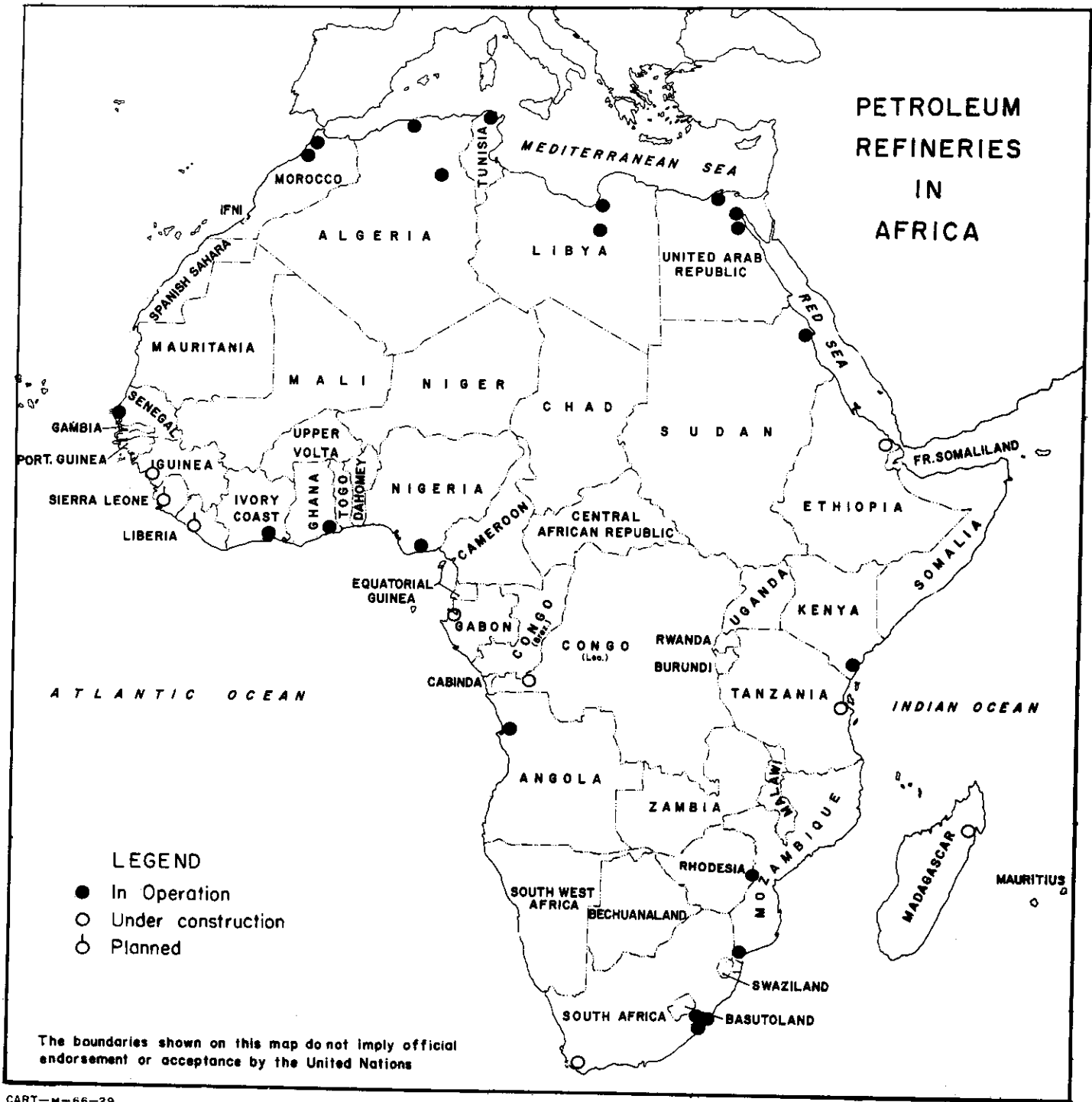
Bunkers - Total supply
(thousand metric tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Senegal	618	1005	1095	1110	1132	1120	1300	1780	1100	1020	1120	980	1000	900		
2. Ivory Coast	-	-	-	-	-	-	-	-	-	10	10	10	10	10		
3. Sierra Leone	1	-	-	-	-	-	60	250	220	220	280	310	280	230		
4. Liberia	-	-	-	-	3	-	-	-	10	10	10	10	10	10		
5. Ghana	31	32	35	23	23	20	20	20	20	20	20	20	20	20		
6. Nigeria	14	10	9	9	7	10	10	10	10	10	10	20	30	30		
Total	664	1047	1139	1142	1165	1150	1390	2060	1360	1290	1450	1350	1350	1200		

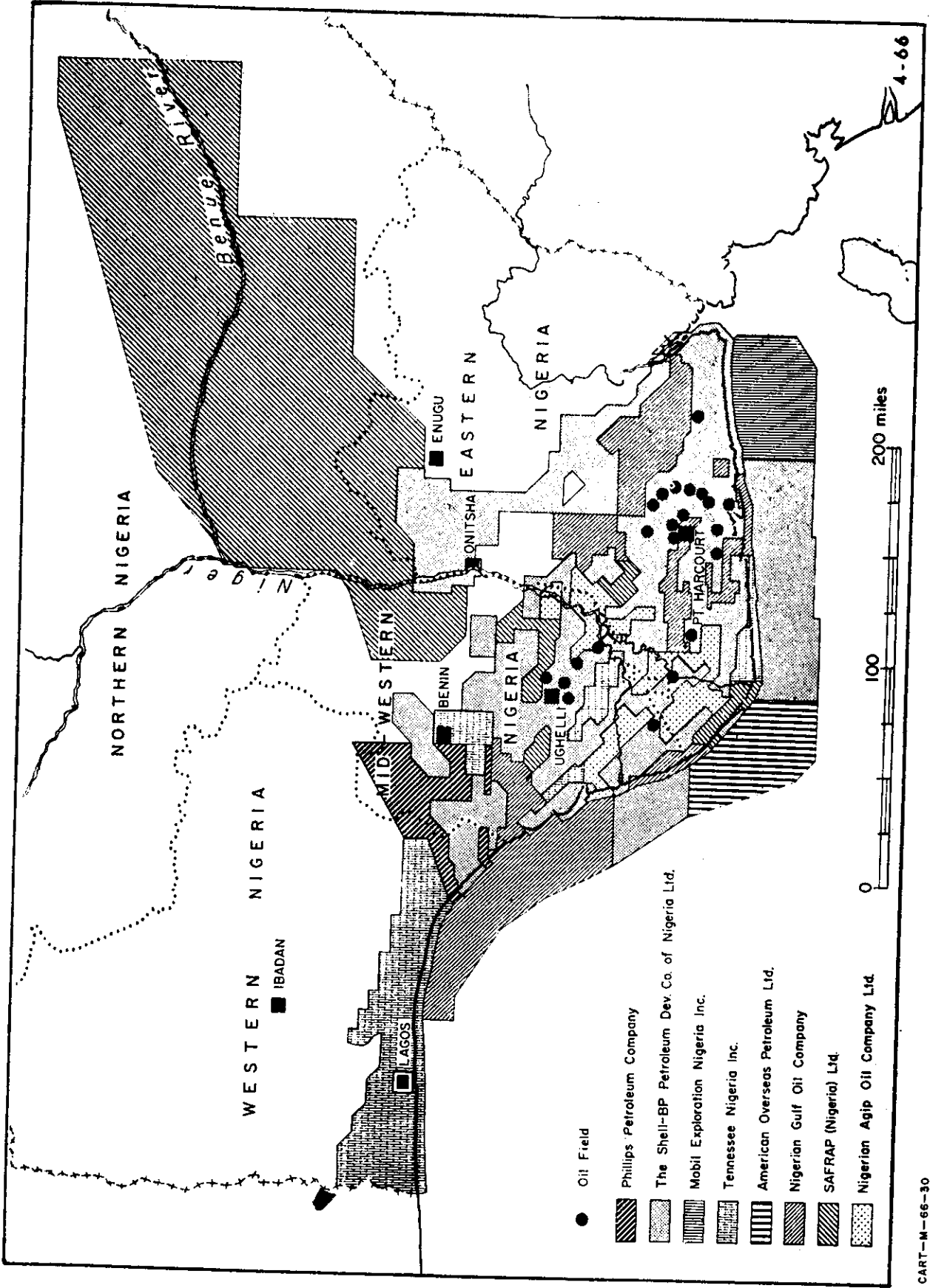
TABLE 8
All Petroleum Products - Inland Consumption
(thousand metric tons)

Country	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
1. Mauritania										10	10	10	20	20		
2. Senegal										236	188	204	264	264		
3. Guinea										50	130	200	210	220		
4. Mali	198	218	259	298	348	356	410	423	455	30	30	40	50	60		
5. Ivory Coast										176	146	176	187	198		
6. Upper Volta										20	20	31	21	31		
7. Dahomey										41	51	31	41	31		
8. Niger										10	10	10	21	21		
9. Gambia	4	5	4	3	5	7	10	10	10	10	10	10	10	10		
10. Sierra Leone	17	15	15	17	19	32	53	113	56	83	44	85	105	118		
11. Liberia	16	15	17	18	32	21	21	31	31	41	51	52	84	93		
12. Ghana	189	175	192	213	238	320	293	369	369	396	439	418	396	495		
13. Togo	5	8	14	10	11	10	10	10	11	30	31	31	31	41		
14. Nigeria	208	174	218	231	264	323	383	416	467	627	641	780	731	835		
Total	637	610	719	790	917	1069	1180	1369	1399	1760	1801	2078	2171	2517		

PETROLEUM
REFINERIES
IN
AFRICA



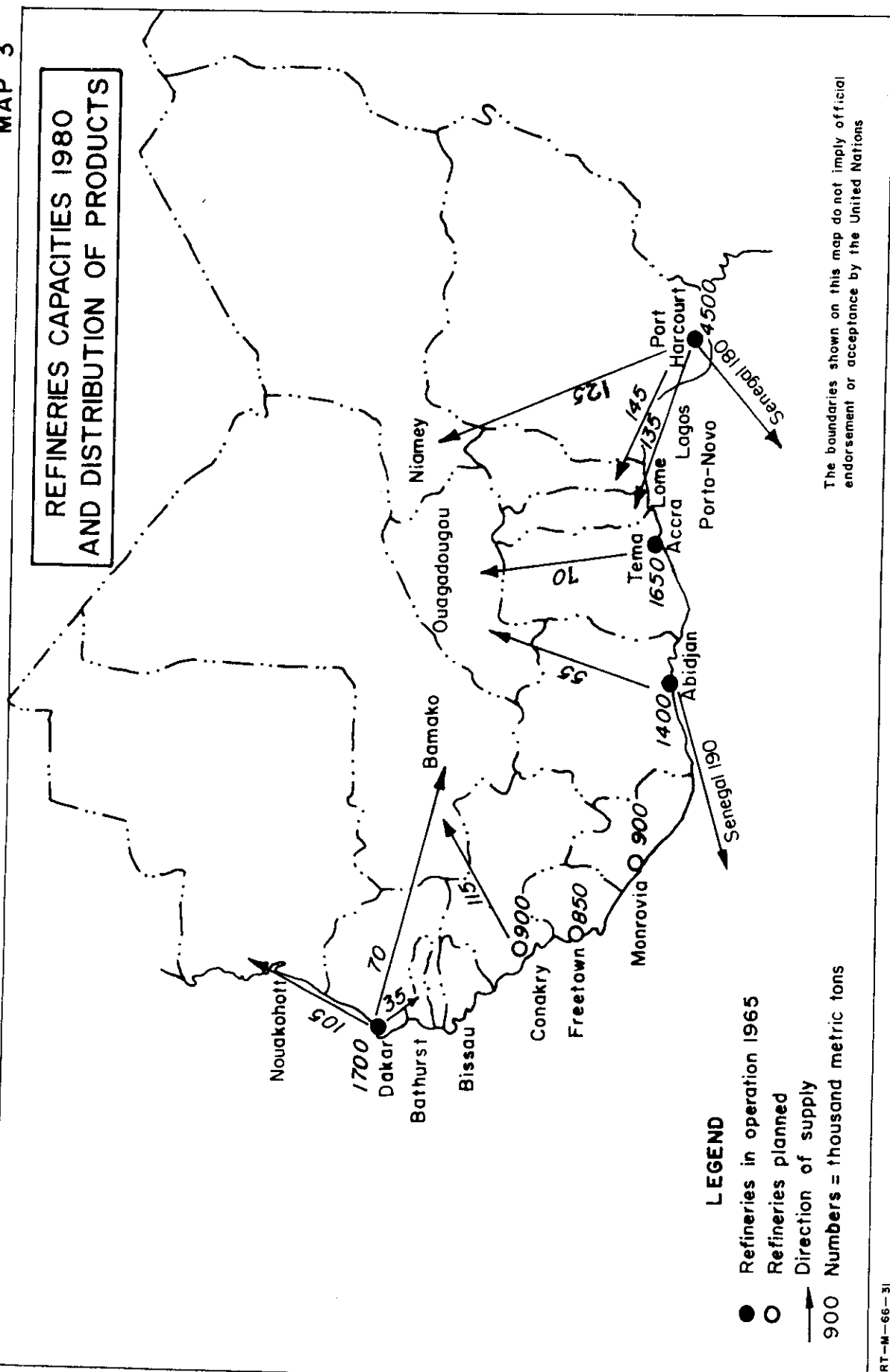
CONCESSION MAP OF NIGERIA SHOWING SOME OIL DISCOVERIES



REPRODUCED BY KIND PERMISSION "WORLD PETROLEUM"

MAP 3

**REFINERIES CAPACITIES 1980
AND DISTRIBUTION OF PRODUCTS**



LEGEND

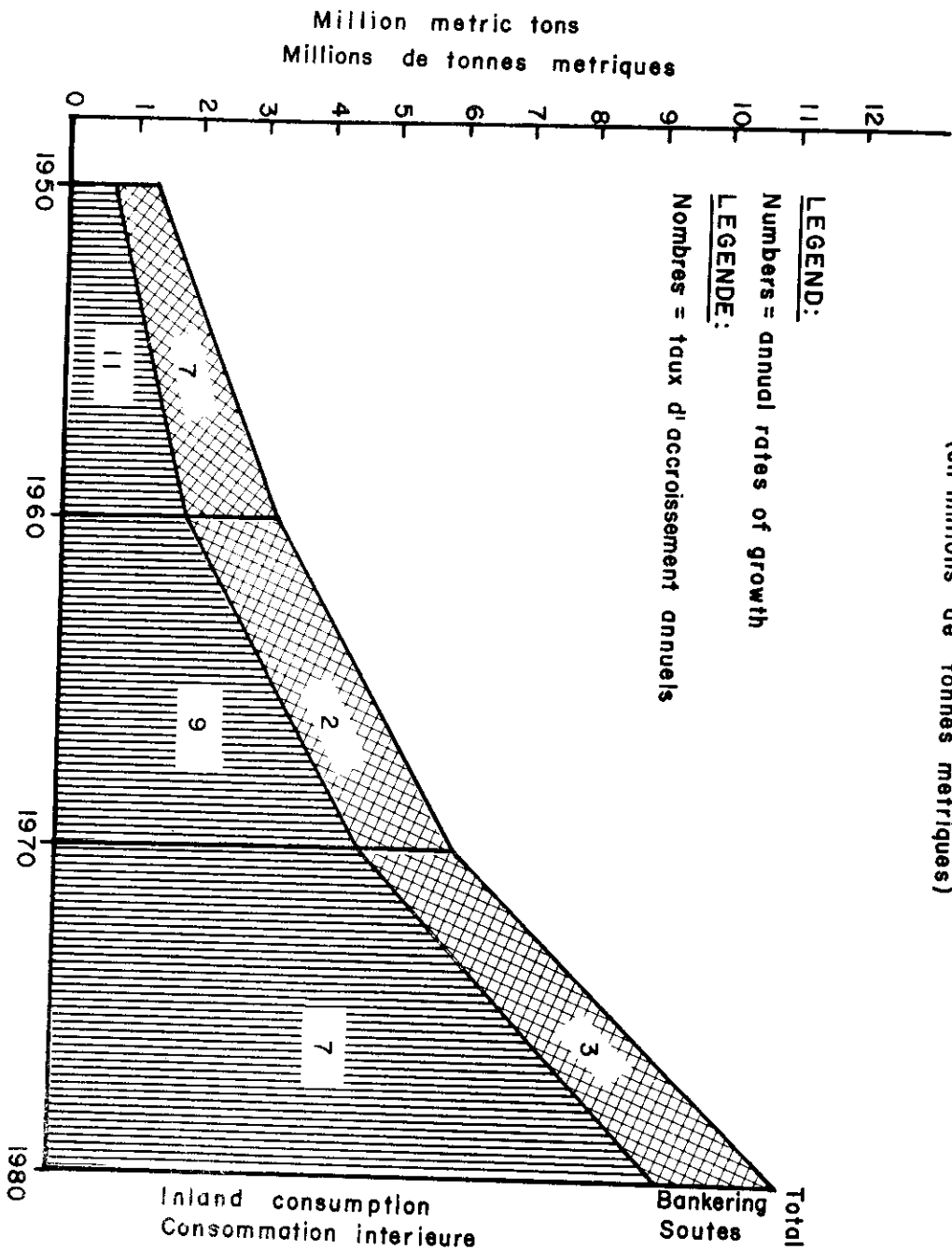
- Refineries in operation 1965
- Refineries planned
- Direction of supply
- 900 Numbers = thousand metric tons

The boundaries shown on this map do not imply official endorsement or acceptance by the United Nations

GRAPH 1
GRAPHIQUE 1

**PETROLEUM CONSUMPTION IN THE WEST AFRICAN
SUB-REGION**

**CONSUMMATION DE PETROLE DANS LA SOUS-REGION DE
L'AFRIQUE DE L'OUEST**
(in million metric tons)
(en millions de tonnes metriques)



Graph 2
 Graphique 2
 PETROLEUM (INLAND) CONSUMPTION
 OF WEST AFRICAN COUNTRIES 1960, 1970, 1980
 CONSOMMATION (INTERIEURE) DE PETROLE
 DES PAYS DE L'AFRIQUE DE L'OUEST
 (1960, 1970, 1980)

