ENERGY IN NIGERIA

By

EDWARD I. ONYEBUCHI

A Practicum Submitted
In Partial Fulfillment of the
Requirements for the Degree,
Master of Natural Resources Management

Natural Resources Institute
The University of Manitoba
Winnipeg, Manitoba, Canada

January, 1980

ENERGY IN NITEGIA

By

EDWARD I. ONYEBUCHI

A practicum submitted to
the University of Manitoba in partial fulfillment of the
requirements of the degree of

MASTER OF NATURAL RESOURCE MANAGEMENT

ABSTRACT

This study presents a comprehensive survey of energy in Nigeria. Fossil fuels, electricity, and traditional sources of energy such as forest fuel, solar, and human energy resources are examined and discussed. Complementary sources of energy, including windpower, geothermal nuclear energy, and energy from wastes are assessed in terms of their potential contribution to future energy supplies. The present and future production and consumption of energy and its associated problems are discussed in some detail.

An overview of the energy use patterns of rural and urban dwellers indicates that the majority of Nigerians depend on traditional sources of energy. Yet these sources are ignored in the energy-related sections of National Development Plans and Programs.

Recommendations for energy management in Nigeria emphasize action to ensure reliable supplies of conventional and non-conventional energy resources, a greater reliance on renewable energy resources, the conservation of scarce resources, and steps toward achieving the long-term goal of energy self-sufficiency.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank the members of my practicum committee, Professor H. M. Lapp, Department of Agricultural Engineering, University of Manitoba, (Chairman), Dr. A.M. Lansdown, Department of Civil Engineering, University of Manitoba, and Dr. V. Smil, Department of Geography, University of Manitoba, for their advice, useful criticism and guidance.

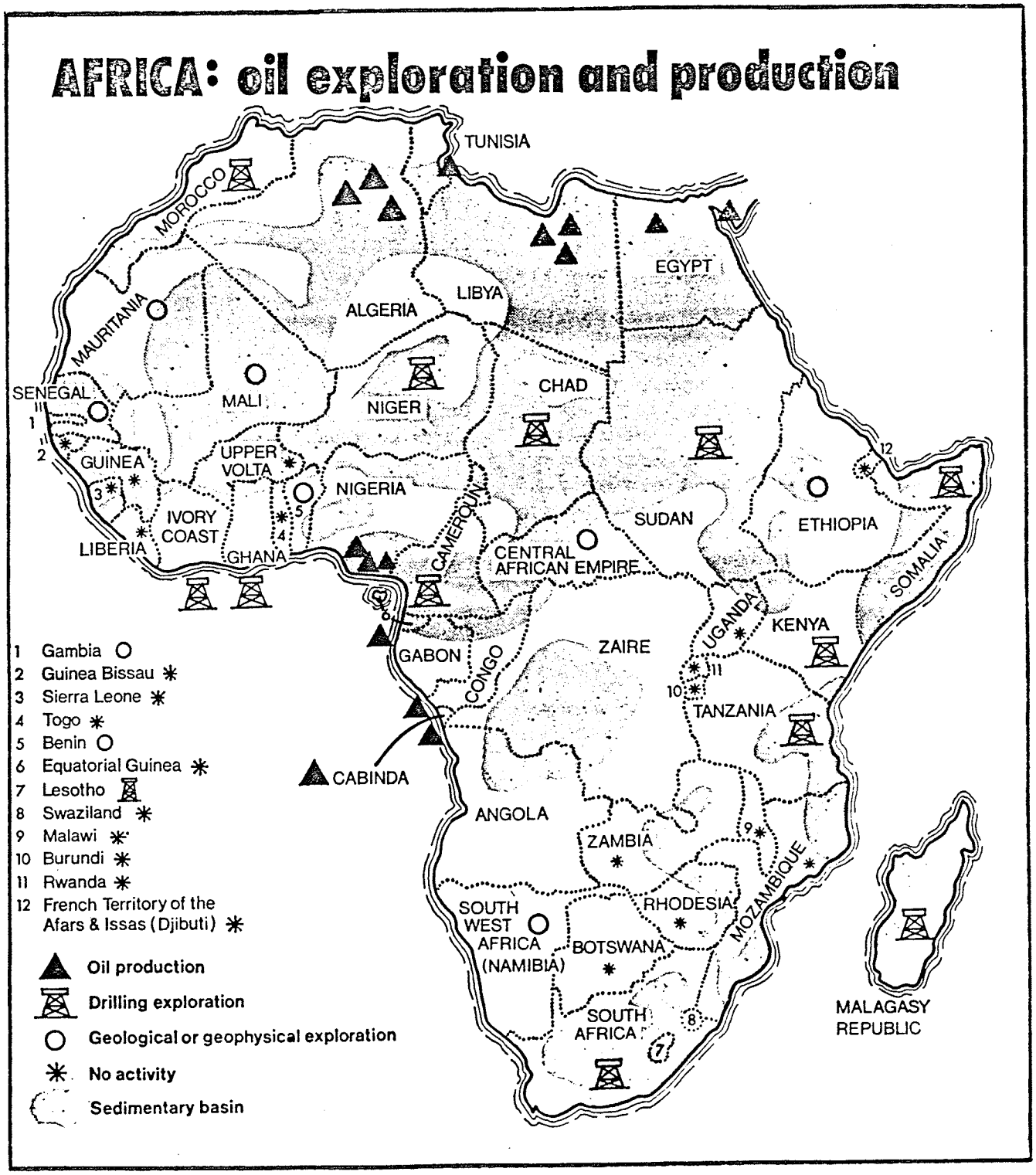
I wish to express my gratitude to Professor Thomas Henley,Assis. Director, and the staff of the Natural Resources Institute for suggestions and advice offered regarding the preparation of this practicum.

I would like to thank Mr. J.E. Umoh, Director of the National Animal Production Research Institute in Zaria, Nigeria, and Mr. T. A. Olowu, Director of the Nigerian Institute of Palm Oil Research in Benin, Nigeria, for their assistance with statistical information.

I am grateful for financial assistance provided by the Natural Resources Institute, Reverend and Mrs. Edwin Broadway, and my father, Mr. David Onyebuchi, which made the completion of this practicum possible.

Finally, I owe special thanks and appreciation to my wife, Danita, for taking the time and responsibility for editing and typing this report, as well as for her encouragement and understanding during the period of this study.

Any errors and defects remain my own responsibility.


AFRICA: oil exploration and production
TUNISIA
MOROCCO
EGYPT
LIBYA
ALGERIA
MAURITANIA
SENEGAL
MALI
NIGER
CHAD
GUINEA
UPPER VOLTA
NIGERIA
SUDAN
ETHIOPIA
IVORY COAST
LIBERIA
GHANA
CAMEROUN
CENTRAL AFRICAN EMPIRE
SOMALIA
UGANDA
KENYA
GABON
CONGO
ZAIRE
TANZANIA
CABINDA
ANGOLA
ZAMBIA
MOZAMBIQUE
RHODESIA
SOUTH WEST AFRICA (NAMIBIA)
BOTSWANA
SOUTH AFRICA
MALAGASY REPUBLIC
1 Gambia
2 Guinea Bissau
3 Sierra Leone
4 Togo
5 Benin
6 Equatorial Guinea
7 Lesotho
8 Swaziland
9 Malawi
10 Burundi
11 Rwanda
12 French Territory of the Afars & Issas (Djibuti)
Oil production
Drilling exploration
Geological or geophysical exploration
No activity
Sedimentary basin

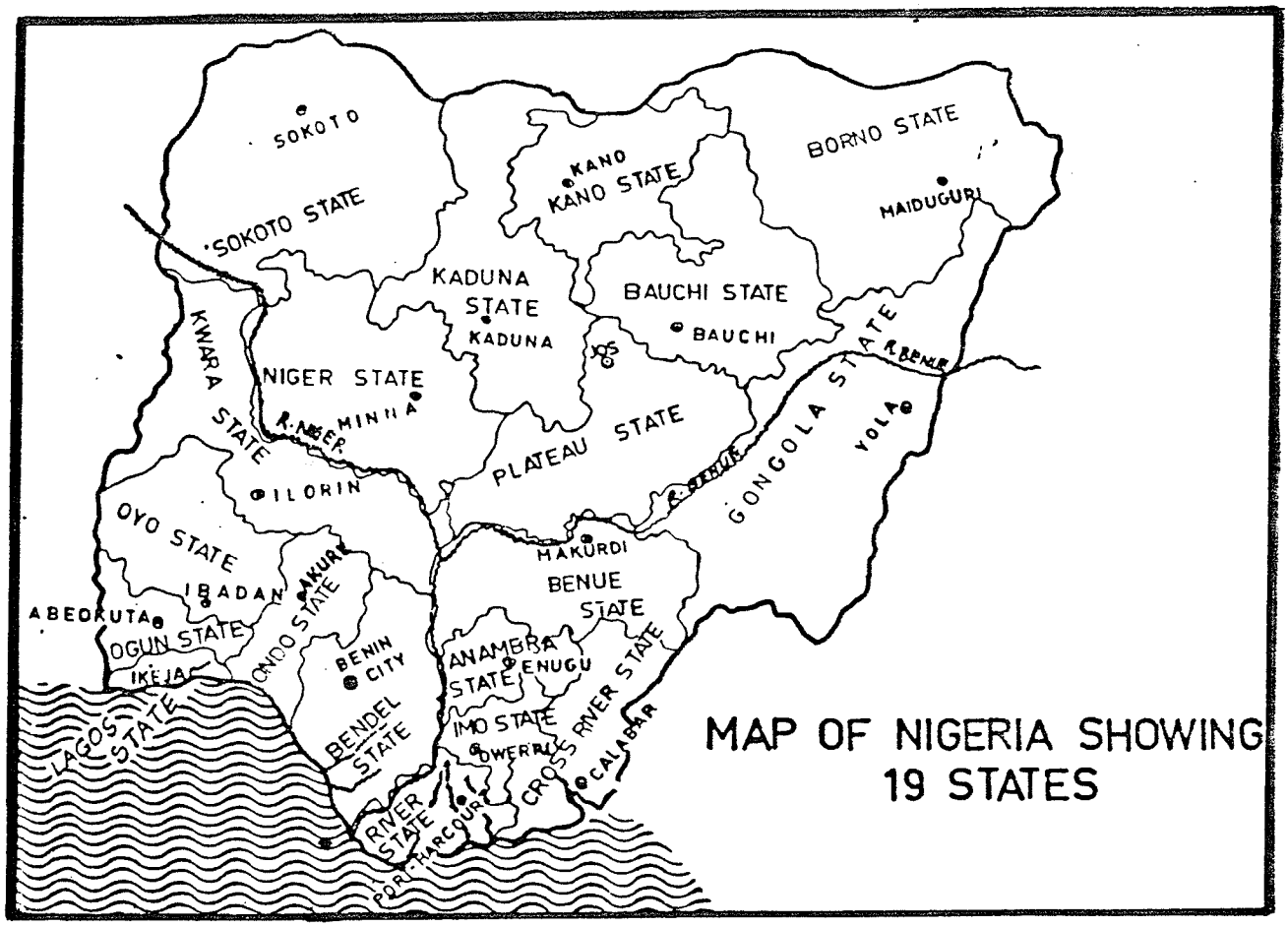

SOKOTO
SOKOTO STATE
KANO
KANO STATE
BORNO STATE
MAIDUGURI
KADUNA STATE
KADUNA
BAUCHI STATE
BAUCHI
KWARA STATE
NIGER STATE
MINNA
R. NIGER
R. BENUE
GONGOLA STATE
YOLA
PLATEAU STATE
ILORIN
OYO STATE
IBADAN
AKURE
ONDO STATE
MAKURDI
BENUE STATE
ABEOKUTA
OGUN STATE
IKEJA
BENIN CITY
ANAMBRA STATE
ENUGU
CROSS RIVER STATE
LAGOS STATE
BENDEL STATE
IMO STATE
OWERRI
CALABAR
RIVER STATE
PORT HARCOURT
MAP OF NIGERIA SHOWING
19 STATES

TABLE OF CONTENTS

TABLES

TABLES CONT'D.

TABLES CONT'D.

FIGURES

APPENDICES (GRAPHS)

CHAPTER 1: INTRODUCTION

Historical Review

The traditional sources of energy in Nigeria have been forest fuels and animate energy. To the majority of rural residents and some urban dwellers fuelwood is still an important source of energy. Solar energy is another traditional source of energy, although its technological exploitation has not been given much attention.

In 1908, coal was discovered in Enugu, and the first mining operations began in 1951. The Nigerian Railway Corporation was the largest domestic consumer of coal production in the country.

The first search for oil in Nigeria was made in 1908 by a German company called Nigerian Bitumen Corporation. Though halted by World War I, the interest was revived in 1937 with the establishment of Shell/D'Arcy exploration parties, a consortium owned equally by the Royal Dutch and British Petroleum. After five years of interruption by World War II Shell-BP, formerly called British Petroleum, intensified its activities of oil search and geological surveys, and made Nigeria's first commercial oil discovery in 1956 in the River State of Nigeria. The first Nigerian petroleum refinery company began operation in 1965.

The natural gas which accompanies petroleum produc-

tion is wastefully flared. The distance to possible markets, the absence of adequate transportation and distribution systems, and the low domestic demand for natural gas are factors which combined to make the production of natural gas economically unfeasible until very recently.

The major electrification project in Nigeria was begun in 1951 when the hydroelectric power potential of the River Niger upstream of Jebba was tapped to meet the rising demands of industries and urban centers. The largest national hydroelectric station at Kainji was begun in 1964 and completed in December of 1968.

On August 4, 1976 the Nigerian Atomic Energy Commission was established by the Federal Military Government. The Commission is charged with the responsibility for promotion of the development of nuclear energy in the country.

Statement of the Problem

As part of the Third National Development Plan, the Nigerian government has embarked on a major program of industrialization and infrastructure development. The government realizes that as a direct result of such development, the country is going to face problems of increased demands of energy. In anticipation of these demands, the government has proposed several policy objectives in the area of energy development:

i) Active state participation in mining operations.

ii) Diversification of mineral products.

iii) Manpower development and accelerated transfer of technology to Nigerians.

iv) Goals of internal sufficiency of petroleum products.

v) Measures for the provision of an effective distribution network for petroleum products.

vi) Programs relating to the export of petroleum and related products.

vii) Commercial utilization of the natural gas.

viii) An emphasis on hydroelectric power development which includes increasing the generating capacity to supply the national grid and to extend the transmission and distribution facilities to accommodate load growth and improve the quality of service. Extensive training programs were to be implemented to provide skilled personnel capable of managing, operating, and maintaining new plants and transmission systems as they came into being.

ix) To ensure that all suitable dam projects are designed to serve multipurpose development, provide flood control measures, and provide hydroelectric power generation.

These proposals are limited to petroleum resources, hydro power, and coal. Alternate sources of energy are ignored, including forests which are still the main source of fuel for the majority of rural people and for some urban dwellers. If the government is to fulfill needs of the people and to ensure

that economic and social development of the country is not hampered by endemic shortages of energy, all of the country's energy resources and reserves must be examined.

Research Objectives

In view of the need for a comprehensive and integrated approach to energy in Nigeria, the objectives of the study are as follows:

i) To determine renewable energy reserves and resources in Nigeria.

ii) To determine the non-renewable energy resources and reserves in Nigeria.

iii) To identify the problems associated with the present energy supply in Nigeria.

iv) To examine the policy objectives laid out in conjunction with the government's National Development Plan, in the area of future energy development.

v) To evaluate the energy use patterns in both urban and rural areas, in order to determine the implications for the national energy development policies.

Importance of the Study

The findings of this study will serve as a comprehensive compilation of information on energy in Nigeria to date. Fragmented data are scattered in various government departments and ministries, in journals, both local and foreign, and in files and reports of private companies who

are, or have been, involved in the development of these resources.

This study is designed for use by future policy makers in Nigeria. Although energy has contributed greatly to international recognition of Nigeria, and to government revenues, the emphasis, both externally and internally, has been primarily on crude oil and natural gas. The full scope of available energy resources, including human energy, forest fuels, and solar energy must be known in order to meet the needs of the majority of Nigerians, who rely on these other resources as their primary source of energy. Awareness of these sources of energy is the first step toward ensuring that Nigeria continues to enjoy her present position among the world's leading energy producers, and that she can maintain energy self-sufficiency.

Delimitations

The study focuses on Nigeria as a whole, and does not deal with regional differences as they relate to energy.

The study will not include discussions of interstate conflicts in the area of energy management.

The study is not designed to evaluate the performance of the government of Nigeria.

Definition of Terms

Animate - Having to do with living creatures such as humans, camels, oxen and bullocks.

Energy - Energy is the capacity to do work.

Energy Conservation - The strategy of adjusting and optimizing energy-using systems and procedures so as to reduce energy requirements per unit of output without affecting socio-economic developments.

FAO - Food and Agricultural Organization of the United Nations.

Identified Resources - Specific bodies of mineral-bearing material whose location, quality, and quantity are known from geologic evidence supported by engineering measurements with respect to the demonstrated category.

Indicated - Reserves or resources for which tonnage and grade are computed partly from specific measurements, samples, or production data and partly from projection for a reasonable distance on geologic evidence.

Inferred - Reserves or resources for which quantitative estimates are based largely on broad knowledge of the geologic character of the deposit and for which there are few, if any, samples or measurements.

LNG - Liquefied natural gas, i.e. Natural gas that has been liquefied by compression accompanied by cooling for purposes of storage and transportation.

Measured - Reserves or resources for which tonnage is computed from dimensions revealed in outcrops, trenches, workings and drill holes and for which the grade is computed from the results of detailed sampling.

Non-Renewable Energy Resources - Non-renewable energy resources are those which are used up in the process of being converted, and which cannot be replaced.

Renewable Energy Resources - Renewable energy resources are those restored through natural processes, or that man can adapt and influence through the renewable process.

Reserve - That portion of the identified resource from which a usable mineral and energy commodity can be economically and legally extracted at the time of determination. The term ore is used for reserves of some minerals.

Resource - A concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust in such form that economic extraction of a commodity is currently or potentially feasible.

Rural - Rural means relating to the country, country people, or agriculture.

Urban - Urban areas are those containing large, heterogeneous, highly differentiated society characterized by great diversity.

Conversion Factors For Common Energy And Power Units

Energy	To			
	Joule	Kilocalorie	Kilowatt hour	British Thermal Unit
From		Multiply By		
Joule	1	2.389×10^{-4}	2.389×10^{-7}	9.486×10^{-4}
Kilocalorie	4186	1	$1.16]8 \times 10^{-3}$	3.9685
Kilowatt hour	3.6×10^{6}	860.5	1	3412.8
British Thermal Unit	1005	0.252	2.928×10^{-4}	1

Power	To			
	Watt	Horsepower	Kilocalories/ minute	British Thermal units/ minute
From		Multiply By		
Watt	1	1.36×10^{-3}	1.433×10^{-2}	5.688×10^{-2}
Horsepower	745.7	1	10.68	42.44
Kilocalories/ minute	69.783	9.351×10^{-2}	1	3.9865
British Thermal Units/minute	17.58	2.356×10^{-2}	0.252	1

Research Methods

The first stage will establish the framework for determining various energy resources in Nigeria, as in Figure 1.1. The second step in the method is to determine the type of data required for the study. Data for this research will be predominantly secondary data consisting of reports from government departments, ministries, private companies, corporations, published journals, and international publications.

The method will involve gathering evidence from various sources of secondary data, their evaluation as to the authenticity of the document and the meaning and relevance of the facts conveyed.

Treatment of data in this project will involve assembling available information and screening out irrelevant data. Further screening will be done to eliminate conclusions that may have been invalidated by subsequent studies. Finally, relevant and valid information will be utilized to achieve study objectives.

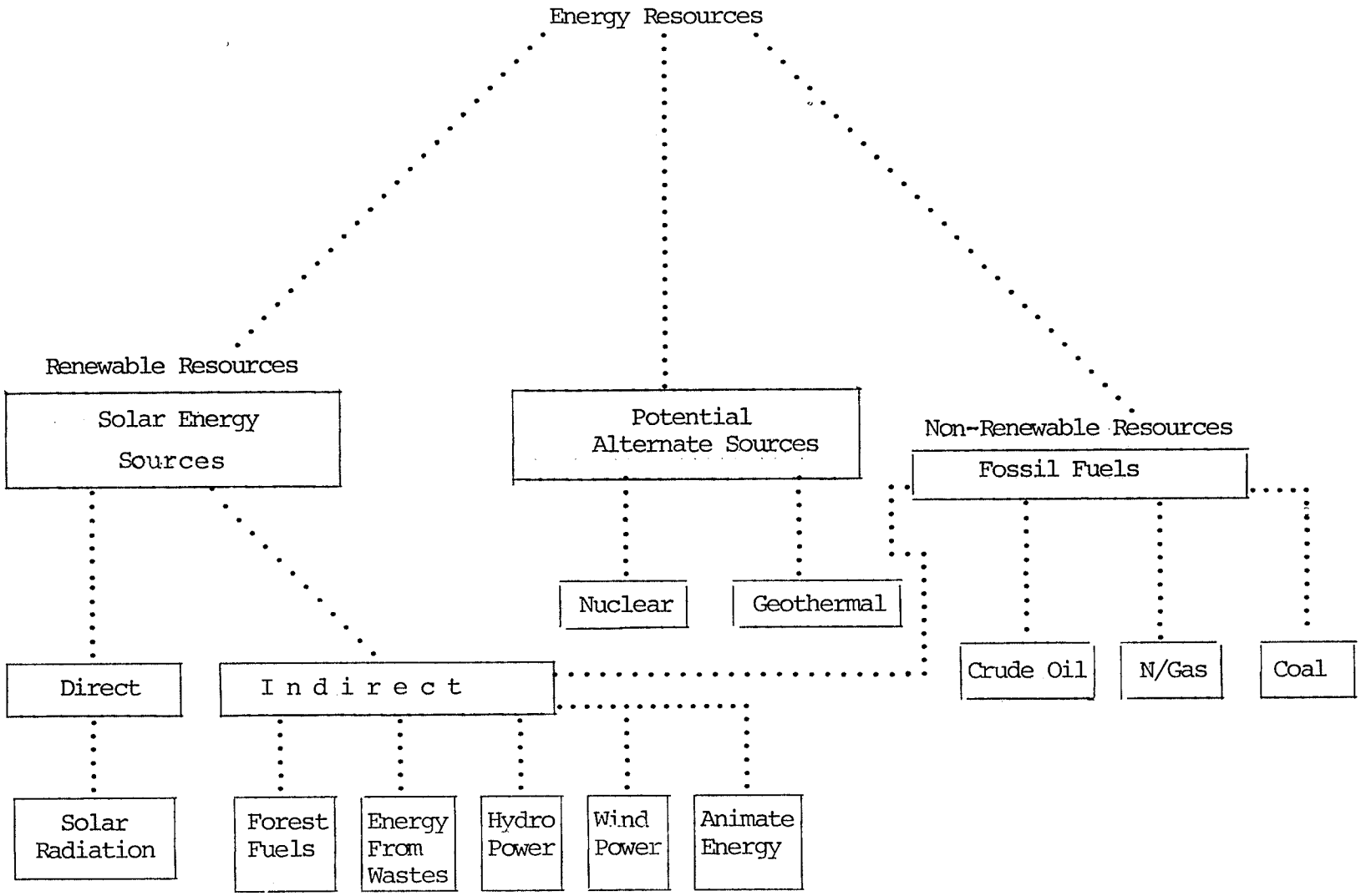


Figure 1.1 Energy Resources By Type

CHAPTER 2: ENERGY RESOURCES AND RESERVES, INCLUDING PRODUCTION AND CONSUMPTION

Renewable Energy Sources

Forest Products

Slightly over one-third of the total area of Nigeria is covered by forests, but forest reserves occupy just one-tenth of the total land area. Forest reserves are comprised of three broad types of vegetation; derived savanna forests cover an estimated 3,208 square kilometres (km^2), high forests occupy about 20,764 km^2 in the southern regions, and savanna woodland extends for approximately 72,089 km^2 in Northern Nigeria (Table 2.1). The timber contained in the high forest reserves is owned and strictly controlled by the state, while savanna forests are the most valuable source of firewood.

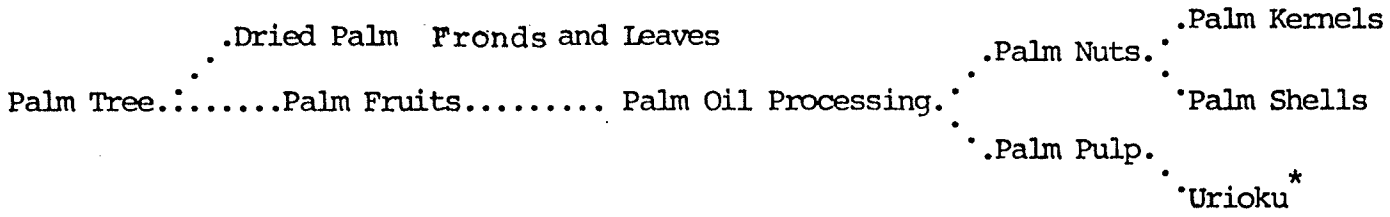
Another source of forest energy is palm tree products. In addition to their many domestic uses, dried palm leaves and palm fronds, kernels, shells, palm oil, and palm pulp are used as sources of fuel. A zone of oil palm bush occupying hundreds of square kilometres in Southeastern Nigeria supplies palm products. Figure 2.1 demonstrates the processes involved in the utilization of palm trees as a source of energy.

Various dried grasses are additional sources of forest-product energy. Figure 2.2 identifies the numerous types of

Table 2.1 Area of Forest Estate by Vegetation Type

Vegetation Type	Area km^2	% of Land Area	Area of Forest Reserve km^2	% of Total Land Area Reserved	% of Type of Reserve
Savanna Area (Sahel, Sudan, Guinea)	773,789	78	72,089	7.4	9.32
Derived Savanna	75,707	8	3,208	0.3	4.24
High Forest Areas	133,717	14	20,764	2.1	15.55
GRAND TOTAL	983,213	100	96,061	9.8	9.8

Source: Third National Development Plan, 1975-80



*Urioku is produced by mixing unedible palm oil with palm pulp, moulding it into a candle-like form, and supporting it in a bottle to be used as a lighting device.

Figure 2.1 The Processes Involved in the Utilization of Palm Trees as a Source of Energy

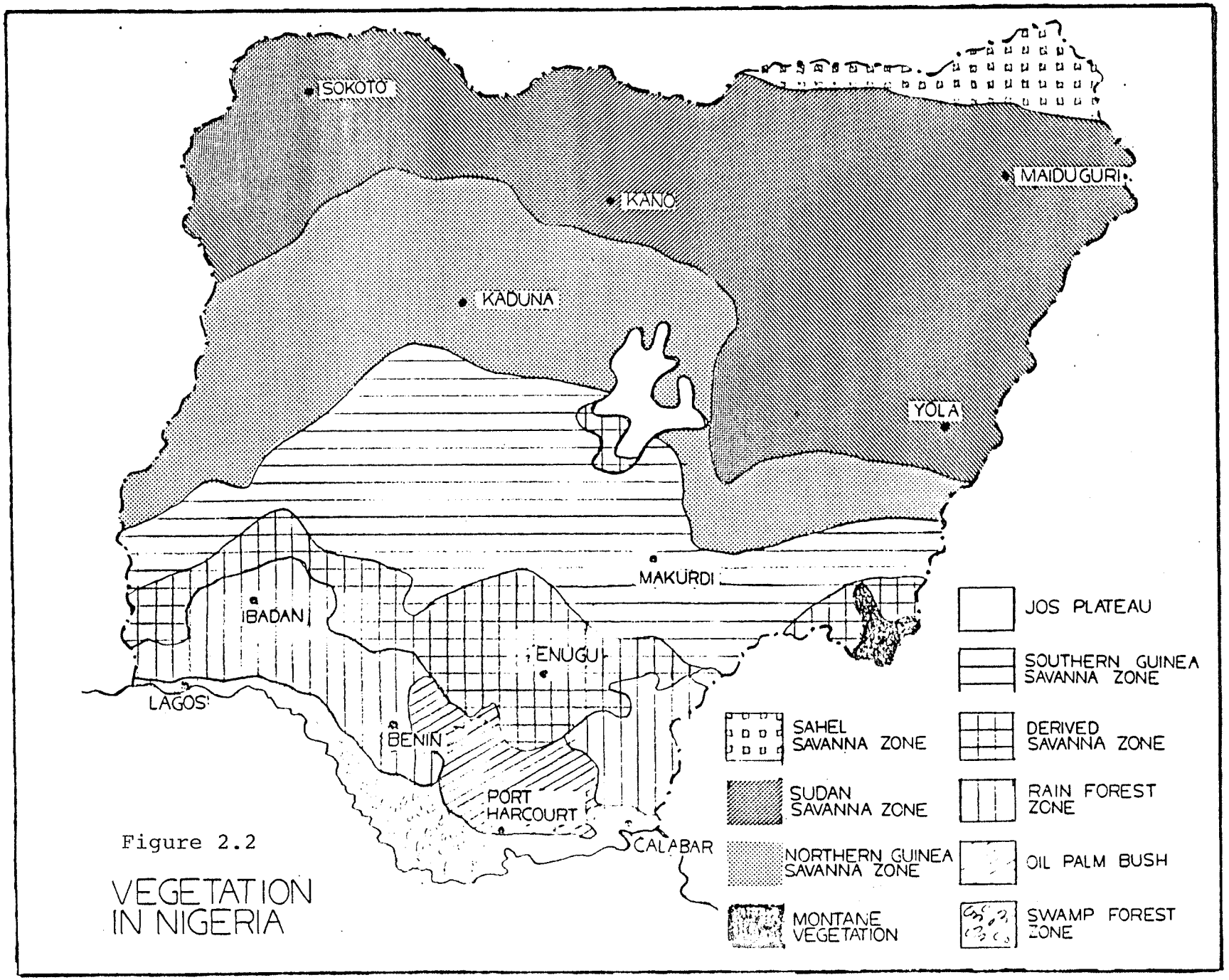


Figure 2.2

VEGETATION IN NIGERIA

vegetation in Nigeria, and their location. Agricultural residues can also serve as a source of energy. Presently, over 90 percent of the stalks of cassava, cotton, and okra crops are left to rot or are burned off as wastes. These wastes could be used for homelighting, igniting fires, for baking traditional clay products, or source of biomass synthetic fuels. Their usefulness should not be overlooked.

Production and Consumption

Fuelwood

There are no precise data available on total volumes of forest energy resources consumed in Nigeria. The Food and Agricultural Organization (FAO) of the United Nations estimated, however, that about 28.5 million cubic metres (m^3) of fuelwood were consumed by Nigerian in 1960. The ratio of consumption between urban and rural dwellers is approximately 1:9, respectively. It was also estimated that in 1980 fuelwood consumption would rise 60 percent above 1960/61 levels, assuming that there are no major changes in technology and preferences (FAO, 1966). This would imply that a total volume of 45 million m^3 of fuelwood would be consumed in 1980, with urban/rural ratios remaining constant.

Forest resources provide the major source of energy for food processing and industrial production by the majority of the Nigerian rural population, and also by some urban dwellers. The significance of forest energy in relation to total

energy consumption is illustrated in Table 2.2.

As shown in Table 2.3, Nigeria is presently producing more fuelwood than by the past FAO estimates is being consumed, and this coupled with insufficient time allowed for reforestation to take place, may result in future shortages of this important source of energy.

Palm Products

The greatest proportion of palm products produced in Nigeria are exported in their raw form. These products are used domestically as fat or oil and industrially for the manufacture of soap and margarine. Thus, production and consumption of palm products as fuel has been largely ignored in statistical data.

Problems Associated with Forest Energy Supplies

Wood, grasses, and palm fronds can be used only when dry. This means that they are not easily available as a source of energy during the rainy season (May to October) when vegetation is green.

A second problem is the scarcity of fast-growing species of trees which yield increased supplies of forest fuel. This is one of the reasons for the slow rate in forest regeneration. In addition, because of the heavy demand of urban dwellers for wood supplies and charcoal, very little time is allowed for natural reforestation to take place.

Thirdly, wood demands a great deal of space for

Table 2.2 Per Capita GNP and Energy Consumption in Nigeria

Estimated GNP Per Capita (U.S. $)	Consumption Per Capita Of Fuelwood m^3	Energy Consumption Per Capita kgce[1]		Proportion of Total Energy Supplied by Fuelwood in Percent
		Forest Only	Total	
120	1.0	434.9	480	90.6

Source: D.E. Earl, Forest Energy and Economic Development. London: Oxford University Press, 1975, p.10.

[1] kgce means kilograms of coal equivalent.

Table 2.3 Production of Fuelwood in Nigeria
1971 - 1976

YEAR	FUELWOOD PRODUCTION (Quantities in Million Cubic Metres)
1971	55.400*
1972	56.800*
1973	58.400*
1974	60.000*
1975	64.265
1976	64.265

*Statistical Office Estimate

Source: United Nations, World Energy Supplies 1971-1975, New York: 1977, p.223, and World Energy Supplies 1972-1976, New York: 1978, p.225.

storage. This hinders efficient utilization of the resource when it is abundant, during the dry season. Rather than store wood made available at this time, it is left in the forest to rot during the rainy season. Such a waste of forest resources is considerable. For example, residues from logging sites, sawmills, and wood furniture workshops are wastefully disposed of.

Environmental control is not adequate, especially with regard to forest fires and soil erosion. Indiscriminate killing of fauna in some areas poses real danger to extinction of some species.

With the recent trend to urbanize rural areas, local development projects, such as construction of permanent roads and houses, have been undertaken with no prior research done to examine their impact on forest lands on which they are built.

Land tenure is another associated problem. Scattered plots of private land are characteristic of Southern Nigeria. This impedes effective formulation and implementation of control policies necessary for adequate management of forest resources.

Finally, in the National Development Plan little attention is given to forest energy development. The government is more concerned with the control of high forest vegetation which contains timber species than with savanna zones from which firewood is gathered.

Solar Energy

Nigeria is located within latitudes 4^{o} N and 14^{o} N of the equator and on an annual basis there is a general increase of sunshine from the Atlantic coast to the interior. The amount of sunshine ranges from a minimum of 1300 hours in the Niger Delta to over 3200 hours in the extreme northeast. Mean annual radiation in the northern part of the country is estimated to be about 190 kcal/cm^2, while in the south it is about 110 kcal/cm^2.

Only about 55 percent of total incoming radiation is available as net radiation, though this varies with the seasons. During the dry season, with clear skies, net radiation is about 70 percent of the total incoming radiation, but only 45 percent in the rainy season under cloudy conditions. Figures 2.3 and 2.4 show mean annual radiation in Nigeria.

The General Significance of Solar Energy, and its Uses

Solar energy is the most abundant and widely distributed energy resource in Nigeria. It is also the most widely used; while only a small proportion of the population has access to and uses petroleum products or electricity, almost everyone makes use of solar energy on a daily basis. Only forest fuel products are used at a comparable rate by the majority of Nigerians.

Presently, only passive solar energy is being used by Nigerians. It is most commonly used for drying agricultural

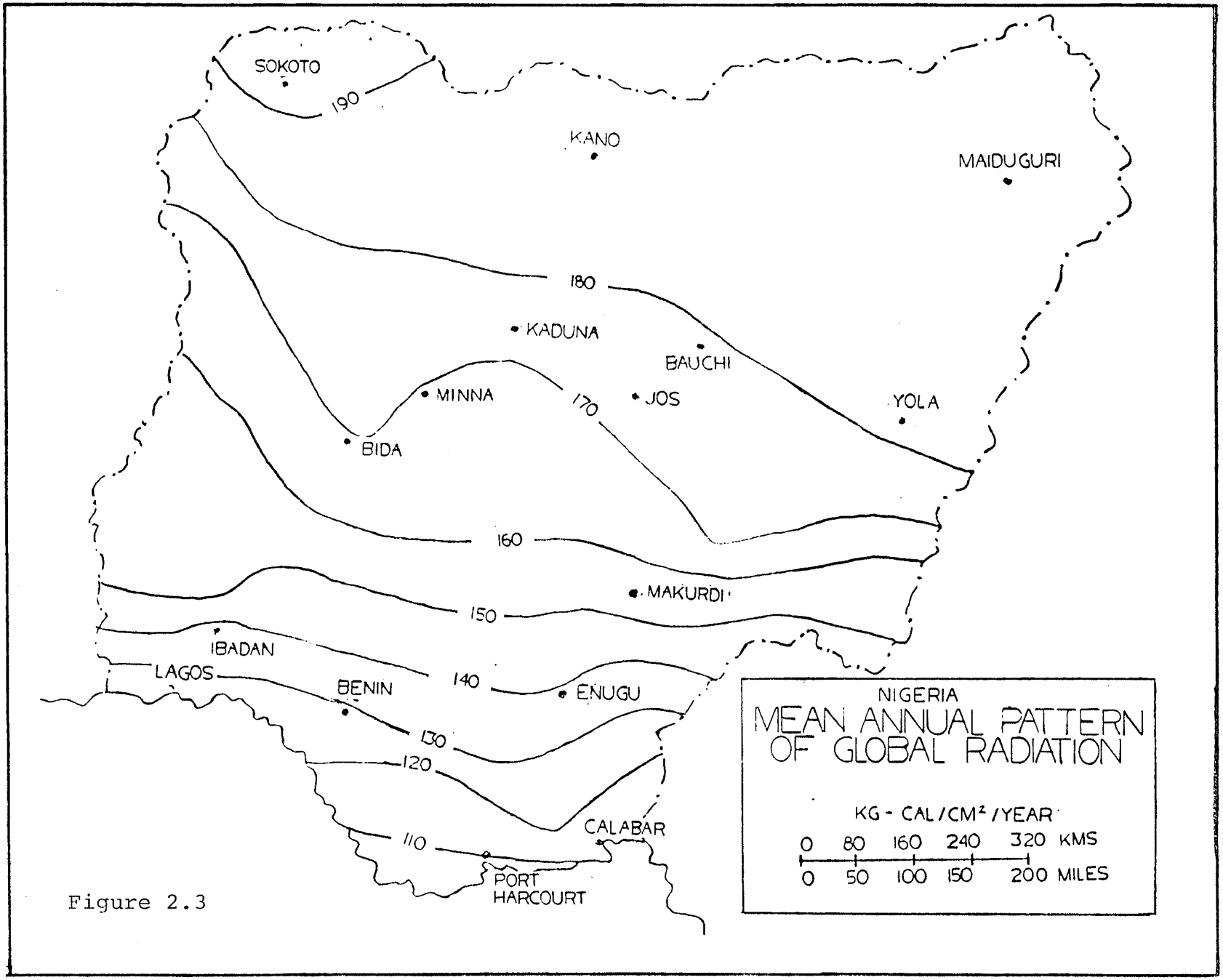

SOKOTO
190
KANO
MAIDUGURI
180
KADUNA
BAUCHI
MINNA
170
JOS
YOLA
BIDA
160
MAKURDI
150
IBADAN
LAGOS
140
BENIN
ENUGU
130
120
CALABAR
110
PORT
HARCOURT
NIGERIA
MEAN ANNUAL PATTERN
OF GLOBAL RADIATION
KG - CAL/CM² /YEAR
0 80 160 240 320 KMS
0 50 100 150 200 MILES

Figure 2.3

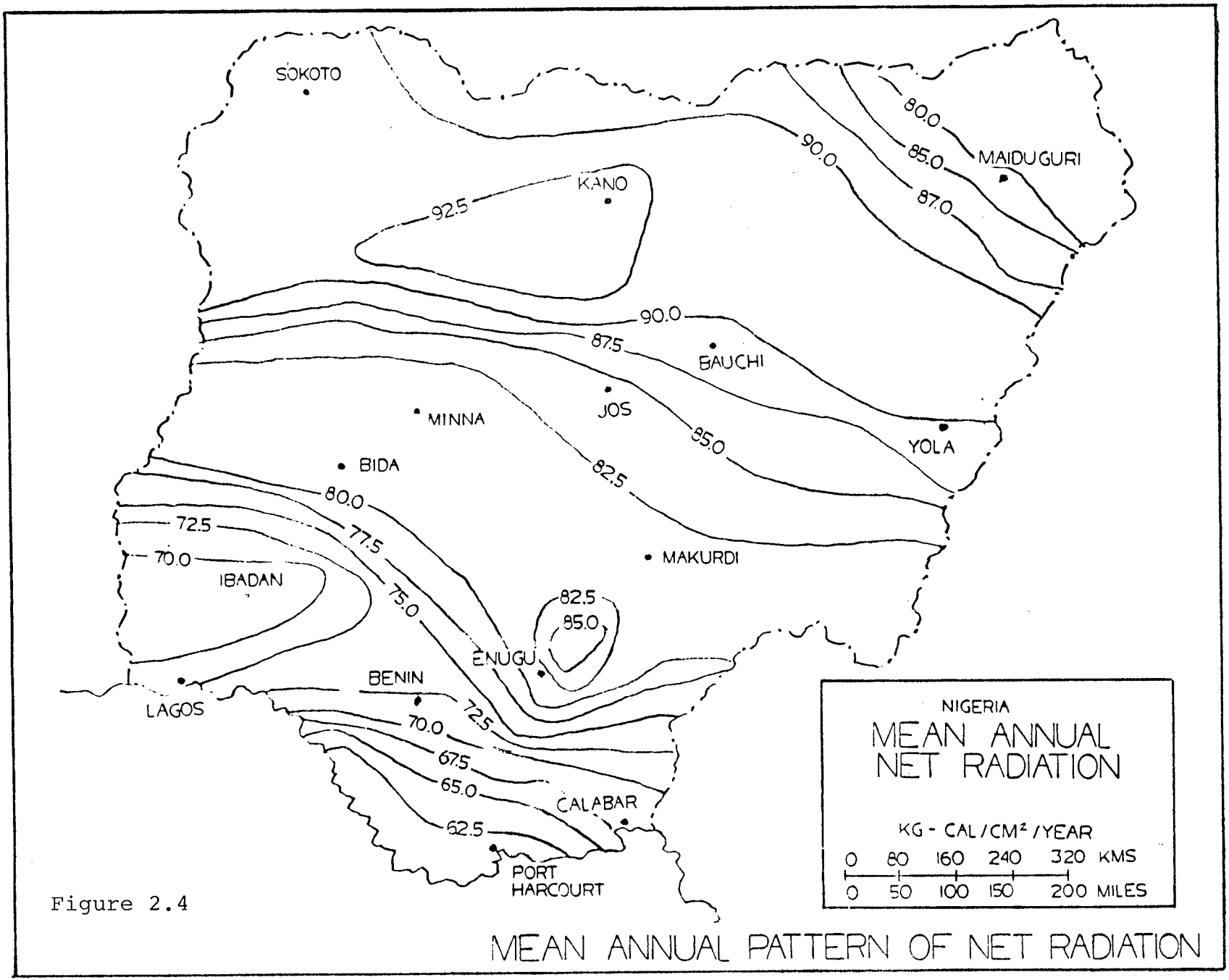


Figure 2.4

MEAN ANNUAL PATTERN OF NET RADIATION

products before they can be stored, transported, or sold. This is done by spreading groundnuts, beans, millet, cocoa, or various grains on mats until they are dried adequately. Other activities involving use of solar energy include brickmaking, preliminary processing of clay products, drying lumber and firewood. In addition, almost all of the laundry businesses in Nigeria depend on direct solar energy for drying clothes.

Due to the limited electrification of homes, particularly in rural areas, most homes and offices are designed to use sun rays as a source of light during the day. Sunshine is let in through windows and, when necessary, is kept out by shutters and blinds.

Problems Associated With Solar Energy Resources and Their Present Usage.

It has been argued that Nigeria has not embarked on use of solar energy collectors because of the high cost of these collectors and other conversion equipment, and because of the shortage of skilled workers with expert knowlege of solar energy. This problem may be minimized, however, if the emphasis is not so much on the adoption of complex technology. Rather, small, simple units to satisfy demands of small centres could first be constructed, and a program of solar energy utilization could be expanded.

Another problem is the uncontrollable spatial variations in solar radiation supply. Local turbidity and cloudiness,

particularly in the southern states might hinder plans for reliance on solar energy. Present use of solar energy for drying is often interrupted by high atmospheric humidity, clouds, and rainfall. This results in moulding and the deterioration of the quality of the products. Furthermore, even if weather conditions should remain favorable, drying can take place only during sunlight hours. Finally, a constant watch must be maintained to ensure that drying products are not damaged or eaten by domestic livestock or vermin.

One solution to these problems may be the use of solar kilns in the form of "green houses" such as those used by industrialized nations to grow crops under adverse weather conditions. Solar kilns collect and store energy, enabling drying to continue during both day and night. The glass-covered kilns would prevent rain and pests from reaching the commodities to be dried, and the temperature and humidity level within the kiln could be regulated. This technique would save time and result in a higher quality product.

The associated benefits of solar energy in terms of reduced pollution and increasing concern over depletion of non-renewable resources require that immediate attention be given to this abundant source of energy in Nigeria.

Animate Sources of Energy

Animals

Transport animals such as horses, donkeys, and camels

are found primarily in the northern parts of Nigeria. The availability of these animals is limited, as Table 2.4 indicates. Approximately 30,000 of the available horses are used for transportation purposes, whether it be for riding or for carrying very light loads. Most of the donkeys are used for carrying loads, and camels are used for both human transport and for carrying loads.

In the agricultural sector about 5,000 bullocks are used in northern parts of Nigeria for cultivation. This use of ox-drawn equipment is limited by the shortage of fodder and heavy infestations of tsetse flies.

Small animals such as fowl, goats, and sheep are kept by almost all rural dwellers in Nigeria. Dung from these animals provides a major source of fertilization for crops grown around villages, thereby serving as an indirect source of energy. Fertilization of soil with waste products is not often practiced by organized large-scale farmers, except in government and institutional farms where the requisite equipment and personnel are available.

The use of dried animal dung as a source of fuel is practiced only by nomadic Fulanis in northern Nigeria.

Human

Human energy is an important component of the country's energy supply because all rural industries are labor intensive, as are most of the industrial activities of the country in

Table 2.4 Estimated Numbers of Large Domestic Animals in Nigeria

Species	States			Total
	Northern States	Eastern States	Western States	
Horses	430,900	---	300	431,200
Donkeys	2,085,000	---	---	2,085,000
Camels	16,800	---	---	16,800
Cattle	10,255,700	434,100	168,800	10,858,600

Adapted from: FAO, Agricultural Development in Nigeria, 1965-1980, Rome: United Nations, 1966, p.216.

general. The population of Nigeria is about 80 million, with a growth rate of almost 2.5 percent per year.[1] About 95 percent of the population is self-employed or work as unpaid family laborers. Almost 80 percent of the population live in rural areas and work primarily in agriculture, trade, and service sectors. Thus, the majority of Nigerians are engaged in agriculture in rural areas, as Table 2.5 illustrates.

The present and potential decline of the agricultural population in relation to total population is a result of increased migration of the labor force from rural to urban centres. This large scale movement of workers from rural areas has caused a shortage of laborers in agriculture, while creating a situation of high unemployment in Nigerian cities. Table 2.6 shows urban and rural population figures, and Table 2.7 presents an estimate of the Nigerian labor force.

The greatest proportion of unemployed migrant workers in Nigerian cities are those who completed primary and secondary school but who did not continue their education. Unwilling to return to work as field hands, they seek employment in the service sector of cities, where employment opportunities are limited. Table 2.8 outlines employment status in urban and rural areas.

---

[1] Researchers differ on the exact population of Nigeria at a given time. This is due to the lack of reliable census figures. Fortunately, these differences do not affect the validity of this study.

Table 2.5 Nigerian Estimated Agricultural Population in Proportion to Total Population

	1963/64	1967/68	1973/74	1979/80[1]
Total Pop.(in Millions)	55.6	61.4	72.2	86.2
Agric. Pop.(in Millions)	38.5	41.9	47.8	55.3
Non-Agric.Pop.(in Millions)	17.1	19.5	24.4	30.9
Agric. Pop Estimates as Proportion of Total Pop.	70%	69%	67%	65%

[1] Estimates, based on growth rate of 2.5 - 3 percent per annum.

Adapted from: FAO, Agricultural Development in Nigeria, 1965-1980, Rome: United Nations, 1966, p.302.

Table 2.6 Nigerian Population - Urban and Rural, Actual and Projected for 1985

Year	Population (In Thousands)			Percent Urban	Annual Rate of Increase (Percent)			Urban-Rural
	Urban	Rural	Total		Urban	Rural	Total	
1950	4,742	29,589	34,331	13.81	---	---	---	---
1955	6,055	32,186	38,241	15.83	5.01	1.70	2.18	3.31
1960	7,668	35,279	42,947	17.85	4.84	1.85	2.35	2.99
1965	9,830	38,846	48,676	20.20	5.09	1.94	2.54	3.15
1970	12,535	42,539	55,074	22.76	4.98	1.83	2.50	3.15
1975	16,098	46,924	63,022	25.54	5.13	1.98	2.73	3.15
1980	20,772	52,012	72,784	28.54	5.23	2.08	2.92	3.15
1985	26,878	57,822	84,700	31.73	5.29	2.14	3.04	3.15

Source: Wouter Tims, Chief of Mission and Co-ordinating author, Nigeria: Options for Long Term Development. Report of a Mission Sent to Nigeria by the World Bank. London: The John Hopkins University Press, 1974, p.202.

Table 2.7 Nigerian Population and Labor Force Estimates and Projections by Sex, 1950-85
(in thousands)

	POPULATION			LABOR FORCE		
Year	Male	Female	Total	Male	Female	Total
1950	17,322	17,009	34,331	9,334	6,711	16,045
1955	19,302	18,939	38,241	10,199	6,971	17,170
1960	21,685	21,262	42,947	11,249	7,273	18,523
1965	24,579	24,097	48,676	12,500	7,951	20,451
1970	27,686	27,387	55,073	13,803	8,731	22,534
1975	31,577	31,445	63,022	15,242	9,652	24,895
1980	36,381	36,403	72,784	16,905	10,702	27,607
1985	42,269	42,269	84,701	18,988	11,986	30,974
	Annual Rate of Increase (Percent)					
1950-55	2.2	2.2	2.2	1.8	0.8	1.4
1955-60	2.3	2.4	2.4	2.0	0.9	1.5
1960-65	2.5	2.5	2.6	2.1	1.8	2.0
1965-70	2.4	2.6	2.5	2.0	1.9	2.0
1970-75	2.7	2.9	2.6	2.0	2.0	2.0
1975-80	2.9	3.0	2.9	2.1	2.1	2.1
1980-85	3.0	3.1	3.1	2.4	2.3	2.3

Source: Ibid., p.203.

Table 2.8 Nigerian Employment Status in Rural and Urban Areas

By industry:	(Percent) Urban	Rural
Agriculture	25.7	80.0
Employers & Self-Employed Workers	20.3	46.4
Employees	0.6	0.7
Unpaid Apprentices & Household Workers	4.8	32.9
Non-Agriculture	74.3	20.0
Employers & Self-Employed Workers	47.9	17.1
Employees	21.0	1.5
Unpaid Apprentices & Household Workers	5.4	1.4

Source: Ibid., p.29.

Employment and Productivity

In absolute terms, a sizeable majority of Nigerians are employed, in either agricultural or non-agricultural activities; but less than half of the total labor force is active economically. The full potential of the labor force is not being tapped in Nigeria, resulting in underemployment. Table 2.9 shows the economically active portion of the population of Nigeria for selected years.

Two significant facts emerge here. First, the majority of the economically active population is engaged in agricultural activities, and this majority is decreasing; in 1963/64 it represented 80% of the economically active population of Nigeria, in 1973/74 it was 78%, and in 1979/80 it was estimated at 72%. Furthermore, the slack is not being taken up by non-agricultural sectors, resulting in a steady decrease in the number of workers who are economically active. Secondly, the female population of Nigeria has not increased its economic participation in the last three decades. Yet, females comprise 40% of the economically active population of Nigeria.

Although agriculture claims the highest proportion of economically active laborers, there has been a steady decline in the agricultural productivity of Nigeria. This is due largely to under-employment of workers in the agricultural sector, a situation which results from the decreasing size of farms.

Table 2.9 Estimated Employment and Productivity in Nigeria

In Millions:	1963/64	1967/68	1973/74	1979/80
Population Total	55.6	61.4	72.2	86.2
Economically Active Population	25.1	27.2	31.2	36.1
Male	15.0	16.3	18.7	21.7
Female	10.1	10.9	12.5	14.4
Agriculture	20.1	21.2	23.4	26.0
Non-Agriculture	5.0	6.0	7.8	10.1

Source: FAO, Agricultural Development in Nigeria, 1965-1980, Rome: United Nations, 1966.

In addition to pressures of a rapidly multiplying population and restrictions of the traditional land tenure system, activities of "gentlemen farmers" have exacerbated the land shortage problem. Those farmers who are wholly dependent on agricultural activities for their livelihood are robbed of farm lands by these salaried workers who are actively engaged in farming as a secondary occupation. Their status in the area enables "gentlemen farmers" to acquire particularly productive land and cheap labor. Their earnings are neither declared nor taxed, and their gross profit is high.

Advantages enjoyed by "gentlemen farmers" discourage local farmers from competing with them in a market-economy. Because they grow their own produce these salaried workers need not do business with local farmers, thereby depriving them of a share of the market. This situation has not been investigated by policymakers, and the local farmers continue to bear the blame for decreased crop yields, their reluctance to adopt modern farming techniques, and their unwillingness to change from subsistence farming to a market-oriented agro-economy.

Non-agricultural sectors of the economically active labor force include salaried workers and self-employed businessmen. On the basis of their education salaried employees may be divided into two categories: clerical or unskilled laborers at one level, and executive officers and skilled personnel at a higher level. Chances of upward

mobility for workers from lower levels are extremely slim. The over-riding emphasis on academic qualifications, with little or no regard for experience or job performance, provides workers with no incentive to develop their full potential. They cultivate nonchalant attitudes toward their work, and perceive their jobs merely as temporary, pending an opportunity to enter a higher academic institution and acquire "qualification". This attitude is reflected in their delay or refusal to render services to customers, whether it entails bank services, providing information about ministries, administering medical aid, or a host of other services.

Although the second level of workers enjoy high salaries and the best working conditions, their skills are also underutilized. All too often these highly trained personnel are not given the opportunity to demonstrate their expertise. A specialist in the field of geology, for example, may be assigned to the position of administrator in a land cultivation agency. Here he plays the role of co-ordinator, having a great deal of authority, but rarely using his specialized training. Similarly, an engineer may work out the construction of a bridge on paper, but rarely get involved in the actual construction process.

Next to those involved in agriculture, self-employed businessmen, ranging from hawkers to high level trading merchants, make up the highest proportion of the population which is gainfully employed. High profits entice these

entrepreneurs to work towards realizing their full potential.

Electric Power

Nigeria is blessed with a widespread network of rivers (Figure 2.5). Presently, only one of the country's 11 drainage basins has been developed for hydroelectric power. Yet, total potential hydroelectric power in Nigeria is estimated at 17 billion kilowatt hours (kWhr) (United Nations, 1976).

The first set of hydroelectric power stations was constructed by a private company on Jos Plateau, using the Niger River upstream of Jebba. These stations supply power to the mining industries in the area, with an energy capacity of 25 MW (Schatzl, 1969).

The most recent hydro power development is at Kainji Station. The construction of Kainji Dam was begun in 1964 and completed in 1968. The lake formed by the dam extends 136 km upstream and covers an area of 1280 (km^2) having a usable storage capacity of 11466.9 million m^3 (The Federal Ministry of Information, 1976). The first phase of the project, designed to supply most of the power needed by industries, was completed by the installation of four Kaplan-type turbines and drive generators rated 80MW, 80MVA output. The main transformers, situated between the Dam and the power house, are rated at 170 MVA and convert the voltage from 16 kV to 330 kV. This is fed to a switchyard from where it is transmitted to the major

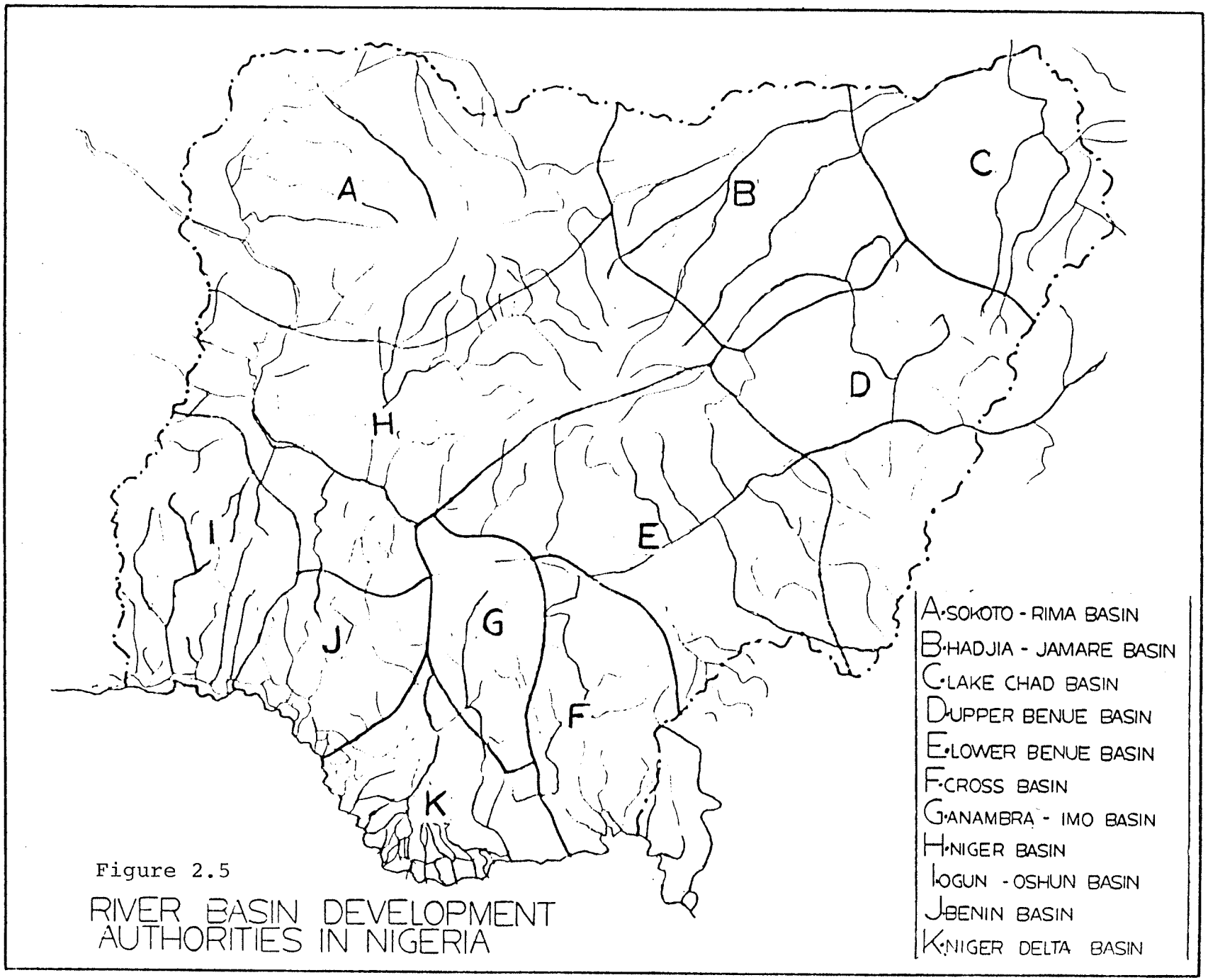


Figure 2.5

RIVER BASIN DEVELOPMENT AUTHORITIES IN NIGERIA

substations at Jebba, Benin, Kaduna and Onitsha. At each substation the voltage is stepped down from 330 kV to 132 kV before power is supplied to the distribution centres. By 1975 two additional generators were installed and a second transmission line constructed to boost the supply to the southern parts of Nigeria, especially Lagos (Ogumtoyimbo, Areola, & Filani, 1978). In addition to fulfilling the primary objective of supplying adequate and cheaper electricity for industrial and domestic consumption, the Kainji Dam Project created opportunities for the development of agriculture through irrigation, the development of fisheries, and of transportation.

Of the total installed capacity of electricity-generating plants (960 MW in 1976), 43.75 percent was in thermal stations. Power stations at Jora, Ughalli, Aram, Ojo River and Kaduna have a total thermal capacity of approximately 340 MW. Table 2.10 illustrates the estimated installed capacity of industrial and public electric generating plants by type.

Electricity Production

There has been tremendous growth in the generating capacity of power stations in Nigeria; the total installed generating capacity increased from 173 MW in 1960 to approximately 960 MW in 1976. The pattern of growth is illustrated in Table 2.11. The actual amount of electricity generation has increased with the growing capacity of power stations; electricity generation in the country increased from 554

Table 2.10 Estimated Installed Capacity of Industrial and Public Generating Plants in Nigeria, by Type

(Quantities in Megawatts)
Between 1970-1976

Year	Industrial & Public			Industrial			Public		
	Total	Hydro	Thermal	Total	Hydro	Thermal	Total	Hydro	Thermal
1970	805	320	485	4	---	4	801	320	481
1971	805	320	485	4	---	4	801	320	481
1972	883	320	563	4	---	4	879	320	559
1973	855	320	535	4	---	4	851	320	531
1974	860	320	540	5	---	5	855	320	535
1975	860	320	540	5	---	5	855	320	535
1976	960	420	540	5	---	5	955	420	535

Source: United Nations, World Energy Supplies, 1970-1976. New York, 1978.

Table 2.11 Generating Capacity of all Power Stations in Nigeria (By Megawatts)

Year	Generating Capacity	Percentage Increase
1960	173	---
1961	207	+19.65
1962	238	+14.97
1963	256	+7.56
1964	274	+7.03
1965	358	+30.66
1966	432	+20.67
1967	450	+4.17
1968	485	+7.78
1969	804	+65.77
1970	805	+0.12
1971	805	+0.00
1972	883	+9.69
1973	855	-3.17
1974	860*	+0.58
1975	860*	+0.00
1976	960*	+11.63

*Estimates

Derived from: United Nations, World Energy Supplies, 1950-1976, New York, 1978.

gigawatthours (GWhr) in 1960 to approximately 3400 GWhr in 1976. Increased production is shown in Table 2.12.

Despite the great potential for thermal generation, Nigeria is presently placing more emphasis on hydroelectric power. This is partly due to the less complex operational and maintenance requirements of hydroelectricity, and is partly in response to the need to conserve non-renewable resources consumed through production of thermal electricity. Table 2.13 illustrates the amount of fuel used in the generation of electricity from 1960 through 1976.

Consumption of Electricity

Electricity consumption in Nigeria has increased tremendously over the past decade; consumption rose from 1550 GWhr to 3400 GWhr between 1970 and 1976, representing an annual growth rate of about 17 percent. The per capita electricity consumption increased from approximately 30 kWhr to about 50 kWhr over the same period. Industrial and commercial consumers are the major users of electricity in the country and account, on the average, for about 60 percent of total electricity consumed in the country. Although the amount of electricity consumed by commercial and industrial sectors is expected to rise substantially by the end of the current development plan period in 1980, its share of the total electricity consumption in the nation is expected to fall to about 55 percent, because of increasing

Table 2.12 Production of Electricity in Nigeria, by Type

(Quantities in Gigawatthours)

Year	Total	Percent Change	Total Thermal Production	Total Hydro Production	Proportion of Hydro to Total Power in %
1960	554	---	459	95	17.15
1961	642	+15.88	541	101	15.73
1962	750	+16.82	642	108	14.40
1963	893	+19.07	775	111	13.21
1964	1024	+14.67	898	126	12.30
1965	1177	+14.94	1045	132	11.21
1966	1279	+9.67	1135	144	11.26
1967	1105	-13.60	971	141	12.76
1968	1248	+12.94	979	126	10.10
1969	1550	+24.20	349	899	58.00
1970	1550	+00.00	185	1365	88.06
1971	1820	+17.42	246	1574	86.48
1972	2158	+18.57	711	1447	67.05
1973	2625	+21.64	767	1858	70.78
1974	2828	+7.73	870	1958	69.24
1975	3211	+13.54	870	2341	72.91
1976	3400	+5.89	875	2525	74.26

Adapted from: United Nations, World Energy Supplies, 1950-1974, New York, 1976.
United Nations, World Energy Supplies, 1972-1976, New York, 1978.

Table 2.13 Fuel Used for Generating Electricity, in Nigeria by Type 1960-1973

Year	Coal in Thousand Metric Tons	Gas/Diesel in Thousand Litres	Natural Gas in Thousand Cubic Metres	Residual Fuel Oil in thousand Litres
1960	128.3	N/A	N/A	N/A
1961	136.0	N/A	N/A	N/A
1962	184.8	N/A	N/A	N/A
1963	151.2	35,582	26,774	152,994
1964	172.8	60,354	44,405	161,363
1965	198.3	88,162	70,508	185,753
1966	166.6	123,435	154,684	181,753
1967	56.9	85,821	95,433	172,297
1968	17.3	105,519	126,982	141,233
1969	1.3	38,325	31,110	72,756
1970	0.5	18,325	39,553	14,825
1971	---	19,466	62,946	12,361
1972	0.5	34,641	106,011	46,316
1973	39.6	48,425	130,704	94,545

Source: Federal Office of Statistics, Nigeria, Digest of Statistics, volume 14, 1965, 1967, volume 19, 1970, volume 23, 1974.

demands by other sectors. Most electricity consumption takes place in urban centres, with the urban-rural ratio being about 49:1. Table 2.14 illustrates electricity consumption by major sectors.

Annual increases in the amount of electricity consumed by the main classes of consumers are a reflection of not only increased consumption per se, but also of the increasing number of customers within the various classes. This is illustrated in Table 2.15.

The annual growth rate of electricity consumption in Nigeria would have been higher were the generating capacity, distribution channels, and skilled manpower available to completely satisfy actual electricity demands. This fact was recognized by those who formulated the Third National Development Plan 1975-80 when they remarked,

> The rapid expansion of the economy after the civil war, marked as it was by phenomenal growth of industries, commerce, and urbanization, has left the National Electric Power Authority (NEPA) hard pressed to maintain an adequate supply of power. At present the demand for power is far from being met in most areas of the country, even without taking into consideration the high level of suppressed demand.

General Problems Associated with Power Supplies

The major problem associated with power supplies in Nigeria is lack of reliability; frequent power failures, load shedding, and deteriorating quality of service are problems faced by users of electric power. This is partly due to the rapidly growing demand for electricity, which is increasing

Table 2.14 Estimated Electricity Consumption Between 1970-1976, in Nigeria, by Sector

Year	Total Consumption in GWhr	Percentage Increase	Total Industrial and Commercial		Residential		Others	
			Total in GWhr	% Increase	Total in GWhr	% Increase	Total in GWhr	% Increase
1970	1550	---	953	---	348	---	249	---
1971	1820	+17.4	1080	+13.0	467	+34.2	273	+9.6
1972	2158	+18.6	1278	+18.3	573	+22.7	307	+12.5
1973	2625	+21.6	1599	+25.0	633	+10.5	393	+18.0
1974	2828	+7.7	1483	-7.3	752	+18.8	593	+50.9
1975	3211	+13.5	1430	-3.6	896	+19.3	885	+49.2
1976	3400	+5.9	1667	+16.6	970	+8.3	763	-13.8

Derived from: United Nations, World Energy Supplies, 1972-76, New York, 1977.
Nigeria's Economic & Financial Indicator, 1970-1976.

Table 2.15 Number of Customers, by Class
1973-1975

Class of Customer	Total No. of Customers 1973/74	1974/75	Percent Change
Residential	309,041	351,713	13.8
Commercial	79,284	83,423	5.2
Industrial	2,012	2,224	10.5
TOTAL	390,337	437,360	12.0

Souce: National Electric Power Authority, Annual Report and Accounts For The Year Ended 31st March 1975. Federal Republic of Nigeria, 1975.

at a much faster rate than the National Electric Power Authorities are able to supply. This problem might be alleviated if the power-supplying industry was given information necessary to forecast effectively growing patterns of economic activity in public and private sectors, enabling officials to plan accordingly.

A second cause of unreliable power supplies is the time lag between planning, construction, and operation of expansion programs for existing power supply units. For example, the average length of time taken to provide additional hydraulic power capacity at an already existing Kainji hydro station is estimated to be 42-50 months. The shortage of skilled management and maintenance personnel, particularly for thermal plants, as well as dependence on foreign nations for equipment and expertise are major causes of this time lag.

The Nigerian government is attempting to solve the manpower shortages by placing more emphasis on hydro power developments, since the National Electric Power Authority has more adequate management and maintenance personnel in this field. By phasing out small and uneconomic thermal power plants scattered throughout the country, while maintaining supplies by extending power grids, available manpower can be concentrated and efficiently utilized at a few major locations rather than being diffused throughout the nation.

The non-industrial consumption of electricity per capita is extremely low; in rural areas electricity is merely

a luxury, and is used for 3 to 4 hours per day, primarily for homelighting. Since most government power production projects are highly capital intensive, the high cost of electricity renders it accessible to only those in high income groups. This might not be the case if alternate sources of electricity were introduced; windmills and small solar power plants could provide cheap energy supplies and would be well-suited to low demands of the rural majority.

The environmental impact of major hydroelectricity projects has not been taken into consideration in the past. With increased population growth and the need for more productive land, flooding of areas for dam projects may become a problem and might provide the needed impetus to explore alternate sources of electricity.

The government of Nigeria is aware of the possibility that the social and economic development of the country might be disrupted by power shortages, and has proposed a series of plans and actions to accommodate demand growth and to improve the quality of service. Yet, consideration must not only be given to power supplies per se, but to cheap and reliable power which could be made accessible to the majority of Nigerians. Alternate sources of power need to be investigated not only on the basis of economics, but also on social and technical realities of Nigerian society.

Non-Renewable Energy Sources

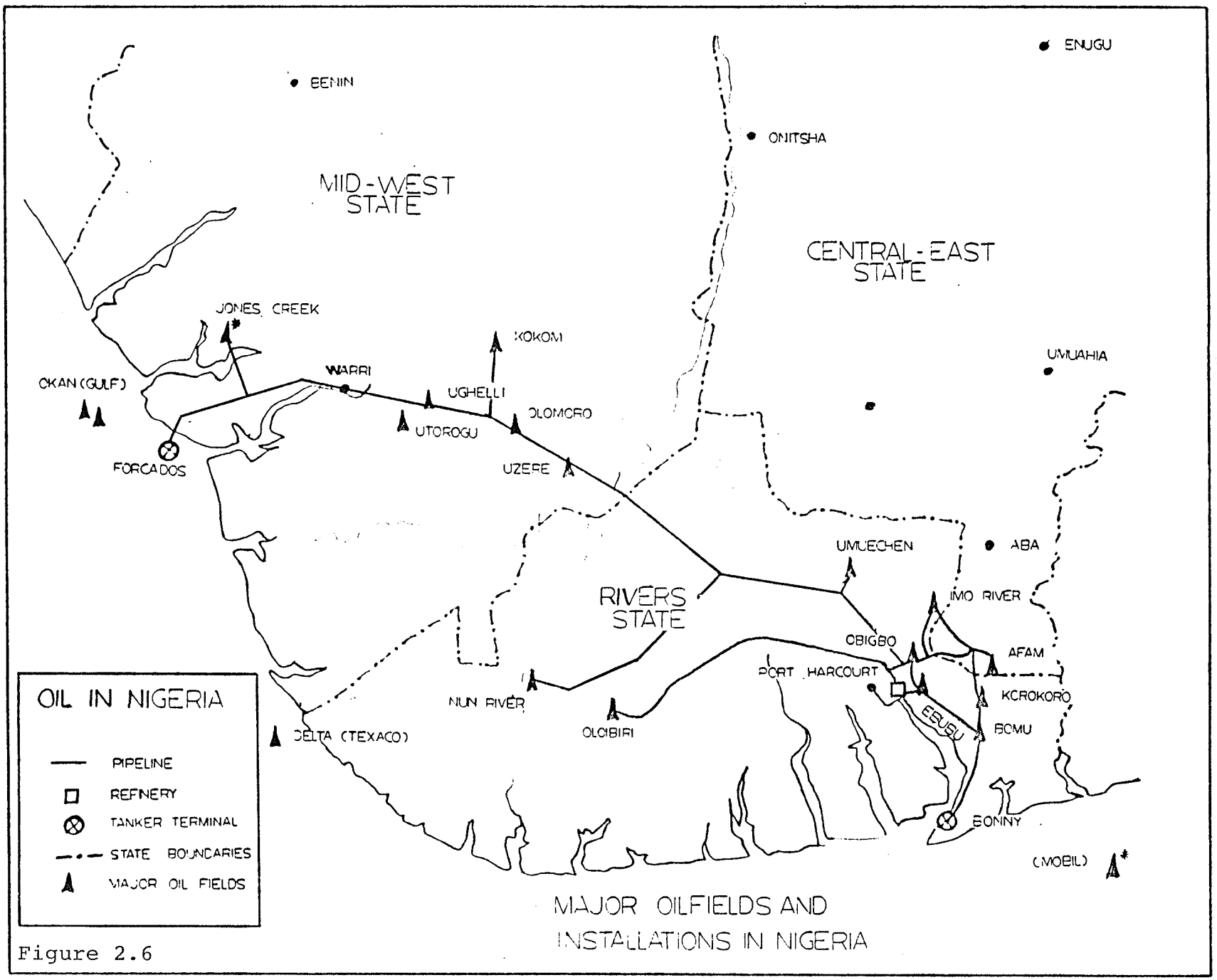
Crude Oil

Over half of Nigeria (about 1 million km^2) is covered by sedimentary basins possibly containing oil-bearing rocks. Most of the rich crude oil fields are concentrated in coastal regions, less than 100 km from the Atlantic Ocean. Most known oil deposits are around Warri and Port Harcourt (figure 2.6). Estimated proven crude oil reserves in Nigeria in January 1978 totalled 2.6 billion tonnes. This represents 32 percent of estimated reserves in Africa and 2.2 percent of estimated total world reserves (Oil and Gas Journal, Dec. 1977). Illustrated in Table 2.16 is crude oil productive capacity of Nigeria and other OPEC countries.

Nineteen companies were involved in Nigerian oil operations in 1974; 11 American, one British Dutch, one French, one German, one Italian and one Japanese, and three Nigerian.

The success ratio of drilling has been very high. On the average, 43 percent of all exploration wells result in new fields, and 84 percent of appraisal and developmental drilling is successful (Tims, 1974).

Nigerian oil is light and has low sulphur content, which has made the demand fairly steady. The low sulphur content provides a decisive advantage, since Nigerian petroleum can be blended with petroleum used in countries with high environmental control standards in order to reduce the



MAJOR OILFIELDS AND INSTALLATIONS IN NIGERIA

Figure 2.6

Table 2.16 Estimated Productive Capacity of OPEC Countries

Million Tonnes/Day

(1979)

Countries	Capacity			Latest Post-Embargo Peak
	Installed	Maximum Sustainable	Available	
Saudi Arabia	1.71	1.30	1.30	1.38 (Dec 78)
Iran	0.95	0.75	0.54	0.91 (Nov 76)
Iraq	0.53	0.47	0.47	0.47 (Jun 79)
Kuwait	0.40	0.35	0.28	0.42 (Dec 76)
Venezuela	0.37	0.34	0.34	0.42 (Jun 74)
U.A.E.	0.34	0.32	0.25	---
Nigeria	0.33	0.30	0.30	0.32 (Jan 79)
Libya	0.33	0.29	0.29	0.29 (Mar 77)
Indonesia	0.24	0.22	0.22	0.23 (Mar 77)
Algeria	0.16	0.12	0.12	0.14 (Jun 79)
Neutral Zone	0.09	0.08	0.08	0.09 (Dec 76)
Qatar	0.09	0.08	0.08	0.08 (Dec 75)
Ecuador	0.04	0.03	0.03	0.04 (May 74)
Gabon	0.03	0.03	0.03	0.03 (Dec 77)

Sources: Oil and Gas Journal, May 21, 1979.

sulphur content to the level prescribed by legislation. The sulphur content of Nigerian oil is relatively low compared to the average sulphur content of petroleum from Venezuela or countries of the Middle East (Table 2.17). As is illustrated in Table 2.18 the prices of crude oil reflect the quality of that oil.

As proven oil reserves in Nigeria increase, so does crude oil production (Table 2.19).

Distribution of Oil

Over 95 percent of the crude oil produced in Nigeria is exported. The concentration of crude oil fields in the coastal regions of the country provides the advantage in both international shipping charges and the security of supply routes. Nigerian oil exports have increased significantly between 1970 and 1975 (Table 2.20). Western Europe is the largest importer of Nigerian crude oil (Table 2.21).

In terms of countries, the United States imports the greatest proportion of Nigerian oil (Table 2.22).

Table 2.17 Characteristics of Major World Crude Oil Export Streams

Designation of Crude Oil	Producing Country	Gravity °API	Pour Point °C	Percent Sulphur
Arabian heavy	Saudi Arabia	28.2	-34	2.84
Arabian light	Saudi Arabia	33.4	-34	1.80
Iranian heavy	Iran	30.8	-21	1.60
Iranian light	Iran	33.5	-29	1.40
Kir kuk	Iraq	35.9	-36	1.95
Kuwait	Kuwait	31.2	-18	2.50
Brega	Libya	40.4	-1	0.21
Hassi Messaoud	Algeria	44.4	-24	0.14
Bonny light	Nigeria	37.6	+2	0.13
Minas	Indoneia	35.2	+32	0.09
Taching	China	33.0	+35	0.04
Tyumen	USSR	34.0	-20	0.97
Romashkinskaya	USSR	32.6	-29	1.61
North Slope	U.S.A.	26.8	-21	1.04
---	Venezuela	26.0	---	1.52

Source: Oil and Gas Journal, March 29, 1976.

Table 2.18

OPEC Countries: Crude Oil Prices U.S. $ Per Barrel

	Gravity °API	Percent Sulphur	4th Quarter 1978		1st Quarter 1979		2nd Quarter 1979		3rd Quarter 1979		4th Quarter 1979	
			Operating Company Cost	Direct Sales Price	Operating Company Cost	Direct Sales Price	Operating Company Cost	Direct Sales Price	Operating Company Cost	Direct Sales Price	Operating Company Cost	Direct Sales Price
Algeria	42	.10	14.10	14.10	14.10	14.10	14.80	14.80	23.50	23.50	26.20	26.20
Qatar	40	1.17	12.88	13.19	14.35	14.54	17.21	17.44	21.26	21.49	25.19	25.42
Libya	40	.22	13.62	13.85	14.96	15.21	19.22	19.49	23.05	23.45	23.71	26.21
U A E	39	0.75	12.73	13.26	14.02	14.61	16.79	17.50	20.68	21.56	24.11	25.56
Iraq	35	1.95	12.66	12.66	13.70	13.70	17.27	17.27	19.96	19.96	23.29	23.29
Indonesia	35	0.09	12.25	13.55	12.60	13.90	15.05	16.35	19.38	20.68	21.18	22.48
Saudi Arabia												
Light	34	1.70	12.50	12.70	13.14	13.34	15.48	15.68	17.80	18.00	20.77	22.00
Berri	39	1.16	13.02	13.22	13.86	14.06	18.13	18.33	21.12	21.32	22.26	23.59
Heavy	27	2.85	11.82	12.02	12.31	12.51	14.60	14.80	16.97	17.17	18.61	21.17
Medium	31	2.40	12.12	12.32	12.69	12.89	15.00	15.20	17.34	17.54	20.35	21.54
Iran												
Light	34	1.35	12.59	12.81	13.45	13.45	17.31	17.31	22.10	22.10	24.92	24.92
Heavy	31	1.60	12.27	12.49	13.06	13.06	16.71	16.71	20.00	20.00	24.19	24.19
Nigeria	34	0.16	13.63	14.01	14.37	14.73	19.25	19.63	23.04	23.39	24.69	25.62
Kuwait	31	2.50	12.07	12.22	13.21	13.36	16.78	16.93	19.34	19.49	22.75	24.14
Gabon	29	1.26	11.79	12.80	12.07	13.23	14.90	16.55	17.60	20.44	16.66	20.44
Ecuador	28	0.93	11.14	12.25	14.94	15.94	21.12	22.12	21.13	22.13	21.98	23.28
Venezuela	26	1.52	12.52	12.72	13.16	13.36	15.86	16.06	19.11	19.31	20.81	20.81
OPEC AVERAGE			12.64	12.91	13.51	13.79	16.80	17.08	19.84	20.14	22.46	23.49

Table 2.19 Nigerian Crude Oil Production 1958-1979

Year	Crude Oil Production In Million Tonnes	Percent Change
1958	0.257	---
1959	0.561	+118
1960	0.872	+55
1961	2.283	+162
1962	3.346	+47
1963	3.793	+13
1964	5.978	+58
1965	13.567	+127
1966	20.710	+53
1967	15.832	-24
1968	7.053	-55
1969	26.794	+280
1970	53.791	+101
1971	75.928	+41
1972	90.392	+19
1973	101.985	+13
1974	112.788	+11
1975	88.800	-21
1976	102.302	+15
1977	103.301	+ 0.98
1978	95.000	-8
1979	114.063*	+20*

*Estimate

Sources: Maduiibeva, "Oil and Nigeria's Economic Development", African Affairs, vol.75, #300, July, 1976, p.313.

United Nations, World Energy Supplies, 1972-76, New York 1978, p.10.

Petroleum Economist, Jan. 1979, p. 6 and Nov. 1979, p.446.

United Nations, Statistical Yearbook, New York, 1978, p.10.

Table 2.20 Nigerian Crude Oil Production and Exports

Year	Production	Exports		Exports as Percentage of Total
	Million Tonnes	Total Million Tonnes	Percent Increase	
1963	3.80	3.75	---	99
1964	6.00	5.88	+57	98
1965	13.57	13.23	+125	98
1966	20.71	19.33	+46	93
1967	15.83	15.01	-22	95
1968	7.05	7.18	-52	102
1969	26.79	26.98	+276	101
1970	53.79	52.10	+93	97
1971	75.93	73.98	+42	97
1972	90.40	88.43	+20	98
1973	101.99	99.69	+13	98
1974	112.79	109.66	+10	97
1975	88.86	87.31	-20*	98*
1976	103.36	100.24	+15*	97*
1977	104.46	99.59	-1*	95*
1978	94.61	86.63	-13*	92*
1979	114.53*	N/A	---	---

*Estimates.

Sources: Madujibeya, S.A.," Oil and Nigerian Economic Development", African Affairs, Vol. 75, Number 300, July, 1976, p.313.

Petroleum Economist, September 1979, Vol. XLVI, Number 9, p.391; June 1979, pp. 44 and 224.

Table 2.21 Proportion of Nigerian Oil Imports, By Regions

Regions which import Nigerian Oil	Percentage of Total Exports
Western Europe	84%
America	14%
Africa	2%

Table 2.22 Nigerian Crude Oil Exports in Tonnes, Month of February, 1977

Destination	Quantity	Percent of Total
Belgium	65,460	1
France	1,038,381	12
Holland	1,724,033	19
West Germany	254,000	3
United Kingdom	758,529	8
United States	3,812,423	42
West Indies	1,175,042	13
Gabon	40,628	0.5
Ghana	101,677	1
Sierra-Leone	16,558	0.2
TOTAL	8,986,731	100

Source: Ministry of Petroleum Resources, Monthly Petroleum Information, February 1977, Lagos, p.23.

Oil Refineries

The first oil refinery in Nigeria was established in 1965 at Alesa Eleme, near Port Harcourt. This was a joint venture operated by the Nigerian Petroleum Company (65 percent), Shell BP (22.5 percent) and British Petroleum (22.5 percent). Its annual output of about 3 million tonnes was at least 1 million tonnes short of national requirements (See Table 2.23). To meet national requirements Nigeria was forced to import refined petroleum products (Table 2.24).

In an attempt to ensure future supplies of refined petroleum products a second refinery was constructed at Warri, on the western coast of the Niger Delta. The 5 million tonnes capacity of this refinery brings the national capacity to 8 million tonnes per year. A third refinery is presently being constructed at Kaduna, and some officials estimate that this refinery will bring Nigerian petroleum product output to 11 million tonnes per year, with the Kaduna refinery having a producing capacity of 3 - 4 million tonnes per year. Assuming that the consumption pattern remains relatively constant, by the mid 1980s Nigeria should be able to reduce her import of oil products to a minimal level (Petroleum Economist, April 1978).

Consumption of Nigerian Petroleum Products

Petroleum consumption in Nigeria more than doubled between 1966 and 1976. The greatest increase in consumption

Table 2.23 Production of Energy Petroleum Products, in Nigeria by Type

(Quantities in Million Tonnes)

Year	Total	Motor Gasoline	Kerosene	Fuel Oils	Liquefied Petroleum Gases
1966	1.544	0.339	0.224	0.980	0.001
1967	0.571	0.133	0.103*	0.333*	0.002*
1968	0.002	---	---	---	0.002
1969	0.019	---	---	---	0.019
1970	0.961	0.219	0.151	0.590	0.001
1971	2.021	0.442	0.273	1.304	0.002
1972	2.151	0.517	0.307	1.318	0.009
1973	2.734	0.717	0.419	1.586	0.012
1974	2.650	0.623	0.372	1.641	0.014
1975	2.207	0.535	0.294	1.364	0.014

*Estimates

Sources: United Nations, World Energy Supplies, 1950-1974, New York, 1975.
United Nations, World Energy Supplies, 1971-1975, New York, 1976.

Table 2.24 Nigerian Imports of Petroleum Energy Products, by Type

(Quantities in Million Tonnes)

Year	Total	Motor Gasoline	Kerosene	Fuel Oils	Liquefied Petroleum Gases
1966	0.078	0.015	0.032	0.023	0.008*
1967	0.474	0.126	0.076	0.268	0.004*
1968	1.061	0.274	0.198	0.583	0.006*
1969	1.218	0.322	0.236	0.649	0.011*
1970	0.685	0.233	0.142	0.293	0.017*
1971	0.051	0.022	0.014	0.002	0.013*
1972	0.147	0.115	0.018	0.003	0.011*
1973	0.165	0.100	0.047	0.008	0.010*
1974	0.309	0.099*	0.116*	0.086*	0.008*
1975	1.020	0.426*	0.236	0.052*	0.006*

*Estimates

Source: Ibid.

was witnessed in the consumption of motor gasoline and fuel oil, which accounted for 35.0 and 47.0 percent respectively of total petroleum product consumption (Table 2.25). The per capita consumption of energy petroleum products increased from 27 kilograms (kg) in 1970 to 46 kg in 1976, while the per capita consumption of fuel oil increased from 15 kg to 22 kg and the per capita consumption of gasoline increased from 8 kg to 17 kg over the same period.

General Significance of the Oil Industry

Over 80 percent of Nigerian government revenue is derived from the oil industry. The industry constitutes about 41 percent of the GNP and 45 percent of the GDP. Even though the contribution of the oil industry may be expected to rise in absolute terms in the future, its proportion of the total revenue might drop considerably because of expansion in other economic sectors.

Oil, which made up a small component of the country's exports in 1962, grew to almost 33 percent of Nigerian exports in 1966, and 92 percent in 1974. The contribution of oil to the nation's foreign exchange reserves has also increased, from 8.5 percent in 1964 to approximately 86 percent in 1974. In 1976 about 4500 Nigerians were directly employed by the oil industry while firms linked to the industry employed about 1,500 Nigerians.

The petroleum industry has enabled Nigeria to embark

Table 2.25 The Consumption of Petroleum Energy Products in Nigeria

(Quantities in Million Tonnes)

Year	Apparent Total Petroleum Energy	CONSUMPTION Gasoline	Jet Fuels Kerosene	Fuel Oils	Liquefied Petroleum Gas
1966	1.426	0.325	0.193	0.899	0.009
1967	0.901	0.245	0.143	0.507	0.006
1968	1.015	0.264	0.168	0.575	0.008
1969	1.209	0.322	0.211	0.646	0.030
1970	1.598	0.452	0.246	0.882	0.018
1971	1.938	0.463	0.256	1.219	0.015
1972	2.099	0.554	0.322	1.217	0.020
1973	2.530	0.722	0.427	1.359	0.022
1974	2.985	0.930	0.441	1.592	0.022
1975	2.826	1.046	0.479	1.281	0.020
1976	2.975	1.100	0.455	1.400	0.020

Source: Ibid.

on many costly national projects, such as industrialization, construction, transport development, and projects such as the current compulsory free nationwide primary education program.

Some Problems Associated With the Petroleum Industry

Climate, vegetation, and terrain in oil-producing areas of Nigeria impede transportation of crude oil by roads, trains, or inland waterways. Inland waterways are uneconomical due to the shallowness of rivers and lagoons which effectively limits the load capacity of vessels to 200 tonnes. The lack of an adequate distribution system has resulted in shortages of internal petroleum supplies, an ironical situation for the world's seventh largest oil-producing country and fourth largest exporter. This has resulted in illegal diversion of petroleum products to unauthorized dealers in periods of shortages.

The Nigerian oil boom has been accompanied by a decline in other exports, notably agricultural products. Since the oil industry employs fewer workers than does agriculture, and since hunger is always a threat in over-populated areas, concentration on oil and neglect of agriculture may have serious consequences. Nigerian oil has led to what may be a false sense of security, accompanied by the assumption that the country is rich enough to buy itself out of any economic problems.

Natural Gas

Natural gas has been found in Nigeria in commercial quantities, either alone or in association with crude oil. Proven reserves were estimated at 1140 billion m^3 on January first 1979 (Oil and Gas Journal, 1979). (Table 2.26). Since most of the natural gas in Nigeria is produced in conjunction with crude oil, reserves of natural gas follow the pattern of proven or recoverable crude oil reserves.

Gas reserves extend from east of Port Harcourt, north to Enugu area, to Ughelli in Midwestern State (Figure 2.6). As efforts progress toward efficient utilization of the country's large reserves of natural gas, exploration activities will increase, particularly off-shore, and additional reserves are likely to be found.

Production and Consumption of Natural Gas

Production and consumption statistics for natural gas in Nigeria are illustrated in Table 2.27. On the average, about 21.2 m^3 of natural gas is produced per barrel of crude oil. Due to a lack of export markets and restraints imposed by transportation facilities, about 28.3 million m^3 (90 percent) of natural gas produced in association with crude oil is wastefully flared daily (Federal Ministry of Information 1976, p. 84). The remaining 10 percent is consumed by industries near the oilfields and by the oil

Table 2.26 Nigerian Estimated Commercial Natural Gas Proven Reserves

(In billion cubic metres)

Year	Estimated Proven Reserves	Percent of world Proven reserves
1970 (Jan. 1)	142	.4
1975 (Jan. 1)	1,422	2.1
1977 (Jan. 1)	1,245	1.9
1978 (Jan. 1)	1,220	1.6
1979 (Jan. 1)	1,140	1.7

Sources: Oil and Gas Journal, June 25, 1979, p.68.
Petroleum Economist, July 1976,
Volume XLIII number 7, p.249;
July 1977, Volume XLIV number 9, p.362;
August 1979, Volume XLVI number 8, p.314.

Table 2.27 Commercial Production and Consumption of Natural Gas In Nigeria (In Billion Cubic Metres)

Year	Production and Consumption	Percent Change
1968	0.10	---
1969	0.04	-60
1970	0.06	+50
1971	0.10	+67
1972	0.20	+100
1973	0.20	0
1974	0.60	+200
1975	0.50	-16
1976	0.40	-20
1977	0.50	+25
1978	0.50	0

Sources: Federal Office of Statistics, Lagos; Economic Indicators, Vol. 12, No. 10-12, Dec. 1976, p. 13.
Petroleum Economist, July 1976 Vol. XLIII no. 7, p.249;
July 1977 Vol. XLIV no. 7, p.262;
Sept. 1978 Vol. XLV no. 9, p.362;
Aug. 1979 Vol. XLVI no. 8, p.314.

industry itself. For example, out of about 1.7 billion m^3 of gas produced in February of 1977, only 46.5 million m^3 was utilized; 15.7 million m^3 were used as fuel by the petroleum industry, and 30.8 million m^3 were sold (Ministry of Petroleum and Resources, 1977).

Apart from the oil industry itself, major consumers of natural gas include electric companies, Nigerian breweries, soap industries, and glass industries located close to oil-fields.

Although negotiations between the federal government and two private, non-indigenous oil companies have been conducted for many years, efforts to establish a fertilizer plant which would utilize natural gas in the production process have been unsuccessful. Arrangements have been made, however, for construction of a gas liquefaction plant, of which Shell and BP will each take a 10 percent interest, Phillip and Agip 15 percent between them, ELF 5 percent, and State NNPC the remainder. The cost of the plant will be $4500 million to $4900 million, estimated in American dollars. The production capacity of the proposed plant is estimated at 45.3 million m^3 per day, or 16.5 billion m^3 per year. Thus this plant will use roughly 90 percent of the natural gas associated with petroleum production in Nigeria. The Nigerian government is looking to Sweden and the U.S. as possible markets for the liquefied gas.

Potential Problems

The greatest limiting factor in the effective utilization of Nigerian supplies of natural gas is inadequate transportation facilities. The necessary network of gas pipelines would be extremely costly in terms of capital expenditure and environmental impact. Additional problems include an uncertain market, particularly in view of current U.S. energy policies and programs to reduce dependence on non-renewable resources.

Domestically, widespread supplies of natural gas are necessary to stimulate glass, iron, and steel industries, as well as to reduce the dependence on forest fuel resources in urban areas. Consideration should be given to the feasibility of using tankers to distribute natural gas across the country pending a thorough investigation into construction of pipelines.

Coal

Nigerian coal reserves are of two types: sub-bituminous and lignite types. Sub-bituminous deposits contain lower coal measures and are located at Enugu, Ogboya, Okaba, Orukpa and Ezima. Table 2.28 identifies the location and estimated reserves of these deposits. The chemical make up of Nigerian sub-bituminous coal is as follows:

Moisture Content = 3 - 17 percent
Carbon Content = 40 percent
Volatile Content = 40 percent

Table 2.28 Estimated Coal Reserves in Nigeria

In Million Tonnes
Seams Over 1.04 Metres Thick

Area	Indicated Reserves	Inferred Reserves	Total Reserves
Enugu Area:			
1. West of Enugu	26.42	8.13	34.55
2. Northwest of Iva Mine	15.24	4.07	19.31
Ezima	29.47	17.28	46.75
Inyi	10.16	---	10.16
Orukpa	50.81	7.11	57.92
Okaba	54.88	19.31	74.19
Ogboyoga	83.33	25.41	108.74
Oti	---	6.10	6.10
TOTAL	270.31	87.41	367.72
Estimated Reserves, Seams Less than 1.04 Metres.....			47.76
Total Estimated Sub-bituminous Resources.....			415.48

Source: Adapted from L.H. Schatzl, Petroleum in Nigeria, Ibadan: Oxford University Press, 1969, p.218.

Sub-bituminous coal is considered a good fuel because it can be ignited easily and burns with a long flame. It has a high resin and wax content which make it a suitable raw material for chemical industries engaged in the production of tar, plastics, synthetics, and fertilizer.

Lignite, or brown coal, is found in greater quantities than is sub-bituminous coal, and reserves are of several hundred million tonnes. Reserves around Asaba in Bendel state are one of the few areas containing lignite deposits which are presently being explored. The Asaba reserve is estimated at 101.63 million tonnes with the seams varying in thickness from 38 to 35 centimetres. The chemical make-up of Asaba lignite is:

Amount of Caloric Value	= 5,000 to 5,700 Kcal
Moisture Content	= 40%
Ash Content	= 5% to 8%
Volatile Component	= 35% to 39%
Fixed Carbon Proportion	= 20% to 26%

Lignite coal can be easily ignited and is extraordinarily rich in resin.

Production and Consumption of Coal

Although Nigeria has a good amount of coal resources, production of coal is declining in response to diminishing domestic consumption. In the past, railways consumed about 50 percent of the country's coal output. Between 1959 and 1974, however, the number of steam engines in use dropped

from 271 to 172 as diesel-powered engines were introduced. Other major consumers of coal such as power companies and cement factories also reduced their coal consumption as substitutes were put into use; the consumption of coal for electricity generation declined from 128.3 thousand tonnes tons in 1960 to 39.6 thousand tonnes in 1974.

About ten percent of the coal produced in Nigeria annually is exported, mostly to West African countries. Taking into account new industrialization programs, total domestic demand for coal was projected to reach a high of 950 thousand tonnes, in 1979-80 (Table 2.29). As Table 2.30 illustrates, however, actual demand for coal is far below projected levels.

Problems With Coal Production

The reason for the discrepancy between projected and actual demand for coal can be understood only in the light of the problems faced by the coal industry in Nigeria. These include inefficient mining techniques, slow progress in development of alternate uses of coal such as coal gasification and carbonization industries, and serious problems resulting from inadequate transportation and shipping facilities.

Unfavorable mining conditions are the greatest hindrance to successful exploitation of the country's abundant lignite coal resources. Open-pit mining is not suitable during the rainy season which lasts from May to October, while surface

Table 2.29 Projected Demand for Coal in Nigeria

(in Thousand Tonnes)

Domestic Consumption by Major Consumers	1975-76	1976-77	1977-78	1978-79	1979-80
Railways	100	100	80	80	80
Electricity	100	100	100	200	350
Cement Factories	150	150	200	270	270
Iron and Steel	---	---	50	100	150
Small Industries	20	20	30	30	50
Household and Others	30	30	40	40	50
Total Projected Domestic Consumption	400	400	500	720	950
Exports	600	800	1000	1000	1500
TOTAL	1000	1200	1500	1720	2450

Source: Third National Development Plan, 1975-1980.

Table 2.30 Actual Production and Consumption of Coal in Nigeria

(In Thousand Tonnes)

Year	Production	Consumption	Exports
1970	69.9	69.9	---*
1971	194	208	---*
1972	341	323	18
1973	326	302	24
1974	304	292	12
1975	237	213	24
1976	310	297	13
1977	290	N/A	N/A

*In 1970 and 1971 the Coal Corporation was faced with reactivation of the coal mines in the area of Enugu, which was disturbed by the civil war. Hence there were no exports in those years.

Source: United Nations, World Energy Supplies, 1972-1976, New York, 1978, pp.10-11.
Federal Office of Statistics, Economic Indicators, vol. 12, no. 10-12, Dec., 1976. Lagos, Nigeria, p.13.

mining is hindered by mud and is not economically feasible.

It is not worthwhile to mine the coal during the dry season and store it, since lignite loses much of its caloric value after a few weeks of storage. The crumbly sub-bituminous coal deteriorates in the tropical climate within a few weeks of storage, making it unsuitable for storage as well.

Coal has never been popular as a household source of fuel because of more desirable alternatives such as fuelwood. The search for new uses of coal is limited by technological constraints, particularly because of the overdependence on oversea developments rather than taking the initiative to engage in research activities within the country, using available skilled personnel.

Primary Commercial Energy Resources

The primary commercial energy resources in Nigeria are petroleum, natural gas, coal and hydro power. Petroleum accounts for approximately 99 percent of the total primary commercial energy produced in the country, with coal, natural gas, and hydro making up the remaining one percent. Only about 2.5 percent of the total petroleum production is consumed domestically, while the rest is exported, usually in its crude form.

Petroleum energy products account for approximately 80 percent of the total domestic consumption of primary commercial energy. Natural gas follows petroleum, but since

the domestic consumers of this resource are only those industries which are close to the oilfields, and the oil industry itself, consumption does not indicate that a large percentage of the population depends on natural gas. Domestic consumption of coal decreased significantly after 1974, and although more emphasis is being placed on the use of hydro power, hydro has not increased substantially in terms of domestic consumption.

Nigeria's dependence on non-renewable resources for commercial purposes has some dangerous implications. The extent of this dependence is demonstrated in Tables 2.31, 2.32, and 2.33. If Nigeria is to be assured of adequate and reliable energy supplies for the future, careful attention must be given to development of all energy resources, both renewable and non-renewable, for domestic and commercial use.

Table 2.31 Total Primary Commercial Energy Production and Consumption in Nigeria (In Millions of Coal Equivalent, 1971-76)

Year	Production	Percent Change	Consumption	Percent Change
1971	112.91	---	3.63	---
1972	134.53	+19.15	4.13	+13.77
1973	150.55	+11.91	4.85	+17.43
1974	165.10	+9.66	5.69	+17.31
1975	131.07	-20.61	5.41	-4.92
1976	153.58	+17.17	6.17	-12.57

Derived from: United Nations, Statistical Year Book, New York, 1978, p.142.
United Nations, World Energy Supplies, 1972-1976, New York, 1978, pp. 10-11.

Table 2.32 Production of Primary Commercial Energy, in Nigeria by Types

(Millions of Tonnes of Coal Equivalent unless Otherwise Indicated)

Type	1971	1972	1973	1974	1975	1976
Coal	.194	.341	.326	.304	.237	.310
Crude Oil	112.274	133.649	149.595	164.020	130.007	152.114
Natural Gas	.245	.364	.404	.538	.535	.842
Hydroelectricity	.194	.178	.229	.241	.288	.311
TOTAL	112.907	134.532	150.554	165.103	131.067	153.577
PERCENTAGE SHARE OF THE TOTAL:						
Coal	0.2	0.3	0.2	0.2	0.2	0.2
Crude Petroleum	99.4	99.3	99.3	99.3	99.2	99.0
Natural Gas	0.2	0.3	0.3	0.3	0.4	0.6
Hydroelectricity	0.2	0.1	0.2	0.2	0.2	0.2

Source: United Nations, Statistical Year Book, New York, 1978
United Nations, World Energy Supplies, 1972-1976, New York, 1978

Table 2.33 Consumption of Primary Commercial Energy in Nigeria

(Millions of Tonnes of Coal Equivalent)

Type	1971	1972	1973	1974	1975	1976
Coal	.208	.323	.302	.292	.213	.297
Petroleum Products	2.983	3.263	3.917	4.623	4.368	4.638
Natural Gas	.245	.364	.404	.538	.538	.842
Hydroelectricity	.194	.179	.229	.241	.288	.288
TOTAL	3.630	4.129	4.852	5.694	5.404	6.065
PERCENTAGE SHARE OF TOTAL						
Coal	5.7	7.8	6.3	5.1	3.9	4.9
Petroleum Products	82.2	79.1	86.7	81.2	80.8	76.5
Natural Gas	6.8	8.8	8.3	9.5	9.9	13.9
Hydroelectricity	5.3	4.3	4.7	4.2	5.4	4.7

Source: Ibid.

CHAPTER 3. FUTURE SUPPLIES

Working Toward the Goal of Self-Sufficiency

Energy self-sufficiency is a current goal of most industrialized nations. It stems from an increasing awareness of the unpredictability of external sources of supply rather than from threats of the sheer limits of the earth. Today energy, oil in particular, has gained an entrenched role in world politics. As Michael Tanzer (1969) asserts,

> Of all the commodities moving in international trade, oil undoubtedly is a supremely political one. Because most oil moves internationally, because huge profits are to be made, because it is a vital necessity to most oil importing countries, because it is of vital importance to the economics of the oil exporting countries and the balance of payments of the developed countries - for all these reasons the ordinary day to day flow of international oil trade are the resultants of enormous and conflicting political pressures among companies, government, and international organizations.

Related to the political role of energy is its emerging role as a weapon of cold warfare. Without some degree of energy self-sufficiency the political sovereignty of a nation tends to be threatened. Nigeria's growing dependence on petroleum energy for her social and economic activities should be examined carefully, and steps taken to ensure that the nation's present and potential energy options are exercised wisely.

The purpose of the following is to highlight aspects

of Nigerian energy resource operations which might be open to modification if the nation is to achieve and maintain energy self-sufficiency. The ability to ensure adequate supplies of energy for present and future generations of Nigerians depends on how they are managed, used and exploited today.

Renewable Energy Resources

Forest Energy

The most important step towards ensuring continued supplies of forest energy resources is to abolish the notion that use of forest energy resources is a sign of primitivity, and of the perception of fuelwood as a limitless commodity. To change public perception and ensure future supplies the government should:

- *see that national development policies relating to energy incorporate forest-energy resources rather than placing an over-riding emphasis on petroleum.*
- *encourage research and development programs in the area of forest energy resources, focusing on forest energy resource inventories, consumption, and the development of techniques for making forest energy economically efficient for both rural and urban industrial production activities.*
- *educate the public about the importance of forest energy resources, and conservation techniques.*

-encourage development of skilled personnel in the area of forest energy resources, as part of its National Human Skill Development Program.

-revolutionize land tenure practices because of their hindrance to the implementation of forest-fuel resource development plans.

-expand reforestation programs. Fast growing non-timber tree species need to be introduced, and village fuel-tree plantations established.

- meet the growing demand for charcoal by organizing charcoal burning and commercial fuelwood removal as a secondary industry to timber operations. The present practice of encouraging the productivity of timber trees by poisoning unwanted competitors or planting the desired timber species in forests which have been cleared through poisoning and burning, has resulted in the wasteful destruction of forest fuel resources. Much of this wood that is cut, poisoned, and burned could be sold as fuel or used in the production of charcoal.

-ensure that environmental impact assessments are made prior to implementation of expansion programs. With the creation of states there has been an increase in the diffusion of urban centres. Associated with this growth is the construction of buildings, roads, and other infrastructure. If such expansion continues to take place without careful evaluation of its consequences,

it will have an irreversible effect on availability of future supplies of forest-fuel resources.

Solar Energy

Rural Nigeria is ill-suited to the provision of hydro-electricity because of its widely dispersed population and low demand. At the same time, however, these areas are ideal for utilization of solar energy because of their low population density. Unlike hydro-generators, small solar-power installations require little capital investment, are small and can be placed where needed.[1] Furthermore, sophisticated technology is not necessary for their use.

Two primary methods are used for generation of electricity; direct sunlight can be converted into electricity through solar cells or through thermal technology. Use of solar cells involves a technology which has been thoroughly explored for the purpose of space travel, and this method is simple and well understood.[2] In thermal technology, direct sunlight is focused on a boiler of fluid to be heated so that it, in turn, drives a turbine generator.

Solar energy can be used in many day to day activities. In addition to the use of solar kilns for drying produce, simple solar cookers costing just $25 can be used to bring .6 litre of liquid to boiling point in ten minutes, at a cost

---

[1] See Abdou Moumoumi, 'Energy Needs and Problems in the Sahelian and Sudonese Zones: Prospects of Solar Power; in Ambio (Stockholm), 1973.

[2] Large scale use of solar radiation for electricity generation is limited by high costs of collectors and conversion equipment. However, energy costs from solar radiation may soon become competitive with conventional sources particularly crude oil imports.

lower than that of kerosene. Solar energy pumps are also able to satisfy the low energy demands of rural dwellers.

It is obvious that efficient utilization of solar energy rests with proper planning rather than with availability of detailed technology. Nigerian engineers and resource managers should be encouraged to take the challenge of utilizing this abundant source of energy.

Human Resources

Human resources are of particular importance to discussion of energy in Nigeria. Not only are most of the nation's social and economic activities dependent upon manpower, but the actual implementation of energy development strategies require domestic supplies of skilled personnel.

Although there has not been a reliable population census taken since 1965, estimates indicate an increase in Nigeria's population from 55.6 million people in 1963/64 to 86.2 million in 1979/80 (F.A.O., 1966). This would be a population increase of approximately 35.5 percent above 1963/64 figures.

With the growth of modern medical facilities, adult and infant mortality rates have been reduced, while the birth rate remains the same. Nigeria's extended family system spreads the burden of childcare and training among many people, unlike societies where couples must resort to having small families in order to cope with pressures of rising costs. The larger the extended family, the more people there are to pull their resources together and assist one another as needs emerge. It is difficult, and perhaps dangerous to break down this tradition, especially without adequate substitutes such as old age pension plans, unemployment benefits,

family counselling, and social welfare programs. Yet, the importance of population control must be recognized if problems of unemployment and underemployment are to be overcome.

While maintaining the valuable extended family system, the following steps should be taken to control Nigeria's population growth:

- *establishing birth-control clinics staffed with qualified personnel.*
- *legalizing voluntary abortion and sterilization, and providing these services at no charge.*
- *removing all restrictions on the provision of birth control information and devices to everyone above 14 years of age.*
- *teaching sex education in the schools, stressing birth control practices and the need to stabilize the population.*
- *implementing a government-sponsored campaign for population control, using the media, public rallies, and community organizations.*
- *providing incentives such as bonuses for couples having less than three children and taxes on couples having more than three children.*

Although birth control is a sensitive issue subject to opposition by various groups, it is imperative that Nigeria reduce population growth to avoid nationwide hunger and poverty.

Over-population is not the only problem facing Nigeria's workforce. Despite the surplus of manpower, the country has not achieved self-sufficiency of human energy, particularly in the area of skilled personnel (Table 3.1). This is partly due to past emphasis placed on arts and humanities by intellectual leaders, particularly by colonialists and neo-colonialists who stressed non-technical knowledge. Another cause is that,

> the differentials in remuneration between the technologist and technicians are rather great and do not reflect their respective contribution to productivity. Hence, because of pay and prestige, most secondary school leavers who are qualified for higher education prefer to enter into the universities rather than intermediate technical institutes (Okunrotife, 1978).

The following measures might be taken to rectify this situation and ensure adequate supplies of skilled manpower:

- *appointments, promotions, and remunerations should not be solely dependent on university and college qualifications as is the practice today. Individuals who successfully complete on-the-job training programs should enjoy the same rights and privileges as their formally trained counterparts.*
- *primary and secondary school curricula should be modified to provide students with a strong foundation in science and mathematics. Presently, exposure to mathematics in primary schools is limited to arithmetic, and the study of sciences is not emphasized, primarily because the majority of teachers have no scientific background. Hence*

Table 3.1

Nigerian Manpower Requirements
in Selected Occupational Categories
1975-1980

Occupational Category	Requirements by 1980	Current Stock (estimated)	Supply 1975-80	Shortfall by 1980
Architects	3,050	1,700	270	1,080
Civil & Structural Engineers	6,410	3,800	630	1,980
Mechanical Engineers	2,970	1,400	720	850
Electrical Engineers	2,870	1,300	670	900
Architectural Assistants	9,200	4,000	200	5,000
Civil & Building Engineering Technicians	31,100	13,600	1,500	16,000
Mechanical Engineering Technicians	14,900	6,200	1,100	7,600
Electrical & Electronic Engineering Technicians	14,400	5,800	1,100	7,500

Source: Ogumtoyimbo, Areola, & Filani, Eds., A Geography of Nigerian Development, Nigeria: Coston Press, 1978, p.195.

the child is oriented toward the arts and humanities. In secondary school where major science and mathematic courses are offered, attempts should be made to make these courses more interesting through the use of innovative teaching aids.

-incentives should be provided for embarking on technical education. For example, reduced tuition and boarding fees could be offered in schools of technology.

-students studying overseas who are not being funded by the Nigerian government should be exempt from service in the National Youths Corps. The present justification for mandatory service in the youths corps following graduation from a university is that the federal government spends about $10,368 per annum on each university student in Nigeria. However, students studying abroad are forced to find their own means of support, and are often indebted to many people. Despite their desire to return home immediately after completing their studies, they delay in an attempt to save enough money to see them through the year that they must spend in the Youth Corps, during which time they will be paid a salary which is approximately one-third the normal wage structure.

Electricity

In order to meet the rapidly growing demand for electricity, the National Electric Power Authority is engaging

in a huge expansion program aimed at a total generating capacity of about 1740MW by 1980 which will be sufficient to meet the estimated load of 1336MW, and provide a reserve margin of 404MW. The reserves are considered adequate to ensure a reliable supply, since they are capable of compensating for any power failures which may occur from other hydro, steam, and gas turbine units. The proposed expansion programs are summarized in Table 3.2

In addition to increasing generating capacity, the National Electric Power Authority plans to add about 3144kM of 330KV and 2272KM of 132KV transmission lines to the existing transmission network in order to accommodate new sources of electricity and to ensure more efficient and reliable supplies. This is very important, since current power failures often last for weeks, during which time industries and hospitals are forced to use oil-fueled standby power plants.

Successful implementation of the proposed expansion programs is dependent on many variables; shortages of experienced engineering personnel and delayed delivery of equipment from overseas may make it impossible to adhere to proposed schedules.

Although construction of hydroelectric plants requires extensive capital expenditures, the benefits are many. Since Nigeria has adopted a policy of multipurpose development of drainage basins, irrigation of food and cash crops can be

Table 3.2 Projects and Programmes for Future Power Generation in Nigeria Between 1974-1984

Name and Type of Power Plant	Product Description	Estimated Generating Capacity in MW	Estimated Year of Completion
Thermal Generation			
Sapele Thermal Plant	Installation of four gas fired steam generating units	480MW	1982
Afam Thermal Station	Extension of installed capacity of 55MW	100MW	1976
Delta No.2 Thermal Plant	Installation of a second gas thermal plant to the Ughelli station	120MW	1975
Kaduna Thermal Plant	Installation of fired steam units	348MW	N/A
Lagos Thermal Plant	Installation of thermal units	750MW	N/A
Hydraulic Generation			
Kainji Extension	Addition of 5th, 6th, 11th and 12th units at Kainji	440MW	2 units completed in 1975
Shiroro Hydroelectric project (Kaduna River)	New hydro power station to be developed at the Shiroro gorge	300MW	1982
Jebba Hydroelectric Power (Niger River)	Engineering studies, site development and port construction	500MW (When Completed)	N/A
Dadin Kowa Power Station (Gongola River)	New hydro power station to be developed	30MW	N/A
Kokoja Power Station (Niger River)	Hydrological, engineering, and design studies	1950 (When Completed)	N/A
	TOTAL.....	5418MW	

Source: Derived from Third National Development Plan, 1975-80.

increased, flood controls improve river navigations, and creation of lakes expands the fishing industry. Should an excess of electricity be produced, Nigeria might export hydro power to neighboring countries such as Benin, Mauritania, which have low hydro potentials.

The first thought that comes to mind when one considers hydroelectric potential in Nigeria, is rural electrification. Advocates of rural electrification cite the need to modernize, stimulate the diffusion of manufacturing industries to rural areas, or the need to conserve fuelwood resources as justification for such an undertaking. Although there are elements of truth in all of these arguments, rural electrification is not warranted, for the following reasons:

- *There is very little demand for electricity in rural areas. Most of the village people can afford neither electric appliances or electricity bills.*
- *Traditional sources of energy such as fuelwood are not being threatened through their use, but through their misuse. People should be taught the importance of fuelwood rather than replacing it with something they cannot afford.*
- *Electricity per se is unlikely to stimulate rural industrial activities if the basic pre-requisites for such development are not available; high per capita income, savings for investment, infrastructure, and social aminities to attract skilled personnel are some of the*

requirements.

-There is already a surplus of labor in Nigeria, and the introduction of machines would merely exacerbate the problem. What is needed are small-scale, labor-intensive industries involving the processing of food for domestic consumption.

-Most of the buildings in rural areas are unplanned and temporal, subject to demolition or reconstruction as the family income improves. Electrification is simply ludicrous in many cases, where the cost of installation is greater than the cost of the entire house.

-The vast amount of money needed to implement a program of rural electrification could be much better put to use providing the basic needs of rural Nigerians. Nutrition, safe water supplies, and increased labor productivity are just a few of the things which should be given priority over the introduction of luxuries such as electricity.

Non-Renewable Energy Resources

It is an unavoidable fact that one day Nigerian supplies of oil, coal, and natural gas will be depleted. Just how soon that day arrives, however, and just what effect it will have on Nigerian economic and social life, is something that can be anticipated and controlled. What is needed now is a full exploration of potential deposits of these resources so that inventory can be taken and plans made to cope with the inevi-

table. In particular, oil revenues should be used to develop renewable sources of energy; industrial activities need to be geared towards renewable energy sources or ones which can easily be transformed. So long as the country is prepared and not taken unaware, the transition from non-renewable energy sources to renewable resources should be a smooth one. Meanwhile, conservation methods should be put into effect to allow adequate time for alternatives to be found.

Complementary Sources of Future Energy Supplies

Energy from Wastes

Although there is no available inventory of Nigerian agricultural and domestic wastes, it is likely that the amount of energy available from this source is great. The advantages of such usage include:

- *Pollution problems resulting from the careless disposal of wastes would be reduced.*
- *Low rural energy needs could be met through the use of crop residues and animal wastes.*
- *The capital cost of waste conversion is relatively small.*
- *Such an energy supply is virtually inexhaustible.*

Some of the problems associated with the conversion of wastes into energy are:

- *Since domestic and agricultural sources are dispersed, collection of wastes may be expensive and unreliable.*
- *The reoccurring problem of the lack of skilled personnel*

and advanced technology would have to be solved.

-Preparation would have to begin well in advance of the actual need for such a supply of energy, and motivation would be low. It is imperative that people be made to understand the importance of being prepared for the time when alternate sources of energy are not only useful, but essential.

Sugar Cane

In countries such as Fiji, sugar cane is the greatest indigenous energy source; approximately 80 percent of the Fiji Sugar Corporation's electricity supply is derived from wastes leftover from processed sugar cane (Uniterra, 1978). Although Nigeria produces a considerable amount of sugar products, this resource has never been tapped as a supply of energy. Table 3.3 illustrates the basic sugar cane conversion processes involved in the use of sugar cane as a supply of energy.

Biomass Energy in General

The use of energy fixed in organic matter by the process of photosynthesis has traditionally focused on the direct combustion of biomass energy sources. However, as a result of the rising prices of oil and growing concerns for environmental quality, there has been increasing interest in the more efficient utilization of biomass energy through conversion of the biomass resources to synthetic fuels with

Table 3.3 Energy From Sugars: Basic Conversion Processes

Resources	Process	Main Products	Users
Sugars			
From juices and cellulose	Fermentation distillation	Ethnol	Transport, chemicals
Euphoriba and other similar plants	Harvesting of Latex	Liquid hydro-carbons	Industry, domestic transport, chemicals.

Note: Industry includes Agriculture.

Source: B.A. Rahmer, Alternative Energy; The Potential of Biomass. Petroleum Economist, October 1979, Volume XLVI, Number 10, pp. 417-418.

higher energy content.

B. A. Rahmer summarized the potentials of biomass energy as follows:

> "Biomass has an important part to play in the energy supply of the less developed nations and with the expected improvements in technology, it may eventually assume greater worldwide significance. Biomass includes all types of organic matter but interest focuses especially on fast-growing crops (e.g. Eucalptus and Poplar) energy-rich crops (e.g. Sugar Cane, Massava, Maize). Certain water needs and algae waste products from agriculture and forestry and - possibly - petroleum-bearing plants such as Euphoriba. The world's poorest people - perhaps half the human population - depend primarily on fuelwood, agricultural waste and animal dung for their modest fuel requirements."
>
> (Alternative Energy; The Potential of Biomass, pp.417-418 and 422. Petroleum Economist, October 1979, Volume XLVI Number 10).

Production of synthetic fuels from biomass would be attractive based on the following general reasons: The amount of the resources is potentially abundant. Second, biomass is a renewable resource. Unlike other alternate sources of energy such as solar, wind and tidal power, the biomass energy is automatically stored for use at will (B. A. Rahmer, 1979). Third, biomass energy has low polluting impurities and the process of synthetic fuel production from biomas could minimize the waste disposal problems. Cheapness of fossil fuels in the past has led to general consideration of by-products of agricultural and wood production as wastes, by most countries. This attitude must change with the significance of biomass technology. Finally, apart from

coal (which is not renewable) biomass is the only energy resource whose products could easily take over petroleum's specific functions as a source of motor fuels and petrochemical feedstocks (B.A. Rahmer, 1979) as illustrated by (Table 3.4).

The major constraint to the biomass energy development is that the cultivation of biomass for energy will normally require very large land areas and this might impinge upon the scarce resources of the agricultural farmlands. This constraint is particularly significant to Nigeria, with high population land pressures and limited agricultural productive land areas.

Another factor is the general lack of conviction of the competitiveness of the biomass energy with conventional sources and other related economics of biomass that is presently understudied. However, it is indicated that the costs of biomass products under most favourable conditions compare well with the production of the products from more conventional energy resources (Table 3.5).

With the increasing depletion of the conventional energy resources, potentially abundant amounts of renewable and environmentally clean energy resources may be derived from biomass. As well as the contribution of the biomass conversion processes to agricultural food production and chemical feedstock, biomass energy will be increasingly important in the next decade. Nigeria should be prepared

Table 3.4 Basic Biomass Energy Conversion Processes

Resources	Process	Main Products	Users
Dry Biomass (e.g. Wood, Residues)	Combustion	Heat, Electricity	Industry, domestic
	Gasification	Gaseous fuels, Methanol, Hydrogen, Ammonia	Industry, transport, Chemicals
	Pyrolysis	Oil, char, gas	Transport, industry
	Hydrolysis - distillation	Ethanol	Transport, chemicals
Wet Biomass (e.g. Sewage, Agnatics)	Anaerobic - digestion	Methane	Industry, domestic

*Industry includes Agriculture.

Source: B.A. Rahmer, Alternative Energy; The Potential of Biomass. Petroleum Economist, October 1979, Volume XLVI, Number 10, p. 418.

Table 3.5 Estimated Products Cost In U.S.A.: Biomass and Conventional Cost: In $ Per Million B.T.U. Unless Otherwise Indicated.

Product	Cost From Biomass	Cost From Conventional Resources	Cost Proportion Biomass: Conventional
Methanol	8.4 - 15.9	8.4	1.0 - 1.9
Ethanol	15.0 - 36.3	19.6	0.8 - 1.9
Medium BTU Gas	4.7 - 7.4	3.0 - 5.0	0.9 - 2.5
Substitute Natural Gas	4.8 - 7.3	3.0 - 5.0	1.0 - 2.4
Ammonia	5.8 - 11.4	7.4	0.8 - 1.5
Fuel Oil	3.6 - 7.9	3.2	1.1 - 2.5
Electricity	0.03 (Per KWH)	0.03 - 0.06 (Per KWH)	0.5 - 4.5

Source: B.A. Rahmer, Alternative Energy; The Potential of Biomass. Petroleum Economist, October 1979, Volume XLVI, Number 10, p. 418.

to participate in this new energy industry.

Geothermal Energy

Science has proven that geothermal sources in the form of geysers and fumaroles can be used for generation of electricity and energy for heating. Such energy can be harnessed in places where reservoirs exist at or above the boiling point or in a very high temperature range. This category of geothermal resources is associated with areas of recent volcanoes, and has provided all the geothermal electrical development in the world to date. There is almost no prospect for such a development in Nigeria, however, as there has been no history of a volcanic eruption in Nigeria later than the Tertiary period.

The other category of geothermal resources which can be used to produce energy are where the temperature gradient is fairly above normal, or where heat is stored deep within the earth's hot rock in areas where the geothermal gradient is normal. These areas can provide hot water for space heating. As Nigeria has almost no demand for space heating the development of such a resource, if available, would not be worthwhile.

Windpower

Windpower generation is a possible energy alternative for Nigeria because of the stable tropical climate. Windmills could be used to generate small amounts of energy

for pumping and other small-scale industrial power needs. The use of windmills would be well-suited to the dispersed nature of rural settlements because they can be placed wherever needed.

Larger windpower driven generators are technologically possible through use of wind concentrators and diffusers, which increase the ambient wind velocity. There are obvious drawbacks to large-scale windpower generators, however, such as the cost of collection and storage equipment, which is presently two to three times higher than conventional energy costs. Cheaper storage techniques such as the fly-wheel technology may be developed in the future, and it may be beneficial to experiment with windpower on a small scale until further advances are made.

Nuclear Power

Nigeria is already in the experimental stage of nuclear power development. Presently progress is being slowed by problems of fuel supplies (Table 3.6) and the assessment of environmental impacts. The uranium and thorium required for nuclear power is associated with some mineral deposits such as aingon, niobium, tantalite, and columbite of the Jos Plateau, but their low quality and the difficulty of extraction hinders their potential for providing reliable supplies of fuel for nuclear power generation. Even though Nigeria's participation of 16 percent in the uranium project develop-

Table 3.6 Measured Recoverable Reserves of Uranium Resources
(In Million Terajoules Energy Content)

Location	Uranium (a)
O E C D Countries	
U.S.A.	284
Canada	161
West Europe	43
Japan	3
Australia (New Zealand)	104
Total O E C D	595
O P E C Countries	
Middle East	---
Libya / Algeria	---
Nigeria / Gabon	18
Venezuela/ Ecuador	---
Indonesia	---
Total O P E C	18
Other Countries	211 (b)
WORLD	824

(a) The figure shows approximate energy yields in conventional fission reactors of established Uranium reserves excluding those producible at a cost of over $26/kg U, also excluding reserves in Communist countries.

(b) Of which South Africa is 148 million terajoules.

NOTE: Breeder reactors use their fuels about 60 times more efficiently than Conventional ones and, if were to be in general use, the energy content of the established Uranium reserves above would have increased automatically to 49,500 million terajoules. Unfortunately, widespread use of breeder techniques is limited by inherent risks of radioactive contamination.

Source: Petroleum Economist, July 1975, Volume XLVII, Number 7, p. 251.

ment of the Niger Republic was designed as a measure to overcome the handicap of lack of uranium supplies, there are still problems of transportation and storage of the nuclear fuel, as well as the problem of disposal of highly radioactive wastes, which remain active for hundreds of thousands of years.

Susceptibility to sabotage of the nuclear operation, or the diversion of nuclear materials to terrorist use and its attendant danger, are serious problems which Nigeria must overcome. Rather than developing a full program of nuclear power generation, Nigeria should attempt to participate in programs of other nations. By specializing in certain aspects of nuclear development, Nigeria would eventually be able to successfully and safely embark on a program of nuclear power.

Future Demand

Nigerian primary energy consumption increased from 2.091 million tonnes of coal equivalent in 1970 to approximately 5.644 million tonnes of coal equivalent in 1975 (World Energy Supplies, 1950-1974; 1971-1975). When the rapid population growth of Nigeria, combined with increasing industrial and construction activities, is taken into account one might expect that national primary energy consumption by 1985 will be almost ten times greater than it was at the beginning of the seventies.

While policies relating to Nigeria's energy sector have reflected the need for increased energy supplies, little

attention has been given to the present inefficiency with which available resources are used. Energy conservation perhaps seems unimportant because of the country's relatively low energy usage and its citizens inability to engage in luxurious energy consumption because of the low average income. In addition, domestic energy consumption primarily entails renewable resources such as fuelwood, agricultural wastes, and solar energy. But as Tolba (1978, p.11) points out,

> The commonly held axiom that "only the affluent can afford conservation" is thoroughly discredited by an examination of what has recently been called "the other energy crisis: firewood". Proper management of energy resources is essential in poor countries because of energy's importance in domestic life, agriculture, the creation of productive jobs, and the balance of trade with other nations.

In Nigeria the need for energy conservation is particularly ignored because of the widespread notion that the country has a limitless supply of energy resources. While it is true that Nigerian energy resources are plentiful, energy conservation would yield several economic and environmental benefits:

- *Energy conservation today will allow the Earth's limited resource base of high-quality fuels to be "stretched" further, so that generations of tomorrow will be able to share in the Earth's finite stock of fossil fuels.*
- *Energy conservation will allow a portion of these fuels to be reserved for non-energy purposes; drugs, lubricants*

and other compounds can be derived from them.

-Reduced energy consumption will reduce environmental degradation associated with all current energy-production technology.

-Energy conservation will provide us with additional time to search for safe, sustainable sources of energy.

-Conservation decreases the likelihood that the climatological threshold will be crossed (for example, with carbon dioxide production or with regional heat generation), triggering consequences that may be devastating (Tolba, 1978).

Now is the time, while Nigeria is on the threshold of modernization, for the nation's decision makers to embark upon a program of energy conservation. To reduce future energy demand, particularly of oil, the following objectives should be pursued:

-Wherever possible, coal, hydroelectricity, or other substitutes should be used instead of oil.

-The government should implement a reliable mass transit system to replace the use of private automobiles.

-The importation of automobiles and unnecessary energy-consuming gadgets should be strictly controlled and discouraged; it is much easier to keep people from getting accustomed to a luxury than it is to take the commodity away from them once they have become dependent upon it.

-Approval for construction of a plant should be withheld unless its technological design includes devices for

maximum energy efficiency, and allowance has been made for the use of energy alternatives, particularly renewable energy resources.

-The industrial sector should be motivated to reduce energy use through the production of more durable products and the recyling of materials whose production is energy intensive.

-Emphasis should be placed on a return to the traditional usage of environmentallly safe and renewable energy sources such as manpower and solar energy, wherever possible.

-The government must embark on a program of population control, as discussed earlier. Per capita use of energy resources must be decreased if energy is to be conserved.

Development and implementation of these and other conservation programs require the establishment of an energy conservation office to work in co-operation with the various departments, particularly that of mines and energy. This office would provide the government with information on how to reduce energy demands without impeding economic growth. Energy conservation need not demand the sacrifice of desirable lifestyles, result in lower standards of living, or deny economic opportunity to low income groups. What it does call for is making what is available to go further.

Potential problems of reducing energy demands

If Nigeria is to discriminate against energy ineffi-

cient industries the rate of industrialization will be slowed. In the long run, however, the country will be further ahead if it is not forced to develop energy substitutes.

Although employment opportunities may change because of conservation measures, those jobs which are eliminated will be replaced by new positions. For example, although creation of a mass transit system may take employment away from taxi drivers, those same drivers will be needed in the operation of the transit system. In addition to drivers, maintenance personnel and a whole network of office workers will be required. In industries, labor may be substituted for oil-intensive activities, thereby employing far more workers than were needed previously.

Another potential problem associated with conservation is its impact on economic growth. Presently, however, the production of gadgets calling for wasteful energy consumption is done outside the country and imported into Nigeria. With the banning of these products monies involved in conspicuous consumption may be diverted to savings, investments and, therefore, economic growth.

Although conservation measures may call for some sacrifices, one need only look at North America to realize that the real problems arise when people are unprepared to do without energy resources which are no longer available. By embarking on conservation programs today, Nigerians will have had the advantage of being allowed to adjust socially and economically to the depletion of non-renewable energy resources.

CHAPTER 4: ENERGY USE PATTERNS AND GENERAL PROBLEMS OF ENERGY SUPPLIES

Energy Use Patterns, Urban and Rural

Energy use patterns in Nigeria vary between rural and urban areas, and are regulated by the nature of economic activity in the respective location. In rural areas, where almost 80 percent of Nigeria's population resides, economic activities include farming, local crafts, small-scale industries, and low-level trading. Almost all of Nigeria's modern industries, manufacturing establishments and high-level commercial activities are located in urban centres. Sources of energy used by urban and rural dwellers in their economic and social activities vary greatly, as a result of marked differenced in their environments.

Farming

The typical farming area of a rural landowner is about 1.5 to 2 hectares. Rural farmers grow a variety of crops to sell at markets and for their own use. The direct and highest energy input into farming activities of rural Nigeria is human energy. An adult male in a village works, on the average, over 3020 hours annually, and approximately 85 percent of this time is spent farming.

Solar radiation provides energy, for drying of rice, beans, millet and groundnuts before storage, transportation and sale. The drying process entails spreading these crops

on mats in the open air for three or four sunshine days.

Vegetable seeds such as okra, pumpkin, and melons are preserved in calabashes and hung from kitchen ceilings, above cooking furnaces. Here they are kept dry by heat generated from wood, until planting season arrives. Hence preservation through packaging is unnecessary.

Implements used by rural farmers include hoes, cutlasses, and other hand tools. This equipment is made by local blacksmiths who use charcoal and palm kernels as their source of heat-energy in making these tools.

Animal dung is used as fertilizer and insecticide by most rural farmers. Dung is dissolved in water and sprayed on crops, thereby deterring insects from attacking plants.

No powered machinery is used in rural Nigeria farming activities. Use of ox-drawn equipment is hampered by heavy infestations of tsetse flies and a lack of fodder. The scale of farms, agricultural yield, and low per capita income of rural farmers makes the use of machines and animals impractical. Thus use of powered machinery is limited to government farms and institutions such as schools as agriculture. This group of farmers is small, and their farms are mostly "model" farms which contribute very little to total food supplies.

Nigerian farmers' slowness to adopt "modern" farming techniques is not indicative of ignorance but, rather, reflects their knowledge of what is appropriate for the environ-

ment in which they live. As Waters (1974,p.45-46) remarks,

> It is frequently assumed that African farmers live in a state of blind ignorance, using inappropriate methods, and only waiting to be taught the excellent technology which stands ready to be used. The available evidence indicates that this is grossly wrong. The alternative hypothesis is that the small-scale farmer in Africa knows his environment, his resources, and his own ability better than anyone else can at present, and that he acts rationally to take advantage of his knowledge.

Industries

Rural industries can be divided into two strata. The upper stratum of production involves some form of processing, or at least conversion of primary raw material into intermediate forms different from their primary base, before a final product is realized. In the lower stratum, production consists only of giving different shapes to, or making different designs or artistic impressions upon, the primary material base. Wood carving, clay works, and hide crafts are examples of lower stratum production. In either stratum, the highest direct energy input is from human energy, since no machines are used. Other sources of energy utilized in these operations are forest energy, for building fires and producing charcoal, and solar energy, for drying. Figure 4.1 illustrates the use of these energy sources in the pot-making process. These three sources of energy-human, forest-product, and solar - dominate most rural industrial activities.

Urban industries are generally energy intensive, using non-animate sources such as petroleum oil, electricity, natural

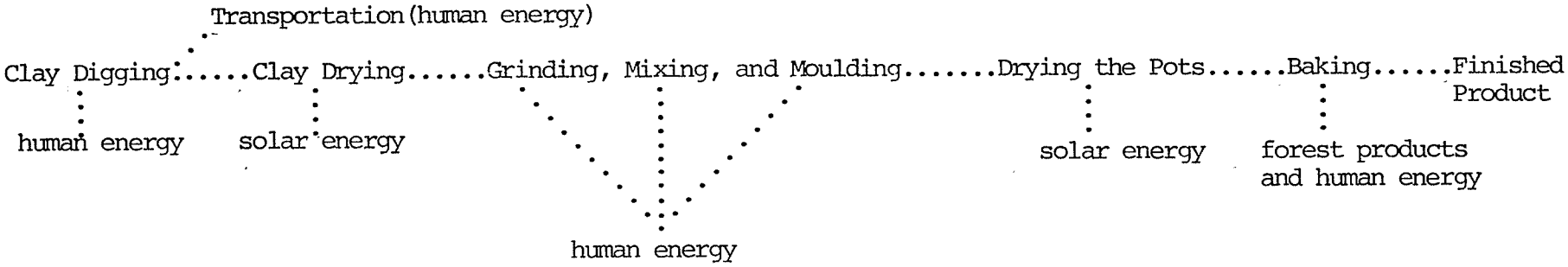


Figure 4.1 Energy Inputs by Type, in the Pot-Making Process (Rural Industry)

gas, and coal. The U.S.I.D. report on energy in Nigeria estimates that the energy consumed by industries in Nigeria in 1963, excluding electricity, was equivalent to 11×10^5 barrels of fuel oil. Highly energy-intensive industries used the equivalent of 7.73×10^5 barrels of fuel that year, while background industries used 3.37×10^5 barrels (Onyemelukwe, 1966).

On the average the modern industrial sector of Nigeria, located in urban centres, accounts for approximately 42 percent of the total primary commercial energy consumed in the country. While most industries in rural areas are labor-intensive, depending on renewable energy resources, almost all industries in urban centres are highly energy-intensive, using primarily non-renewable resources.

Transportation

The pattern of movement in the rural areas of Nigeria can be divided into two categories: movement within rural areas is generally limited to a distance of 32 km while movement between rural and urban areas is usually above 80 km.

Movement within rural areas is predominantly by foot or bicycle. Types of transport used for rural-urban movement are usually those which serve dual purposes of carrying passengers and goods; lorries, mammy wagons, and buses are most often used. Although this type of movement involves consumption of petroleum energy products, the infrequency of

these trips results in minimal use of energy. People most often engaged in this type of travel are rural traders or businessmen who travel to urban centres to purchase retail goods.

Railways present another method of transportation, used primarily to carry crops such as cocoa, groundnuts, and palm produce to urban markets. Still, the majority of rural Nigerians rely on animate energy for transportation. This is illustrated in Table 4.1, which shows the most frequently used methods of transporting food.

Transport animals such as horses, camels and donkeys are found in limited numbers in rural parts of the northern states and some western states. The scarcity of these animals renders them available to only a few well-to-do individuals.

Modern transportation facilities are found in urban centres throughout Nigeria. Movement within cities is primarily by private automobiles, transit buses, taxis, and motorcycles. Movement between cities is usually made in modern buses, aircraft, or railway trains. Thus, petroleum oil is the major source of energy for urban transportation. Modern transportation in Nigeria accounts for approximately 34 percent of the total primary energy consumption of the country, with an approximate ratio of 97 percent petroleum oil to 3 percent coal.

Table 4.1 Methods of Food Transportation in Nigeria

Percentage of Food	Method of Transportation
44%	On The Head
35%	By Lorry
6%	By Railway
5%	By Canoe
5%	In Pushcarts
5%	By Bicycle
41%	Powered Machinery
59%	Animate Energy, predominantly Human Energy

Adapted from: D. Olatumbosun, Nigeria's Neglected Rural Majority. Ibadan: Oxford University Press, 1975. p.111.

There is a great deal of wasteful consumption of petroleum products associated with urban transportation; taxis and buses roam the city half empty. This is partly due to the ease with which entry is made into the transport business, and partly because of the growth in number of privately owned vehicles. This wasteful consumption of petroleum products has contributed to shortages of fuel and to rising costs. Using 1960 as a base year of 100, the All Cities Composite Consumer Price Indices (Lower Income Groups) for selected sectors is illustrated in Table 4.2. The greatest price increase was witnessed in food, followed by fuel and light.

Electricity and Other Homelighting Devices

Major rural electrification has occurred in midwestern states of Nigeria, although it has been slowed by the low building density which is characteristic of rural areas. Most rural people prefer to have their property walled- or fenced-off from neighboring areas, thereby increasing the cost of making electricity available by means of distribution mains. Even where electricity is made available to rural dwellers, its usage is limited to a single lightbulb suspended from the ceiling of living rooms. No electrical appliances are used in these rural homes.

The majority of rural Nigerians rely on sun rays for homelighting during the day, let in through windows and

Table 4-2 Nigerian All Cities Composite Consumer Price Indices

Lower Income Group
(Base: Average 1960 = 100)

YEAR	GENERAL	% change	FUEL AND LIGHT	% change	TRANSPORT	% change	FOOD	% change
1969	132.3	-----	132.5	-----	132.0	------	133.9	-----
1970	150.6	+13.80	144.9	+9.36	143.4	+8.64	164.4	+22.78
1971	174.7	+16.00	161.6	+11.53	144.0	+0.42	211.4	+28.59
1972	179.6	+2.73	178.3	+10.33	149.4	+3.75	216.6	+2.46
1973	N/A	------	N/A	------	N/A	-----	N/A	------
1974	214.7	------	180.9	------	214.3	-----	258.7	------
1975	287.4	+33.86	253.4	+40.08	247.2	+15.35	367.2	+41.94
1976	348.2	+21.16	278.0	+9.71	249.3	+.85	465.7	+26.82
1977	423.1	+21.51	333.2	+19.86	251.9	+1.04	592.2	+27.16

Source: "Nigeria's Principal Economic and Financial Indicators, 1970-1976", Economic and Financial Review, volume 16, no.1, June, 1978.

kept out, when necessary, by shutters, and blinds. Similarly, schools in rural areas are constructed with dwarf walls which let in sufficient amounts of sunlight to lighten the classrooms adequately.

At nights, rural Nigerians depend on kerosene and palm oil for homelighting. While kerosene is used in modern lamps, palm oil is used in locally made can lanterns. Matches are a very important product to most rural dwellers, especially in case of any sudden disturbance, as matches are used to light these lanterns.

In the southern rural areas of Nigeria 'Urioku' is used as a substitute for kerosene. In the northern rural areas, dried straw is the most commonly used alternate source of homelighting. Straw is dried in bundles, and set on fire to generate light. As described earlier, urioku is lit and supported in a bottle like a conventional candle.

Domestic consumption of electricity in city centres is low compared to that of most developed countries. Although homes of middle and upper class individuals are well lit and stocked with the latest electric appliances, the urban poor rarely live in electrified homes. Thus, per capita consumption is low. Major users of electricity in urban areas are industries, hospitals, and other commercial establishments.

Cooking

Powered cooking utensils and appliances are almost

never used in rural areas in Nigeria. The most important sources of energy for cooking are firewood, dried palm fronds, and coconut shells and pulp. Of all of these, the most important is firewood because wood burns for the greatest length of time.

In urban centres, only middle and upper class individuals use gas, kerosene, or electric stoves on which to cook. The unavailability and rising cost of gas and kerosene, combined with the unreliability of electricity supplies is sure to result in continued dependence upon firewood and charcoal for cooking.

SUMMARY

Rural and urban dwellers differ greatly in terms of energy consumption. Urban residential, commercial, industrial and transportation sectors are highly dependent on non-renewable energy resources, whereas rural activities involve renewable energy resources almost exclusively. Available sources indicate that per capita energy consumption in rural areas of Nigeria in 1975 was approximately 16 gigajoule of fuelwood, but only .04 gigajoule of commercial energy (Cecelski, Dunkerley and Ramsay, 1979). Table 4.3 illustrates the characteristics of major urban energy demand sectors.

While there are wealthy rural dwellers who enjoy the energy use patterns of the urban middle and upper classes,

Table 4.3 Characteristics of Nigerian Major Urban Energy Demand Sectors

	Residential	Industrial & Commercial	Transportation
Estimated share of Total Energy Usage	18%	48%	34%
Major Use	Cooking, lighting, & space cooling.	Industries such as iron & steel, cement, glass, and street lighting (approx. 55%).	Land Transport, (approx. 95%).
Main Energy Sources	Approx. 30% electricity, 60% kerosene & gas, 10% firewood/charcoal.	Approx. 70% oil & gas, 15% coal, 25% electricity.	Approx. 97% oil, 3% coal.

so do the urban poor share consumption patterns with the rural majority. Similarly, modern industries located in rural areas follow the same energy use pattern as urban industries. Generally speaking, however, rural and urban energy use patterns differ greatly.

The renewable and non-conventional energy sources which are used by the rural majority are erroneously referred to as "non-commercial" because it is widely assumed that they are not paid for. Although direct solar energy is presently a "free" commodity, firewood and charcoal used by urban dwellers must be purchased. Even in the rural areas approximately 10 - 15 percent of the fuelwood consumed is exchanged for cash or other commodities. It is this misconception which is perhaps responsible for the absence of figures relating to supply of and demand for firewood and other forest products in energy statistics. One can only assume that the reason that these important sources of energy are completely ignored in Nigeria's energy-related National Development Plans is that Nigerian policy-makers also fail to recognize their importance, particularly because they are not included on the yardstick of "modernization".

The importance of human energy to Nigeria's economy must not be underestimated; almost all of the economic activities carried out in rural areas are highly labor intensive, as are many urban industries. Furthermore, a change to dependence on non-animate energy sources would have a

devastating impact in terms of unemployment and its associated social problems. It is, therefore, imperative that discussions of energy in Nigeria give particular attention to all aspects of human energy.

General Problems Associated with Energy Supplies

Over-Dependence On Petroleum

Although the majority of Nigerians depend almost exclusively on renewable energy resources, the oil industry dominates the country's economy; petroleum leads in the mineral value production of Nigeria, and petroleum-industry products have the most export value of all commodities produced in the country. The contribution of oil to the Nigerian economy is steadily increasing, accounting for 92.8 percent of all exports in 1975, up from its share of just 29.8 percent in 1967. In 1963 oil contributed just 6.9 percent of Nigeria's total foreign exchange, but by 1974 that percentage had risen to 86. As oil gained importance in the Nigerian economy so did the government's emphasis on petroleum. This has resulted in a significant displacement of traditional exports by petroleum products, with serious consequences. First, production of most traditional exports in the Nigerian economy requires labor-intensive methods, and provides employment for many hundreds of thousands, as well as economic support for their dependents. The oil industry, by contrast, is capital intensive and employs just seven percent of the

total wage-earning labor force (Baker, 1977). Secondly, international prices are generally unstable, and although it seems improbable that oil prices will fall, dangers of over-reliance on one industry are obvious. The Nigerian government would be wise to take advantage of current international prices and markets, and use oil revenue to diversify the nation's economy through exploration of non-fuel mineral resources and to rejuvenate the declining agricultural sector,[1] while limiting production to ensure future oil supplies.

Although the majority of Nigerians still rely on traditional renewable sources of energy, little is being done to make these sources more attractive. Rather, emphasis is being placed on the adoption of "modern" methods of home-lighting, transportation, farming, and cooking. While the cost of such methods is totally out of the reach of most Nigerians, the efficiency with which traditional energy resources are used could be increased at very low cost, as Table 4.4 demonstrates. More attention needs to be given to these traditional energy resources not only for immediate purposes, but also to supplement domestic energy demands so

---

[1] In the mid-1970's, the Nigerian government embarked on a program of increased food production, "Operation Feed the Nation," which involves major government investments, including several large-scale irrigation schemes in the drought-stricken northern parts of the country. Other programs involve large government loans, the bulk of which unfortunately go to already prosperous farmers rather than those rural farmers who comprise the largest parts of the agricultural sector and whose output the majority of Nigerians depend upon.

Table 4.4 Quoted Cost Estimates of Selected Energy Technologies, Fuels, and Appliances

Technologies, Fuel, or Appliances	Quoted Cost Estimates
Electric:	
Mini-Hydro (excluding dam and penstock costs)	$0.03 - 0.10 per kwh
Wind Generators	$0.04 - 0.18 per kwh
Diesel Electricity	$0.10 - 0.30 per kwh
Other:	
Biogas	$0.07 - 3 per gigajoule
Fuelwood	$0.40 - 2 per gigajoule
Kerosene	$3.00 - 6 per gigagoule
Solar Cookers	$7.00 - 35 per unit

Source: Cecelski, Dunkerley, & Ramsay, Household Energy and the Poor in the Third World. Washington D.C.: Resources for the Future, Inc., 1979, p. 54.

that finite petroleum resources will be available to Nigeria for a longer period of time.

Patterns of Development

There is a tendency for modernizing nations today to attempt to hurry the process by importing models and technologies from industrialized nations rather than going through rigors of experimentation. Since industrialized nations developed in environments extremely different from that of Nigeria, the appropriateness of their large-scale, capital-intensive, non-renewable energy-oriented technology is questionable. Yet, faced by the familar trio of capital, human, and time constraints, Nigeria seems unwilling to develop alternate technologies herself, and since the market is small, advanced nations see no profit in developing and exporting the approriate technology. As Earl (1975, p. 103) remarks,

> It is particularly dangerous for developing countries to rely upon trends which have occurred in the present developed countries. Oil resources are being depleted at a much faster rate than formerly and this is certain to lead to substantial price increases not only for oil but for all substitutes. Although developed countries with adequate funds will utilize their consumer surplus to purchase fuel for their expanding needs, the outlook for developing countries is bleak since substitution is realistic only for those countries which can afford the substitutes.

Judicious planning requires the availability of reliable information on the inventory of energy resources which may be affected by development programs. Furthermore, the particular nature of the resource and its importance to

human life needs to be known so that long-term consequences of its use can be carefully considered. Such information is presently not available.

Lack of Public Participation

Despite increased government revenue from oil sales, little has been done to erase mass poverty and suffering in Nigeria. Rather, the gap between the rich and the poor has merely been widened through the misappropriation of funds. This is the direct outcome of restricting involvement in the country's oil industry to members of the elite. Although the government has achieved increased participation within the multinational corporations operating in Nigeria, this increased participation is not shared by the general public. Civil servants struggle to gain power over the government's investments. Government officials move between their roles as permanent secretaries of ministries and directors of local affiliates of multinationals while at the same time, making personnel investments in local industries. Thus, an indigenous bourgeoisie is emerging where access to profitable investment through corruption and bribes, state patronage, or "insider" knowledge about private investment acrrues to individuals linked to the government (Lubeck, 1977).

Developmental programs are more or less geared towards maximization of rewards for the elite rather than for the good of the general public. There is little or no public in-

put into the planning of developmental projects, and even where decisions made have a tremendous impact on the total population, there are no public hearings or debates. In essence, the foreign imperialists of the past have been replaced with indigenous exploiters.

Accurate information regarding the contribution of development programs, measured in terms of increased employment, contribution to the gross domestic product, tax contributions, contractual bids, and corporate profits need to be made accessible to the public. The provision of such information would serve as a means of control and would allow the general public to evaluate the degree to which exploitation of their energy resources is being used to optimize national interests. Steps must be taken to ensure that beneficial development programs do not die in the hands of mismanagement.

Energy and the Environment

Pollution control in Nigeria has been given very little attention for a number of reasons. First, until recently industries in Nigeria were not energy-intensive, particularly traditional industries whose primary source of energy is m a n p o w e r . Secondly, oil industries were concentrated in coastal areas which are characterized by swamplands and which contain sparse vegetation and limited wildlife. Any environmental pollution which occurred did not

spread to interior regions, and therefore did not pose any real threat. Thirdly, pollution resulting from poor sewage systems and careless garbage disposal far outweigh the effect of energy operations. Furthermore, the people's struggle for economic sufficiency leaves little time for thoughts of air quality and the condition of their natural environment. Similarly, policy makers have given priority to achieving a rapid rate of development, at almost any cost to the environment. Finally, Nigeria's peak period of industrialization came at a time when strict pollution-control standards were being imposed in the Western World, so Nigeria was importing machinery that was already equipped with anti-pollution devices.

In spite of this little concern, energy development in Nigeria has had some serious effects on the environment. Most of the buildings surrounding coal mines, for example, are coated with carbon discharges from mining operations. Nearby vegetation has been destroyed, and tremendous erosion has occurred. In 1970, an oil well 60 km from Port Harcourt got out of control, resulting in an oil spill over large areas of land, halting fishing and farming activities in the area for two years. In 1972 a similar accident occurred at Obaji, destroying 60 hectares of farmland and polluting fishing ponds (Akintola, 1978). In forest areas, overwhelming demand for firewood has allowed little time for reforestation to take place, particularly in savannah forest zones. The manner in

which firewood is obtained has also resulted in reduction of soil cover and erosion.

The distribution of petroleum products in heavy tankers from coastal regions to the interior has caused damage to roads and bridges. Oil spills and accompanying fire resulting from road accidents have destroyed vegetation and wildlife. During periods of petroleum shortage, petroleum has been illegally stored in cans and drums which have caught fire and caused much destruction.

Throughout Nigerian oilfields, large quantities of gas associated with oil production is flared, using stacks about seven to nine metres high. Although the effect of these flares is not particularly harmful at this time because oil wells are located in areas where vegetation and soil are poor, great damage may result as new sources of oil are discovered and developed in the interior areas.

Some Potential Impacts

In addition to environmental problems already being experienced in Nigeria because of energy development and usage, there are several which may occur in the near future. First, the Nigerian government has divided the country into 19 states. Each state is developing its own industrialization projects, resulting in industries being developed closer to densely populated areas. If this trend continues, the impact of industrial pollutants on the environment may become a

matter of real concern. As oil explorations and operations shift from coastal regions to the interior, rights-of-way for oil operations may be in areas of rich vegetation and varied wildlife, thereby creating the potential for environmental damage.

Secondly, increasing population is putting a strain on the available land, and the damming and flooding of rivers for multipurpose projects or hydroelectricity may merely exacerbate the problem. Thirdly, Nigeria is presently experimenting with nuclear power, and activities associated with such development can, if improperly handled, have serious effects on the quality of the atmosphere, water, and surrounding life.

Another potential problem stems from increased use of machines for transport, pleasure, and as a substitute for labor. The corresponding noise and air pollution has been linked with respiratory problems, hearing loss, heart disease, high blood pressure, damage to unborn babies, and disorders of nerves and glands, in addition to increased tension and irritability (Dwivedi, D., 1974). In highly concentrated urban centres such as Lagos, these effects are already being felt, a fact which has prompted talk of moving the federal capital to Abuja. Judicious planning is required to ensure that Abuja does not become equally congested and polluted, robbing Nigerians of the surrounding farmlands which are so desperately needed.

The network of gas and oil pipelines which has been proposed under the current Nigerian Development Plan is going to affect the environment in a number of ways. There will be an invasion of the country's wilderness, reducing the country's supply of land in its natural state. Rights-of-way for pipelines, access roads, and construction sites may have an unavoidable and largely negative impact upon the surrounding vegetation and wildlife.

If these and other impacts are to be minimized, if not avoided, it is important that projects not be undertaken before a careful study has been made of all possible consequences to the environment. Such studies must be given the same lead time and financing accorded economic or engineering feasibility studies of major projects. Mechanisms should be devised whereby the public will have access to findings of these studies, and public forums should be organized for an examination of the plans and their consequences. Since it is the people who are going to bear the consequence of development actions, it is only right that people be a part of the decision-making process.

Financial, Personnel, Equipment and Material Constraints

Although endowed with numerous and abundant resources, Nigeria's ability to use these resources depends upon many factors, not the least of which are the availability of capital, personnel, equipment, and material. As Table 4.5

Table 4.5 Nigerian Sources of Finance for Public Sector Investment Programmes Under Various Development Plans, in 1962-80, by Percentage

Sources of Finance	1962-68	1970-74	1975-80
Domestic Sources	40.2	80.6	133.7
External Sources	50.0	19.4	---
Uncovered Gap	9.8	---	-33.7*

*represents net surplus. i.e. Excess domestic public sector resources over planned public sector investment programs.

Adapted from: S.A. Madujibeya, "Oil and Nigerian Economic Development," African Affairs, Volume 75, No. 300, July 1976, p.315.

demonstrates, Nigeria was able to embark upon major development projects with minimum dependence on external sources for financial assistance after 1973. This was due to rising oil prices and the resulting oil revenues of the country, as is shown in Table 4.6. The negative percentage change in 1975 was the result of a political decision to reduce oil production, and does not reflect a drop in oil prices. Yet, Nigeria suffers from a lack of capital. Most energy-related projects such as the construction of refineries or LNG plants involve the concentration of huge sums of investment outlay within a short period of time. This results in inflation and spiralling costs of consumer goods. These large investments in the energy sector also attract capital away from other sectors of the economy. Thus Nigeria's financial problem is not with finding the money, but of attenuating economic stability.

In terms of qualified personnel, Nigeria is in short supply of the managerial and technical expertise required to man the energy industries effectively. This problem could be minimized by spacing the energy development programs to coincide with the completion of the training programs which have already been set up by the government. A more accurate picture of the existing labor force is required if it is to be effectively utilized.

Nigeria's dependence on nations overseas for the supply of material and equipment necessary for energy develop-

Table 4.6 Estimated Oil Revenues of Nigeria 1970 - 1978

	1970	1971	1972	1973	1974	1975	1976	1977	1978*
Total Amount in $Million	411	915	1,174	2,000	8,900	6,570	7,900	9,600	8,200
% Increase	---	55.08	28.31	70.36	345	-26.18	20.24	25.52	-14.58

*Estimate.

Sources: Jonathan Baker, "Oil and African Development", Journal of African Studies, 15,2, 1977. p.189.

Petroleum Economist, June 1979, Volume XLVI, Number 6, p.224.

ment is a limiting factor. This could not only lead to costly delays but, as was mentioned earlier, these material and their accompanying technology may not be suited to the Nigerian environment. Nigerian scientists and engineers must be urged to meet the challenge of developing the appropriate technology.

Administrative Instruments

While ministries and departments have been set up to oversee most of Nigeria's economic and social activities, such specific administrative instruments do not exist in the area of energy. Although there are ministries of agriculture, health, and defence, the administration of energy resources is split up among corporations and commissions such as the Nigerian Petroleum Corporation, the National Electric Power Authority, the Coal Corporation, and the Atomic Energy Commission. Such an unco-ordinated approach to energy development has had several ill-effects.

First, fragmentation of administrative bodies has left the development of non-conventional sources of energy largely up to chance; solar energy, forest-fuel resources, windpower, and energy from agricultural and human wastes are real and potential energy resources which are not represented in the myriad of commissions and corporations. The exploitation, use, and supply of these energy sources is in no way regulated, and this situation could lead to tradegy for the

millions of Nigerians who are dependent upon them.

Secondly, the present system of administration has resulted in a lack of data from which to construct an accurate picture of the country's total energy supply. Data that does exist are scattered across the country in files of various corporations and commissions, and are not easily accessible. If obtained, data must be transformed into common standards of measure. This type of 'system' does not facilitate the formulation of integrated national energy policies, development of which are sorely needed.

Since various bodies which are presently dealing with energy resources in Nigeria are not linked in any way, the full potential of the people working in these agencies is not being tapped. For a nation faced with shortages of skilled manpower, this is a great waste. Since energy is a crucial aspect of the development and maintenance of the nation's social and economic activities, it is imperative that a department be set up to co-ordinate and oversee all of the country's energy-related activities. This ministry would be involved in research, planning, record-keeping, upgrading of energy resource inventories, and the publication of energy-related information. The greatest benefit of such an agency would be to encourage the diversification of energy supplies and pursue the long-term goal of energy self-sufficiency.

CHAPTER 5: ROLE OF MAJOR PARTICIPANTS

The complexity of Nigeria's energy sector is reflected in the diversity of functions of the various participants in the area of energy supply and demand.

Organization of Petroleum Exporting Countries (OPEC)

The world petroleum situation has undergone some significant changes since the mid-seventies. These evolutions include a shift in the distribution of world crude petroleum reserves from the Western Hemisphere to the Middle East and Africa (Table 5.1). A second change was witnessed in the identity of the non-communist world's leading producer of oil, as the United States lost its dominant position to Saudi Arabia.

Thirdly, the dominating power of the large multi-national oil companies (Exxon, Mobil, Socal [Standard Oil Company of California], Texaco, Gulf, British Petroleum and Royal Dutch Shell) has been regulated as the oil producing nations have been able to undertake effective control of their own oil operations. Finally, is the global felt presence of the Organization of Petroleum Exporting Countries, which now has effective control of the international oil trade.

Table 5.1 World Crude Oil Reserves 1965 and 1978
(Million Barrels)

Western Hemisphere	1965	1978	Percent Change 1965/1978	1978 Share of World Total
Argentina	2,900	12,503	+331	1.9
Barbados	---	1	---	---
Bolivia	500	350	-30	---
Brazil	672	880	+31	.1
Canada	6,711	16,000	+138	2.5
Chile	150	1,440	+860	.2
Columbia	1,700	1,960	+15	.3
Ecuador	25	1,640	+6,460	.3
Guatemala	---	16	---	---
Mexico	2,484	14,000	+461	2.2
Peru	350	730	+109	.1
Trinidad and Tobago	425	650	+53	.1
Venezuela	17,366	18,200	+5	2.8
United States	31,352	29,500	-6	4.6
Total Western Hemisphere	64,645	97,870	+51	15.2
Middle East				
Abu Dhabi	7,500	31,000	+313	4.8
Bahrain	250	270	+8	---
Dubai	---	1,400	---	0.2
Iran	40,000	62,000	+55	9.6
Iraq	30,000	34,500	+15	5.3
Israel	---	1	---	---
Kuwait	70,000	67,000	-4	10.4
Neutral Zone	10,000	6,200	-38	1.0

Table 5.1 - Cont'd.

	1965	1978	Percent Change 1965/1978	1978 Share of World Total
Oman	2,000	5,650	+183	0.9
Qatar	3,800	5,600	+47	0.9
Saudi Arabia	63,707	150,000	+135	23.0
Sharjah	---	25	---	---
Syria	500	2,150	+330	0.3
Turkey	500	370	-26	---
Total Middle East	228,257	366,166	+60	57.0
Africa				
Algeria	6,000	6,600	+10	1.0
Angola	40	1,160	2,800	0.2
Congo Republic	3	360	+11,900	---
Cameroon	---	60	---	---
Egypt	600	2,450	+308	0.4
Gabon	275	2,050	+645	0.3
Libya	13,000	25,000	+92	3.9
Morocco	10	---	---	---
Nigeria	2,500	18,700	+648	2.9
Tunisia	250	2,670	+960	0.4
Zaire	---	150	---	---
Total Africa	22,678	59,140	+161	9.2
Total World	364,735	645,847	+77	100.0

Sources: Oil and Gas Journal, Dec. 26, 1977, pp. 99-100.

Oil and Natural Gas Industries in Canada, 1978 Report ER 78-2 Energy, Mines and Resources Canada, pp. 87-90.

OPEC[1] was formed in September of 1960 in response to the growing concern on the part of a group of oil producing nations that their interests were not the same as those of the multinational oil companies. However, OPEC was not effective until 1970. In the 1950's and 1960's, the giant oil companies had exclusive control over skilled personnel, technology, capital, and facilities. This gave control over production, distribution, pricing, and marketing of crude oil to a small group of companies, with the role of the producing countries being confined to collecting royalties on what was produced.

In the same period, because of the surplus production capacity over demand for oil, oil companies were able to maintain their dominant position by cutting back production in any country that presented any political pressure, and made it up from elsewhere. Through such control of output, multinational oil companies were able to determine the level of incomes to be enjoyed by the producing nations. In the 1970's consumption of petroleum in Western and European nations had increased to such a degree that marketable oil reserves outside of OPEC became very small (excluding Communist U.S.S.R.) and the multinational oil companies began to loose their control of oil operations.

---

[1]Members of OPEC include Nigeria, Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Quator, Saudi-Arabia, the United Arab Emirates and Venezuela.

Assuming that Communist areas continue to be almost self-sufficient in oil, the rest of the world's needs which are estimated at 65 million barrels daily in 1990 would be met as follows: 40 million barrels from OPEC, 15 million barrels from North American and 10 million barrels from other non-OPEC sources (Synods, 1978).

Nigeria became a member of the Organization of Petroleum Exporting Countries in July 1971 and has since been very active in OPEC activities. In response to OPEC resolutions, Nigeria raised the posted price of its oil as in (Table 5.2).

Table 5.2 Nigerian Posted Oil Price Increases 1973-1980

In U.S. Dollars per Barrel (f.o.b.)

Type of Oil	Jan. 1st 1973	Jan.1st 1974	% Increase 1973/1974	Jan.1st 1978	% Increase 1973/1978	Jan.1st 1980	% Increase 1973/1980
37° API Gravity Crude.	3.56	8.31	+133	14.94	+320	30	+743

The price of Nigerian oil has been rising ever since.

The government has also secured participative interest in the concessions of multinational oil operating companies. The government participation rate was 55 percent for all companies with effect from April 1974. However, the most recent arrangement is that the Nigerian government has increased its equity stake in oil operations from 55 percent to 60 percent.

The above changes caused a significant increase in government oil revenues to effect most of the country's ambitious development projects. As Baker (1977, p. 189) asserted,

> As for Nigeria it is no exaggeration to say that oil has had a traumatic effect. Since October 1973, the greatly increased financial flow has enabled impressive development plans to be implemented and in 1974 an estimated 83 percent of all government revenues were derived from oil. Nigeria's third five-year plan which began in April 1975 involves a total investment of about $50,000 million, ten times more than the previous plan.

Nigerian oil revenues are expected to double from $10 billion dollars in 1978 to 20 billion dollars in 1980 (Leon Dash, Washington Post, February 1980).

The industrialized nations responded to the emerging power of OPEC by forming the International Energy Agency, IEA. The 19 members of IEA represent the largest energy users in the free world. IEA was formed to provide a common response to possible future oil embargos.

Towards this end the members agreed to share oil in a crisis, and to maintain reserves of oil for use in an emergency. To further their efforts, the IEA initiated policies relating to energy conservation measures and the development of alternative sources of energy such as nuclear, wind, and solar power technologies.

However, the Organization by Petroleum Consuming Countries of such groups as IEA has not been able to erode the dominant position of the OPEC in the international oil trade.

As remarked in the Petroleum Economist, 1979,

> "Closely connected with the question of OPEC aspirations is the need for all oil importing countries to abandon, once and for all any idea that Western institutions such as the EEC, OECD, IEA, provide convenient machinery for "confronting OPEC".... But while confrontation is ruled out general discussion of common problems is greatly to be desired." (Petroleum Economist, October 1979 Volume XLVI Number 10, p. 399).

For future years the major oil consuming nations will have to learn to live with OPEC.

General Impacts of OPEC

OPEC achieved increased government participation in the oil operations as well as in other related industries. The organization has maintained in the past some levels of solidarity among the major producers in the co-ordinated management of oil production and pricing.

OPEC has been responsible for the increase in the economic, and more recently the political power of the oil-exporting countries. The collective bargaining position of the organization has made it very possible for the individual countries to gain great guaranteed price improvements from the multinational oil companies. OPEC undoubtedly provided the framework within which member African countries were able to carry out their policy of increasing economic independence. This is demonstrated to a large extent by state participation in the operations of foreign industries within their countries and the nationalization of some (Baker, 1977).

OPEC price increases have generated, in absolute terms, high oil revenues to the oil producing countries as is illustrated in (Table 5.3). The total government oil revenue receipts between 1972 to 1977 registered a nine-fold increase, (approximately a rise of 790 percent) from about $14 billion to $128 billion. Since the total OPEC exports increased by only 14 percent (from 25.5 to 29.1 million barrels per day) the general upsurge in the cash flow is almost due to price increases rather than increases in production (Tucker, 1978).

The general huge oil revenues have enabled OPEC countries to import increasing quantities of goods and services to nourish and maintain the economic developments of their countries. Oil price increases meant corresponding increases in the price of the goods and services imported. Naturally then, the industrialized countries continue to be the main beneficiaries of this appetite for imports. The end result is that the oil revenues of the oil exporting countries are being eroded by inflation in the prices of the goods they import from the industrialized nations and the weakness of the U.S. currency.

The oil price increases have significant impact on the balance of payments of most developing countries. As Jonathan Baker (1977, pp. 192-193) remarks,

> African countries face large balance-of-payment deficits, not only because of the increased cost of

Table 5.3 OPEC: Oil Revenues in Million U.S. Dollars

1972 - 1977

	1972	1975	Percent Increase 1972/75	1976	Percent Increase 1972/76	1977	Percent Increase 1972/77
Saudi Arabia	3107	25700	+727	33500	+978	37800	+1117
Iran	23800	18500	+677	22000	+824	23000	+866
Iraq	575	7500	+1204	8500	+1378	9600	+1570
Kuwait	1657	7500	+353	8500	+413	8500	+413
U.A.E.	551	6000	+989	7000	+1170	8300	+1406
Qatar	255	1700	+567	2000	+684	1900	+645
Libya	1598	5100	+219	7500	+369	9400	+488
Nigeria	1174	6570	+462	7900	+624	9600	+701
Algeria	700	3400	+386	4500	+543	5600	+700
Venezuela	1948	7500	+285	8000	+311	8000	+311
Indonesia	429	3850	+797	4500	+949	5600	+1205
Gabon	---	800	---	800	---	800	---
Ecuador	---	550	---	800	---	500	---
Total O P E C	14374	94700	+559	116100	+708	128400	+793

Sources: Derived from E. Stanley Tucker: Revenues and Balances, pp. 285-286; Petroleum Economist, July 1978, Volume XLV, Number 7; June 1979, Vol. XLVI, No. 6, p. 224.

Jonathan Baker, "Oil and African Development", Journal of African Studies, 15, 2 , 1977, p. 189.

> oil but also as a result of the concommitant rise in the price of manufactured goods imported from the developed countries. These deficits can only be covered by foreign borrowing, and this in turn aggravates the already acute debt problem. To make matters worse the recession in Europe and the United States has reduced the demands for African raw materials, thereby decreasing their export value. In addition many countries have been plagued by prolonged drought and poor harvest and this has necessitated the importation of food at high prices.

After the 1973-74 sharp oil price increases the combined deficit of the less developed countries jumped from $9 billion in 1973 to $37 billion in 1975. It dropped to $22 million in 1977 as a result of the world industrial recovery, but increased to $27.5 billion in 1979. The external debts of these less developed countries increased steadily and borrowing from banks has been the main source of finance. Allowing the rise in their reserves the net indebtedness of the less developed countries rose from $3 billion in 1974 to $44 billion in September 1978 (Petroleum Economist, July 1979).

Potential Impacts

As OPEC countries invest more of their oil revenues into economic developments, their domestic oil requirements may rise steeply and this trend might affect OPEC's future export potentials. This is a trend that has been ignored in future oil supply forecasts. As (Table 5.4) for most of the OPEC countries, the growth rate in internal oil consumption exceeded the net oil exports in the periods

Table 5.4 OPEC: Energy Consumption and the Growth Rate 1970 - 1976 (% Year)

	ENERGY CONSUMPTION		OIL CONSUMPTION		NET OIL EXPORTS	
	MB/DOE 1976	Growth Rate 70-76 (% Year)	MB/D 1976	Growth Rate 70-76 (% Year)	MB/D 1976	Growth Rate 70-76 (% Year)
Algeria	117	+11.5	79	+4.4	924	+2.1
Indonesia	426	+14.8	359	+19.4	1159	+12.5
Iran	697	+10.7	429	+15.8	5509	+9.4
Iraq	117	+6.7	80	+3.0	2133	+8.1
Kuwait	133	-0.9	29	+12.6	2138	-2.8
Libya	57	+23.6	57	+23.6	1836	-7.3
Nigeria	85	+15.9	65	+13.8	2059	+14.2
Saudi Arabia	246	+18.7	136	+26.0	8416	+17.9
Venezuela	491	+5.7	232	+4.5	2274	-6.4
Others	133	+10.5	86	+16.7	2792	+16.9
TOTAL	2562	+10.0	1552	+12.0	29240	+6.7

Source: Petroleum Economist, Volume XLVI, Number 10, October 1979, p. 427.

between 1970 - 1976.

In Nigeria for instance, the consumption of petroleum energy products excluding liquefied petroleum gas, greases, and solid products amounted to about 95,000 barrels per day in May 1977 and is estimated to be increasing at an annual rate of 25 percent. Projected 10 to 15 percent annual growth rates over the years to 1988 will raise the domestic consumption to approximately 350,000 barrels per day and 500,000 barrels per day respectively. Except with significant increase of the country's oil reserves, this growth trend of the domestic oil consumption may be expected to significantly reduce the country's oil export availability.

The oil price increases have accelerated the concerns of industrial countries to engage in programs leading to reduced dependence on oil. Measures such as energy conservation, increased efficiency of energy use and attempts to switch to other forms of energy has become increasingly important. Apart from the steep rise in OPEC oil prices checking the growth in demand, it also made it economically possible to develop costly oil reserves (tar sands) and new sources of crude, mainly in the North Sea, Alaska and Mexico. Alternate sources of energy like nuclear have grown in importance. As these sources continue to supply the energy needs of the oil importing nations, the demand for foreign oil might fall, and so would the revenues of oil exporting countries. For most oil exporting countries where oil revenue

is the mainstay of the economies the effects of any dramatic substitute for oil and decline in oil revenues cannot be underestimated.

OPEC nations should attempt to maintain the price level that provides value for their non-renewable asset but check possibilities of creating leverages for industrialized nations to render their 'asset' obsolete.

Federal Government

The federal government's involvement with the energy sector of the economy is based on state ownership of mineral rights, control of land, international trade, its power of taxation, and control of distributive pool accounts. The Nigerian military government imposed a formula for sharing oil revenues among the 19 states: 20 percent of total revenues is given to the oil-producing states as concessionary payment, and of the remaining 80 percent, half is shared equally among the 19 states and half is distributed among the states on the basis of population, with more highly populated states receiving a larger share.

The oil producing states question the precedent for this method of revenue distribution, if in fact there is any. When agricultural commodities were lucrative, they argue, money derived from sale of commodities was enjoyed exclusively by producing regions. However, each region was endowed with at least one cash crop that was valued in the world

market, and the success with which the production of that crop met was a direct result of the people's efforts. The discovery of oil, on the other hand, was a geological accident, and states have no control over the distribution of mineral resources within their borders.

One major drawback of this method of revenue distribution is the allocation of funds on the basis of population. This practice discourages the implementation of population control measures by state officials, and hinders the presentation of reliable census figures.

Through the Indigenization Decree promulgated by the federal military government in 1972, the Nigerian government has gained effective participation in the industrial development of the country. Indigenization does not entail the nationalization of foreign investments, nor does it abolish the entry of foreign capital into the country. What it does is enable the government to engage in joint ventures with multinationals in oil exploration, and the establishment of projects such as petro-chemical complexes, refineries, liquefied natural gas plants, a coal-chemical complex, and pipeline transportation systems. The federal Ministry of Finance deals with taxation, duties, and repatriation of profits, while the federal Ministry of Internal Affairs arranges for work permits and visas for foreigners, and the federal Ministry of Trade issues company licenses and handles some aspects of trade.

The federal government participates in energy industries through corporations such as the Coal Corporation, Nigerian Petroleum Corporation, National Electric Power Authority, Nigerian Mining Corporation, and National Atomic Commission.

Nigerian Coal Corporation

Nigerian Coal Corporation was established under the Nigerian Coal Corporation Act No. 29 of 1950. The Corporation is responsible for the mining, development, and distribution of coal for export and local use. It is also responsible for undertaking studies on alternate uses of coal. The Corporation may mine and sell clay and limestone, and manufactures and sells coal products such as tar, briquettes, and coke.

Nigerian National Petroleum Corporation

The Nigerian National Oil Corporation (NNOC) which today is known as the Nigerian National Petroleum Corporation (NNPC) was established by federal decree in 1971. The National Petroleum Corporation is the commercial arm of the public sector in all activities relating to the petroleum industry, including exploration, production, transportation, and marketing. The Corporation holds approximately 55 percent participatory interest in the private oil companies operating in the country. The government of Nigeria announced in 1972 that it had stopped granting further concessions to private companies, and areas not covered by existing licenses as well

as areas to be relinquished in the future which are now designated as "national reserves" are to be allocated to the Nigerian National Petroleum Corporation. In general, the activities of the Corporation cover both on-shore and off-shore drilling, seismic activities, exploratory drilling, and the development of production fields. Some of the more specific functions of the Nigerian National Petroleum Corporation are as follows:

- *Exploring and prospecting for, working, mining, or otherwise acquiring petroleum.*
- *Purchasing, mining, treating, processing, and marketing petroleum, its products and by-products.*
- *Constructing transportation network systems and acquiring carriage and conveyance facilities for crude oil, natural gase, water, and other liquids.*
- *Constructing, equipping, and maintaining tank farms, depots, and other facilities.*
- *Managing investments in oil companies of which the government of Nigeria is a participant.*
- *Administering the relevant laws, regulations, and terms of agreement relating to the country's petroleum industry.*

The National Oil Corporation was expected to ensure greater and more effective participation by Nigerians in the development of their petroleum resources. The Corporation was to ensure employment for Nigerians, give them experience in the oil industry, and ensure security of supplies and

increased revenues for the people. Unfortunately, however, these benefits have not been reaped by the majority of Nigerians.

National Electric Power Authority

The National Electric Power Authority is responsible for generation and distribution of public electricity plants. The Authority is to assist in training programmes for the development of skilled personnel, as well as participate in studies relating to the development of alternate sources of electric power and in activities involving multipurpose development of suitable dam projects.

Nigerian Mining Corporation

The Mining Corporation is generally responsible for exploration, development, and marketing of all mineral resources, both fuel and non-fuel. Its functions overlap with those of the Nigerian Coal Corporation, the Nigerian National Petroleum Corporation, and the National Atomic Energy Commission.

National Atomic Energy Commission

The National Atomic Energy Commission was established on August 4, 1976 under Decree Number 46 of the Federal Military Government of Nigeria. The Commission is responsible for the development of atomic energy in the country, and its peaceful usage. The Commission's functions include prospec-

ting for and mining radioactive minerals, constructing and maintaining nuclear power installations for the purpose of generating electricity, carrying out research activities, and advising the federal government on matters relating to atomic energy.

The major drawback of these corporations and commissions is that appointments of their high-level personnel are based more on patronage than expertise. Other problems include difficulties in co-ordination among them, and either too much or too little emphasis being placed on certain aspects of energy resources. Forest-fuel, solar- and windpower are not represented by any of these bodies.

Need For Action

The solution to many of the problems associated with energy supplies in Nigeria rests in the hands of the federal government. It is the federal government's responsibility to increase public participation in the decision-making process through the provision of relevant and accurate information. The federal government should use its control over the Distributive Pool Account to allocate some oil revenues to the development of substitute sources of energy, and to encourage the more efficient supply and utilization of traditional, renewable sources of energy. Pollution control standards should be imposed and strictly enforced. Conservation measures should be implemented and closely monitored.

Perhaps most importantly, the federal government should take steps to ensure that all Nigerians benefit from the exploitation of the nation's energy resources.

State Governments

The 19 state governments have replaced former regional administrative governments. Functions and jurisdictional powers of newly created states are evolving with time. Nevertheless, the state governments play an important role in the energy sector of the nation.

State governments are involved in the establishment of compensation rates for damaged crops, the disturbance of fishing rights, land acquisition, and similar matters resulting from the activities of energy development programs such as hydro power dams and petroleum operations. The Rural Electricity Board has been established in each state to cater to the need for electric power in rural areas where the National Electric Power Authority is unable to extend its services. Through their role in education the state governments provide institutions and financial awards to enhance the development of skilled personnel.

Need For Action

The state governments should play a role in the abolish-

ment of land tenure systems and other cultural constraints which adversely affect energy supplies. Population-control programs should be developed by the states and introduced through the state-controlled education systems. State governments should be prepared to offer assistance to lower income groups who are unable to take advantage of newly introduced technologies such as solar cookers and improved fuelwood stoves, in the interest of energy conservation. The establishment of small-scale solar- and windpower facilities and village fuelwood plantations should be the responsibility of the state governments, and they too should be involved in research and development of energy alternatives.

Oil Industry

The Nigerian oil industry consists of indigenous companies as well as foreign-owned multinational corporations. The oil industry is involved with exploration, drilling, development, production, refining, transportation, and marketing of petroleum-based products and petro-chemicals. The oil industry also provides energy for industrial, commercial and domestic usage, through the operation of local refineries and various distribution channels.

Petroleum Training Institutes

Since the federal government has made the training and employment of Nigerians an obligation under the granting of

oil concessions, oil companies have significantly contributed to the training and employment of local people, particularly in supervisory and managerial positions in the industry. In 1972, the federal government established the Petroleum Training Institute and a council to govern it, under Decree No. 37. The institute's major functions are to provide courses of instruction, training, and research in oil technology, and to produce technicians and skilled personnel required for oil production. This is the only specifically energy-related institute in the country, and illustrates the dominating influence of the petroleum oil industry.

Available data indicate that in 1967 about 622 out of a total of 3,252 Nigerian employees in the oil industry held high-level managerial, professional, and supervisory positions. In 1976 the total number of Nigerians in the oil industry rose to about 4,500, and local people working in auxillary firms totalled about 1,500. Since the oil industry is capital-intensive rather than labor-intensive, growth in the oil industry operations is reflected by the expansion of capital investment rather than through increased employment.
The most obvious contribution of the oil industry is that of increased government revenues and gross domestic product. Where the oil industry has failed is in the provision of technology. Oil companies rarely promote basic or applied research activities within the country, preferring to import material, equipment, and specialized services for exploration,

development, and production from the international market. If Nigeria is to realize her goal of self-sufficiency, however, she may have to develop technology peculiar to the Nigerian environment.

Universities

Since 1960 the number of Nigerian universities has increased from three to thirteen. Most of the universities are still very young, with eight of them being established after 1972, and are not yet well-equipped with the necessary facilities and support staff to aid in satisfying the manpower demands of the nation. Still, the universities provide two important services to the energy sector. First is the education of students in various academic fields relevant to energy production. These include petroleum, hydraulic, electrical, civil, and mechanical engineers. The second service relates to the performance of research.

Although Nigerian universities have gained a reputation for research in social sciences, arts, and humanities, their contribution to energy-related research is modest. This is primarily due to the unavailability of funds, personnel, and facilities required to embark upon the intensive and extensive research demanded by the complex energy sector. A second reason for the failure of universities to provide adequate research is that although the study of social problems, for example, may require a narrow margin of expert-

ise, the energy sector is made up of social, technical, and economic components which require investigation at a level beyond the scope of a single discipline. Nigerian universities must endeavor to create a corporate environment within which to take the interdisciplinary approach required to deal with the complexity of the country's energy sector.

Research Institutes

Although there are several research institutes scattered across the country, there are no energy-based institutes. The Federal Department of Forest Research is predominantly concerned with studies relating to timber resources; the Nigerian Institute of Palm Oil Research is concerned with increasing the quality and quantity of oil palm fruit yields, and research into the production and processing of oil palm produce; the National Animal Production Research Institute conducts research into the economics of meat production, nomadism, and the integration of livestock into farming systems. The function of these research institutes could, however, be expanded to cover certain aspects of energy production. For example, the Federal Department of Forest Research could contribute to the energy sector by engaging in studies of forest fuel production and utilization, determining the fastest-growing fuel tree species and studying the possibility of establishing multiple product forestry management whereby less desirable trees which crowd high quality timber could be

used for making charcoal rather than being cleared, poisoned, or burned off. In the same manner, the Nigerian Institute of Palm Oil Research could engage in studies to determine the possibility of utilizing palm produce by-products in the production of charcoal. Similarly, the National Animal Production Research Institute may engage in studies to increase the low supply of transport animals and bullocks, as well as pioneering in the conversion of animal dung into biogas.

In addition to the expansion of the scope of these already existing research institutes, Nigeria requires the establishment of institutes specifically for the research of energy-related issues. These institutes should be affiliated with the universities, which could provide the facilities and personnel from various disciplines. Instead of being scattered across the country, qualified researchers could work together, exchanging ideas and findings, working to accelerate the rate of transfer and usage of appropriate technology. Both commercial and non-commercial energy sources would be represented as Nigerians worked together towards the goal of energy self-sufficiency.

CHAPTER 6: SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Although Nigeria has great potential for producing energy, realization may be impaired through mismanagement. Some energy resources suffer from wasteful exploitation, while others are under-utilized. Firewood, a traditional source of energy, suffers from both of these problems. Gas shortages, accompanied by high prices, have resulted in increased use of charcoal, with firewood being transported from rural to urban areas. Instead of burning wood to produce heat for cooking while at the same time producing charcoal, firewood is immediately burned to produce charcoal without utilizing its fuel energy. The charcoal business has in many instances resulted in the unregulated exploitation of firewood.

Wastefulness associated with use of forest resources is partly due to the lack of public education about the importance of forest fuel resources. Education is necessary to break the chains of the colonial and neo-colonial mentality which sees the use of traditional resources as being indicative of primitivity and underdevelopment.

Problems with supply of firewood and other traditional, non-conventional energy resources are largely due to the lack

of attention given them in National Development Plans. Rather than concentrating on needs of the people, the government seems intent on formulating policy for the development of "advanced" energy sources and technology, adopted from industrialized nations. The replacement of traditional technology, which is based upon renewable resources, with a technology which demands the use of non-renewable resources, may eventually lead to fuel shortages. Standards of rural life can be improved without teaching the people to depend upon something they may someday soon have to do without.

Nigeria is fortunate to enjoy plentiful, domestic sources of oil, making it unnecessary to import large quantities of highly priced petroleum products. This does not mean, however, that Nigeria is immune to the threat of fuel shortages. In the face of a rapidly increasing population, growing industrial and infrastructure development activities, and the widespread use of energy-consuming devices, strong national efforts may be required to use energy more carefully and to develop Nigeria's energy potential, a task which will be extremely costly. Failure to make the effort could mean a high degree of dependence on foreign oil in the next decade, a risky source in an uncertain world.

In highly populated countries such as Nigeria, where most economic and social activities involve the use of manpower, human resources are, and will continue to be, an important source of energy. Here the problem is not so much one

of quantity as of quality; while there is a surplus of manpower, there is a shortage of skilled labor. The Nigerian government has realized that the success of its development programs is to a great extent dependent upon the rate at which the country is able to produce high quality and well-motivated personnel, thereby accelerating the transfer of technology to all Nigerians. Towards this end Nigeria has embarked upon general programs ranging from universal primary education to the expansion of universities and technical institutions, as well as a few overseas training programs. Despite the high cost of training indigenous personnel, however, in many cases little effort is made to find qualified candidates in the local market to fill an opening in the government, public agencies, or multinational corporations. Although qualified, the ethnic background of a potential candidate may result in his being passed over in favor of an expatriate.

The problems experienced by some of the already modernized nations suggest the need for an integrated approach to the energy system. This involves a management and organizational system covering mineral fuels and electric power as well as the non-conventional sources of energy such as forest fuel, solar energy, biogas, and windpower. An integrated energy approach with a unified authority is necessary to ensure that maximum advantage is derived from all indigenous energy resources, and that all disparities between regions are alleviated so that all states can provide a reasonable

level of service to their residents. Towards this goal of an integrated approach to Nigeria's energy system, the following recommendations are offered.

Conclusions

There are bright energy potentials in Nigeria, and with good resource management problems of inadequate energy supplies need not be felt by present or future generations. The major problems associated with present supplies of conventional sources of energy are inadequate internal distribution facilities, under-utilization of natural gas resources, slow diversification of energy, and revenue depending on crude oil. National Development Plans and other government energy-related policies continue to ignore traditional sources of energy such as forest fuel, causing a rapid depletion of exhaustible and non-renewable resources.

The distinct energy use patterns of rural and urban Nigerians may serve as a basis for the development of energy conservation measures. Most rural residents depend almost exclusively on renewable energy sources, and so long as these sources are adapted to the people's changing lifestyles, and appropriate environments for their renewability maintained, the domestic demand for conventional sources of energy might be minimized, thereby conserving exhaustible resources.

Because Nigeria is greatly over-populated, protection of the environment should be a high priority concern of policy makers. Although Nigeria can be proud of her development thus far, she should take advantage of the experiences of those countries which are already highly developed, learning from their mistakes as well as their achievements.

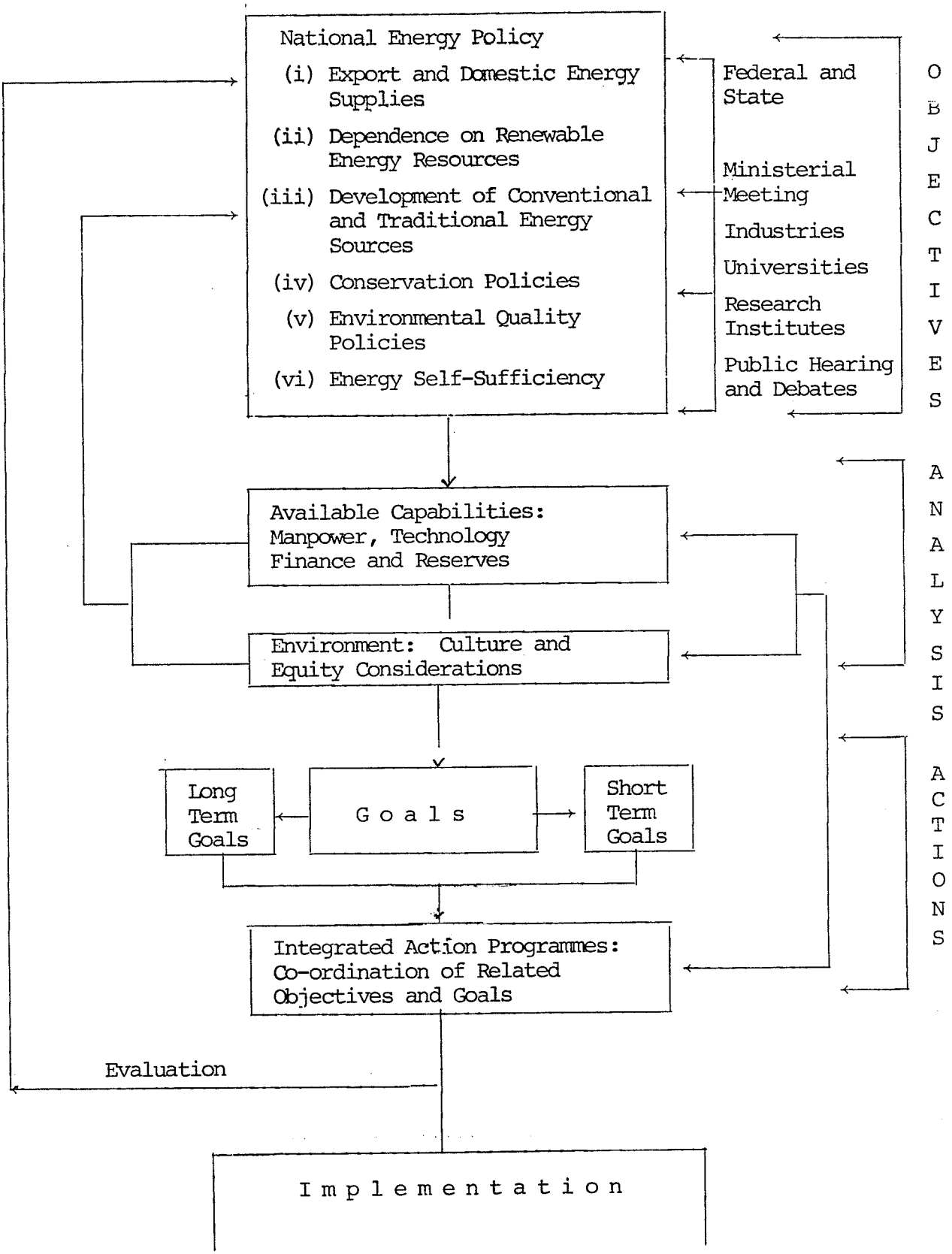
Recommendations

In addition to the specific recommendations already made, some general recommendations are as follows:

- *That a national energy strategy be adopted, with emphasis on energy conservation, increased domestic use of renewable energy resources, substitution of other sources for petroleum oil, as well as improvement of energy transportation and transmission systems (Figure 6.1).*
- *That traditional industries be stimulated by securing a market for their products, instead of replacing these industries with those involving machine labor and intensive use of non-renewable resources. This would serve the dual purpose of both guarding against energy shortages and providing employment opportunities.*
- *That a central body be established for the research and development of all of the nation's energy resources, conventional and non-conventional.*
- *That steps be taken by both federal and state governments to control Nigeria's population growth through the formulation and implementation of effective birth-control programs.*
- *That Nigerian scientists and technologists working in the*

area of research, particularly in relation to the design of appropriate technologies, enable the efficient utilization of traditional sources of energy - fuelwood, solar energy, and agricultural wastes - as well as designing technologies to harness the abundant renewable sources of energy.

-That mechanisms be established to ensure that environmental impact assessments are undertaken prior to the implementation of proposed development policies.


National Energy Policy
(i) Export and Domestic Energy Supplies
(ii) Dependence on Renewable Energy Resources
(iii) Development of Conventional and Traditional Energy Sources
(iv) Conservation Policies
(v) Environmental Quality Policies
(vi) Energy Self-Sufficiency
Federal and State
Ministerial Meeting
Industries
Universities
Research Institutes
Public Hearing and Debates
OBJECTIVES
Available Capabilities: Manpower, Technology Finance and Reserves
Environment: Culture and Equity Considerations
ANALYSIS
Long Term Goals
Goals
Short Term Goals
Integrated Action Programmes: Co-ordination of Related Objectives and Goals
ACTIONS
Evaluation
Implementation

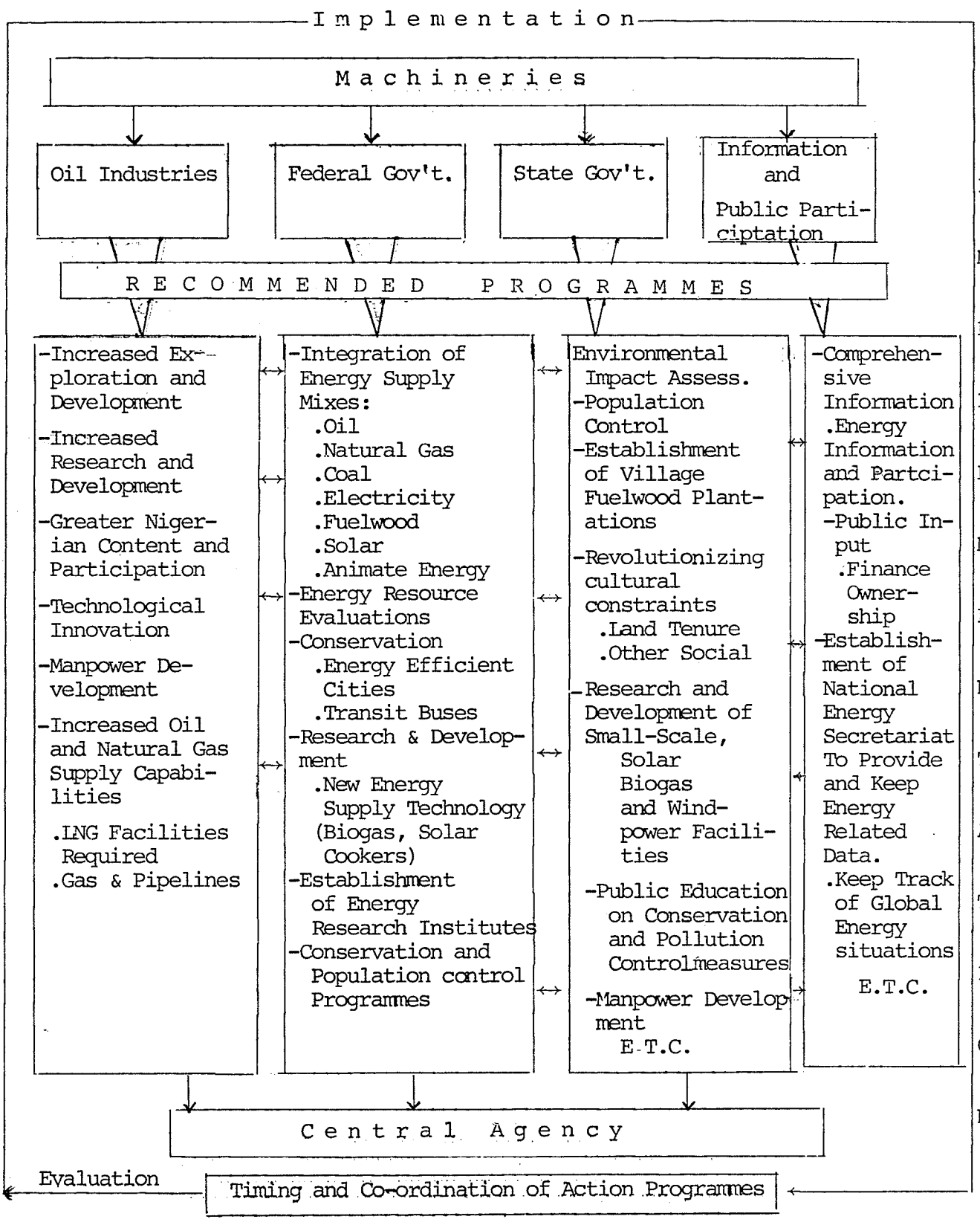


Figure 6.1 Suggested Framework of Action Programme For Energy Resource Planning and Management.

BIBLIOGRAPHY

Africa Research Unit. "Africa Mineral Potential," Pioneer: Africa, No. 78, March, 1978, pp. 103-103.

Akintola, F. O. "Mineral and Energy Resources" in A Geography of Nigerian Development, Oguntoyimbu, Areola, Filani, Eds., Nigerian Coston Press (W.A.) Ltd., 1978, pp.57-71.

Bahmer, B. A.. "The Potential of Biomass," Petroleum Economist, October 1979, Volume XLVI, Number 10, pp. 417-418.

Baker, J. "Oil and African Development," Journal of Modern African Studies, 15, 2, 1977, pp. 175-212.

Berger, M. Industrialization Policies in Nigeria, Muchen: Weltforum Verlag, 1975.

Cecelski, Dunkerley, and Ramsay. Household Energy and the Poor in the Third World, Washington, D.C.: Resource for the Future, Inc., Research Paper, R-15, 1979.

Central Bank of Nigeria, Economic and Financial Review, Vol. 13, No. 1, June, 1975; Vol. 16, No. 1, June, 1978.

Davies, J. "Radiation and Evaporation Approximations for Nigeria," Diss. University of London, 1966.

Dwivedi, D. Protecting the Environment, Toronto: Copp Clark Publishing, 1974.

Earl, D. Forest Energy and Economic Development, London: Oxford University Press, 1975.

Eicher, K. and C. Liedholm. Growth and Development of the Nigerian Economy, Michigan: Michigan State University Press, 1970.

FAO, Agricultural Development in Nigeria, 1965-1980, Rome: United Nations, 1966.

Federal Ministry of Information, Nigerian Handbook, 1977, Lagos: Academy Press Ltd., 1976.

Federal Republic of Nigeria, Third National Development Plan, 1975-80.

Helleiner, G. Peasant Agriculture: Government and Economic Growth in Nigeria, Homewood, Illinois: Richard D. Irwin Inc., 1966.

Hilling, D. "Alternative Energy Sources for Africa: Potential and Prospects," African Affairs, 75, 300, July, 1976, p. 359.

Howe, J. and Staff. Energy For The Villages of Africa, Washington, D.C.: Overseas Development Council, 1977.

Kraus, J. "From Military to Civilian Regimes in Ghana and Nigeria," Current History: A World Affairs, March, 1979, pp. 122-126.

Lubeck, P. "Nigeria: A Political Economy," African News, Vol. IX, No. 20, Nov. 14.

Martin, W., Ed. Energy Supply to the Year 2000, Global and National Studies, Cambridge: MIT Press, 1977.

Ministry of Petroleum Resources, Nigeria, Monthly Petroleum Information, February, 1977; Lagos.

National Electric Power Authority, Annual Report and Accounts for the Year Ended 31st March, 1975. Nigeria.

Nelson, H. et al. Area Handbook for Nigeria, Washington D.C.: United States Government Printing Office, 1972.

"Nigeria: Impact of Oil Economy," Africa Today, 24, 1978: 52

Nigerian's Principal Economic and Financial Indicators, 1970-1976, Contributors: Central Bank of Nigeria, Federal Office of Statistics, Central Planning Office, Federal Ministry of Finance. Printed by The Central Bank of Nigeria.

O'Connor, A. The Geography of Tropical African Development, Nigeria: Coston Press (W.A.) Ltd., 1979.

Oil and Gas Journal, June 1979, Vol. 77, No. 26; May 1979, Vol. 77, No. 21; December 1977, Vol. 75, No. 53.

Oil and Natural Gas Industries in Canada, 1978, Report ER 78-2 Energy, Mines and Resources, Canada.

Okunrotifa. "Education and Manpower Development," in A Geography of Nigerian Development, Oguntoyimbo, Areola, Filani, Eds., Nigeria: Coston Press (W.A.) Ltd., 1978, pp. 193-207.

Olatunbosun, I. Nigeria's Neglected Rural Majority, Ibadan: Oxford University Press, 1975.

Onyemelukwe, C. Problems of Industrial Planning and Management in Nigeria, London: William Clowes and Sons Ltd., 1977.

Pearson, S. Petroleum and Nigerian Economy, Stanford University Press, 1970.

Penrose, E. "Africa and The Oil Revolution: And Introduction To African Affairs," Journal of Royal African Society, July 1976, Vol. 75, pp. 277-279.

Petroleum Economist, June 1979, Vol. XLVI, No. 6; July 1979, Vol. XLVI, No. 7; August 1979, Vol. XLVI, No. 8; September 1979, Vol. XLVI, No. 9; October 1979, Vo. XLVI, No. 10; April 1978, Vol. XLV, No. 4; September 1978, Vol. XLV, No. 9; July 1977, Vol. XLIV, No. 7; July 1976, Vol. XLIII, No. 7; July 1975, Vol. XLII, No. 7.

Quinlan, M. "New Horizons For Nigeria's Oil," West Africa, No. 3199, November 1978, pp. 2178-79.

Rake, A. "Nigeria's Oil Explosion: Who Will Become Rich?" African Development, February, 1970, pp. 11-44.

"Renewable Energy Sources," Uniterra 3, November, 1978, pp. 1-2.

Sanford, W. "The Effects of Waste Gas Flares on The Surrounding Vegeation in South-Eastern Nigeria," Journal of Applied Ecology, Vol 13, 1976.

Schatzl, L. Industrialization in Nigeria, A Spatial Analysis, Munchen: Welforum Verlez, 1973.

Schatzl, L. Petroleum in Nigeria, Ibadan: Oxford University Press, 1969.

Stapleton, G. The Wealth of Nigeria, Ibadan: Oxford University Press, 1967.

Synods, Edward. "Finance and Investment, New York," Petroleum Economist, July 1978, Vol. XLV, No. 7.

Tanzer, M. The Political Economy of International Oil and the Under-Developed Countries, Beacon Press, 1969.

Tims, W. Chief of Mission and Co-ordinating Author, Nigeria: Options For Long-Term Development: Report of A Mission Sent to Nigeria By the World Bank. London: The John Hopkins University Press, 1974.

Tolba, M. "Energy: Half of All Energy Produced Is Wasted," The State of the World Environement, 1978. United Nations Environment Program.

Tucker, Stanley, E. "Revenues and Balances," Petroleum Economist, July 1978, Vol. XLV, No. 7, pp. 285-286.

United Nations Statistical Year Book, New York, 1978.

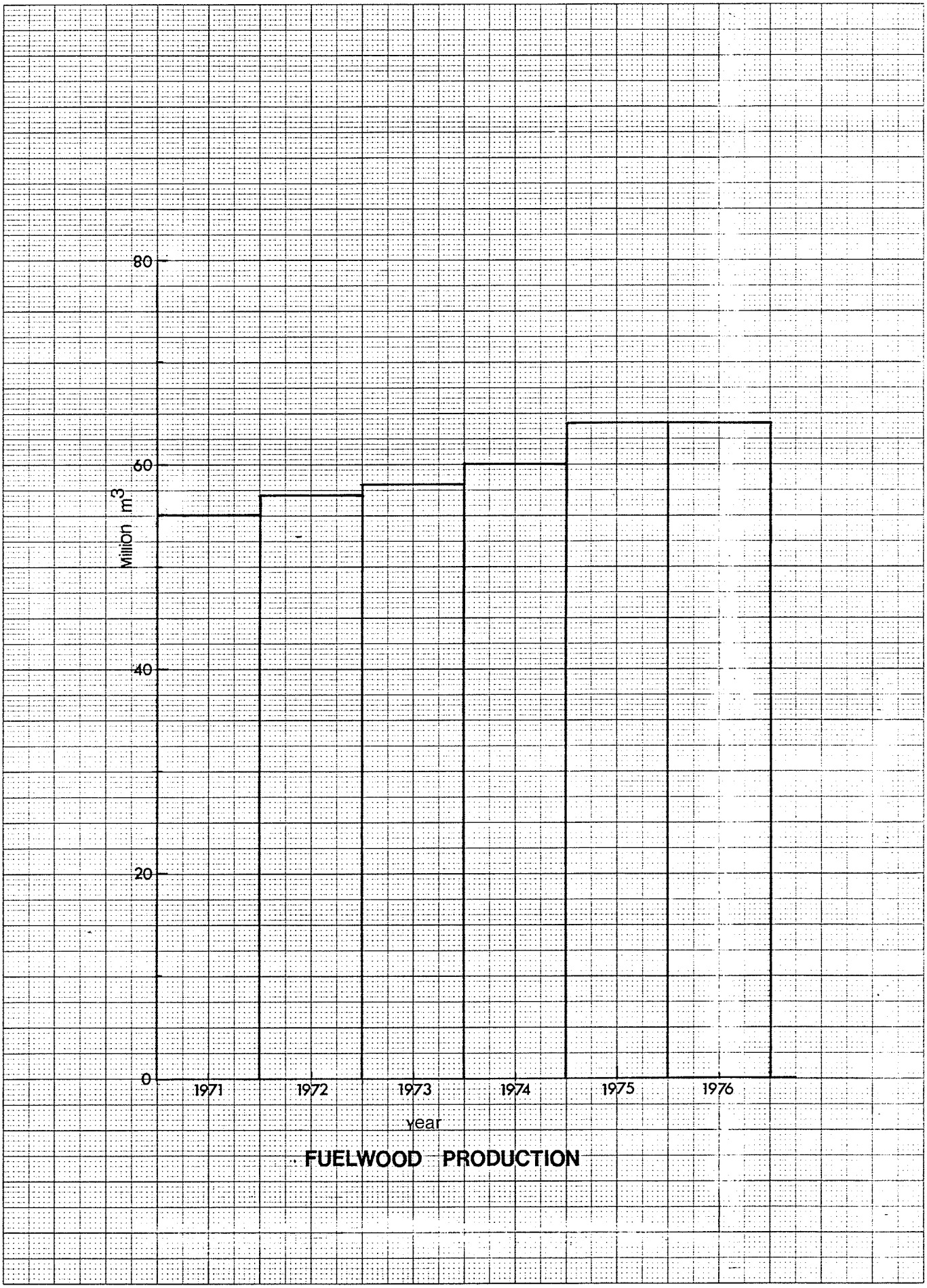
United Nations, World Energy Supplies 1950-1974, New York, 1976; 1971-1975, New York, 1977; 1972-1976, New York, 1978.

Usman, S. "Nigerian Oil, A Doubled-Edged Sword," Africa: Inside Story, No. 81, The Journal of African Studies, 12, 1, 1974.

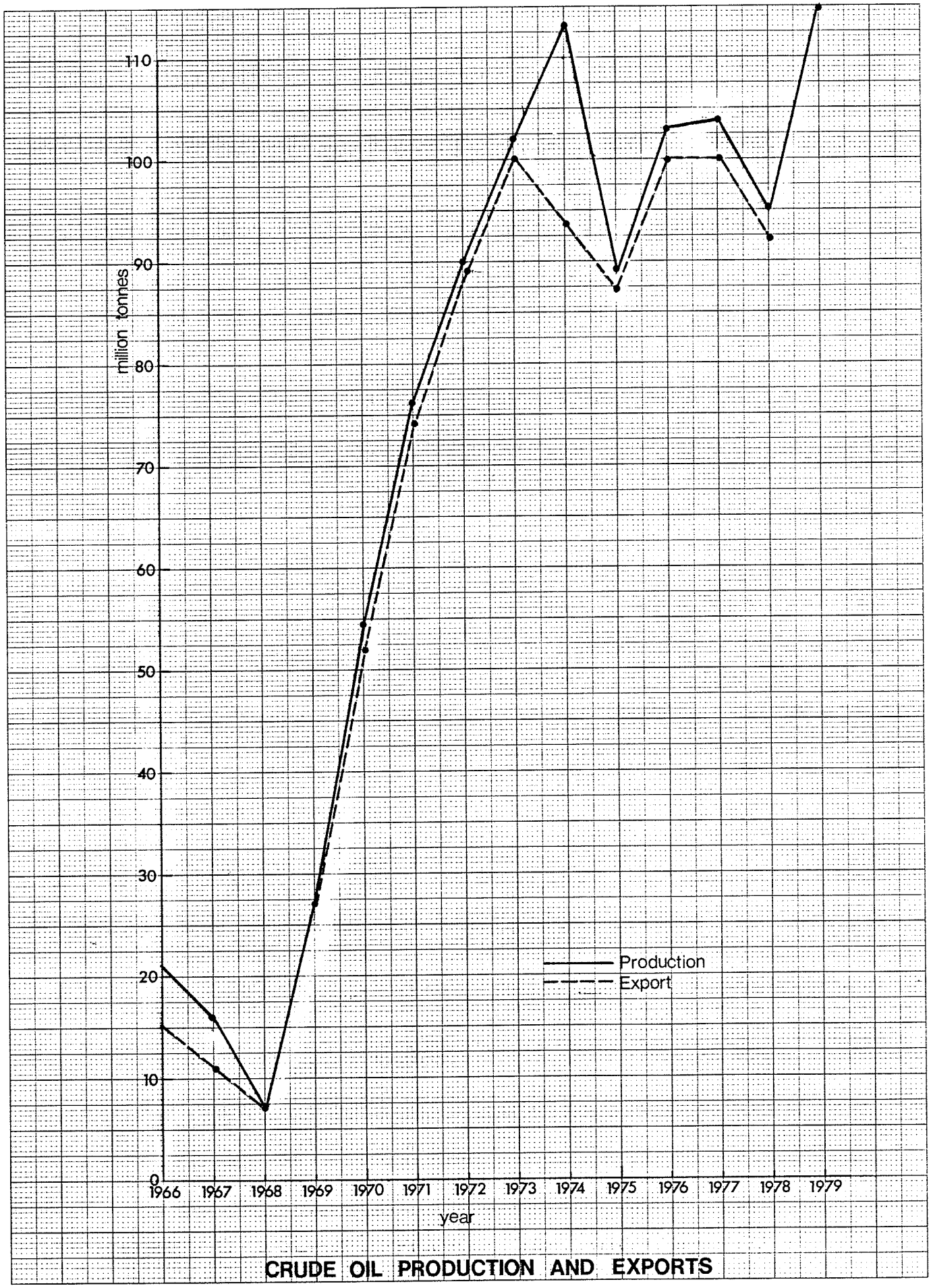
Waters, Rufus A. "Understanding African Agriculture and its Potential for Change", Journal of Modern African Studies, 12, 1, 1974, pp. 45-56.

Wilson, C. Project Director, Energy: Global Prospects 1985-2000, Boston: The Nimrod Press, 1977.

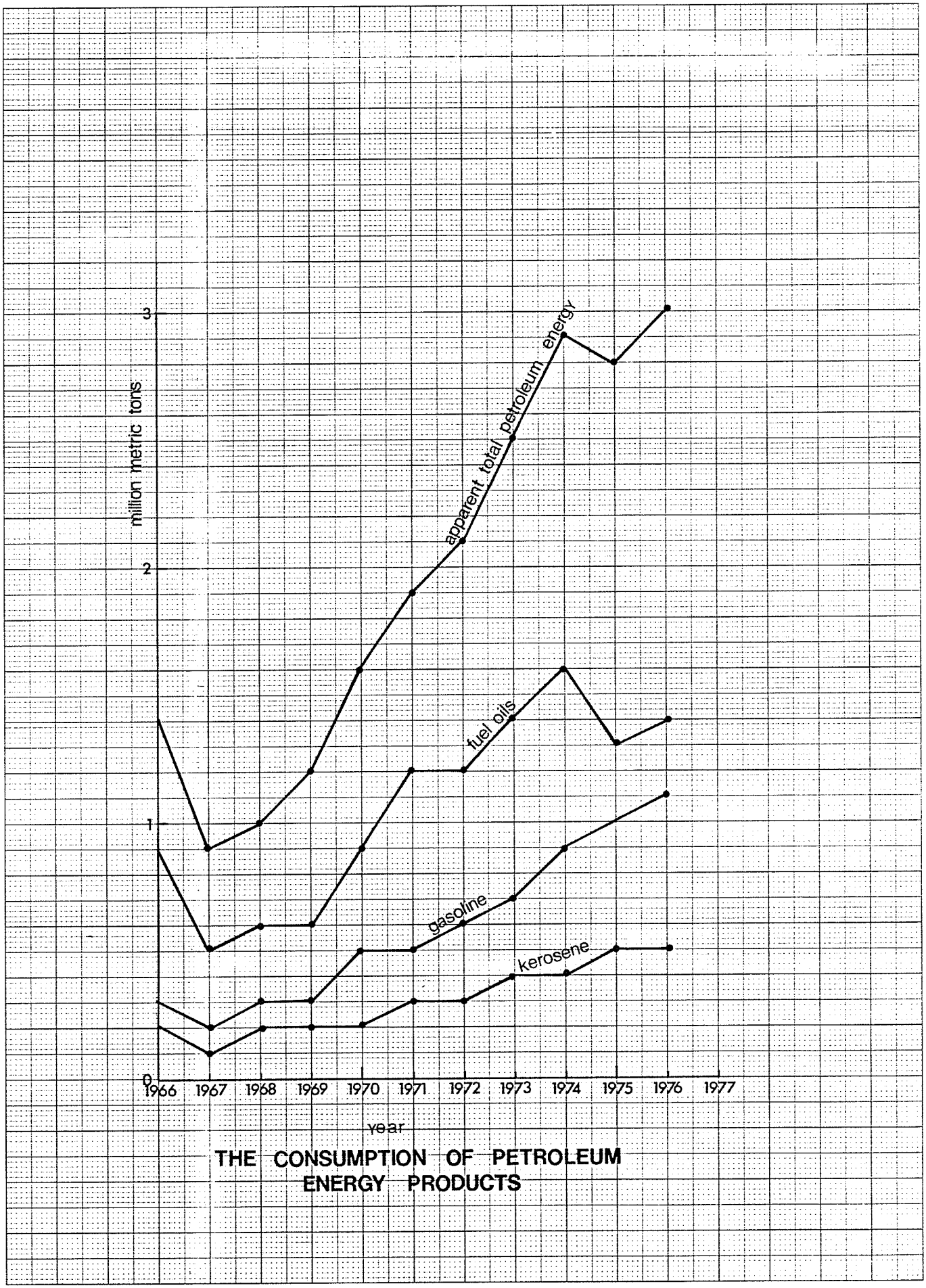
A P P E N D I C E S



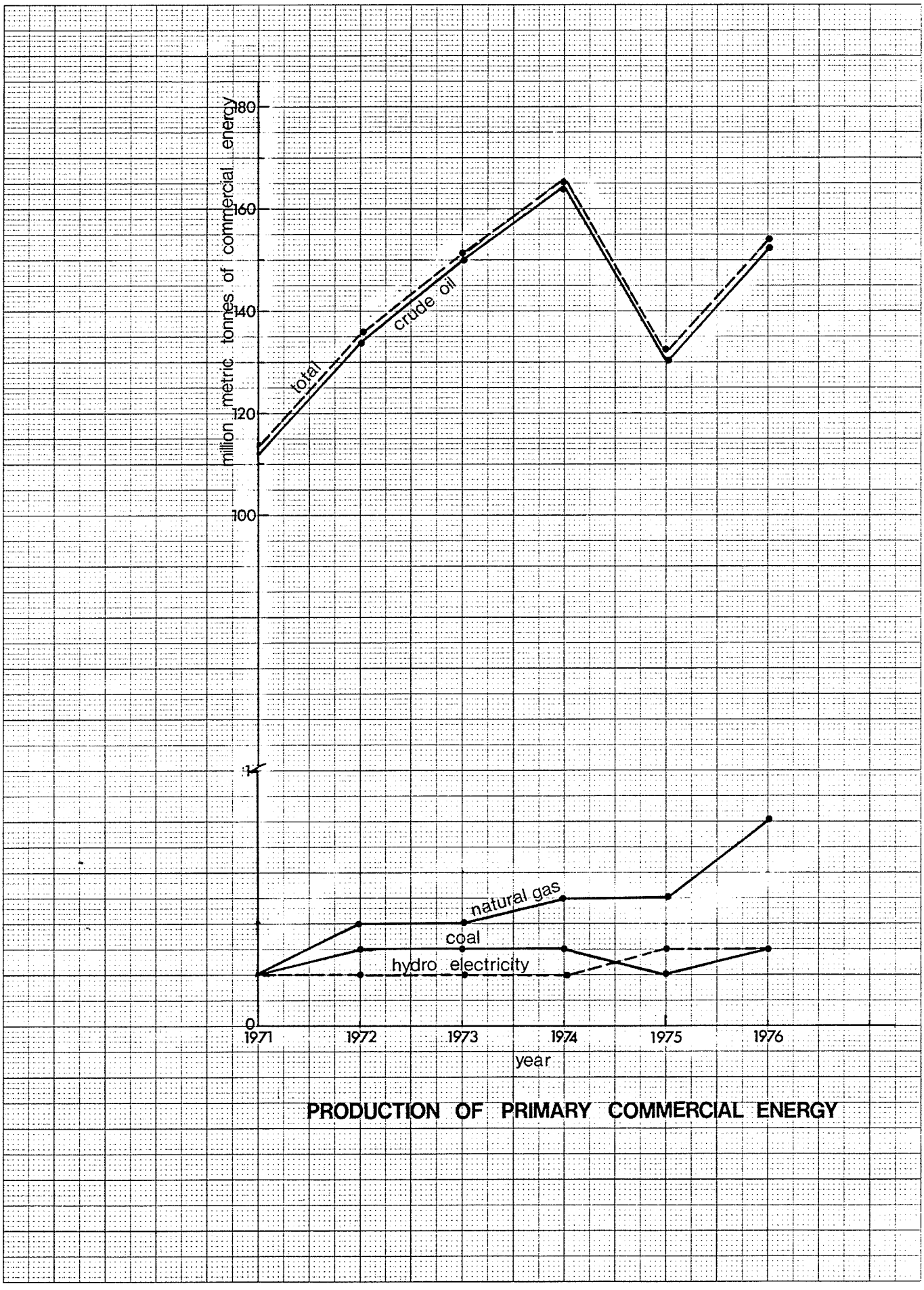
FUELWOOD PRODUCTION



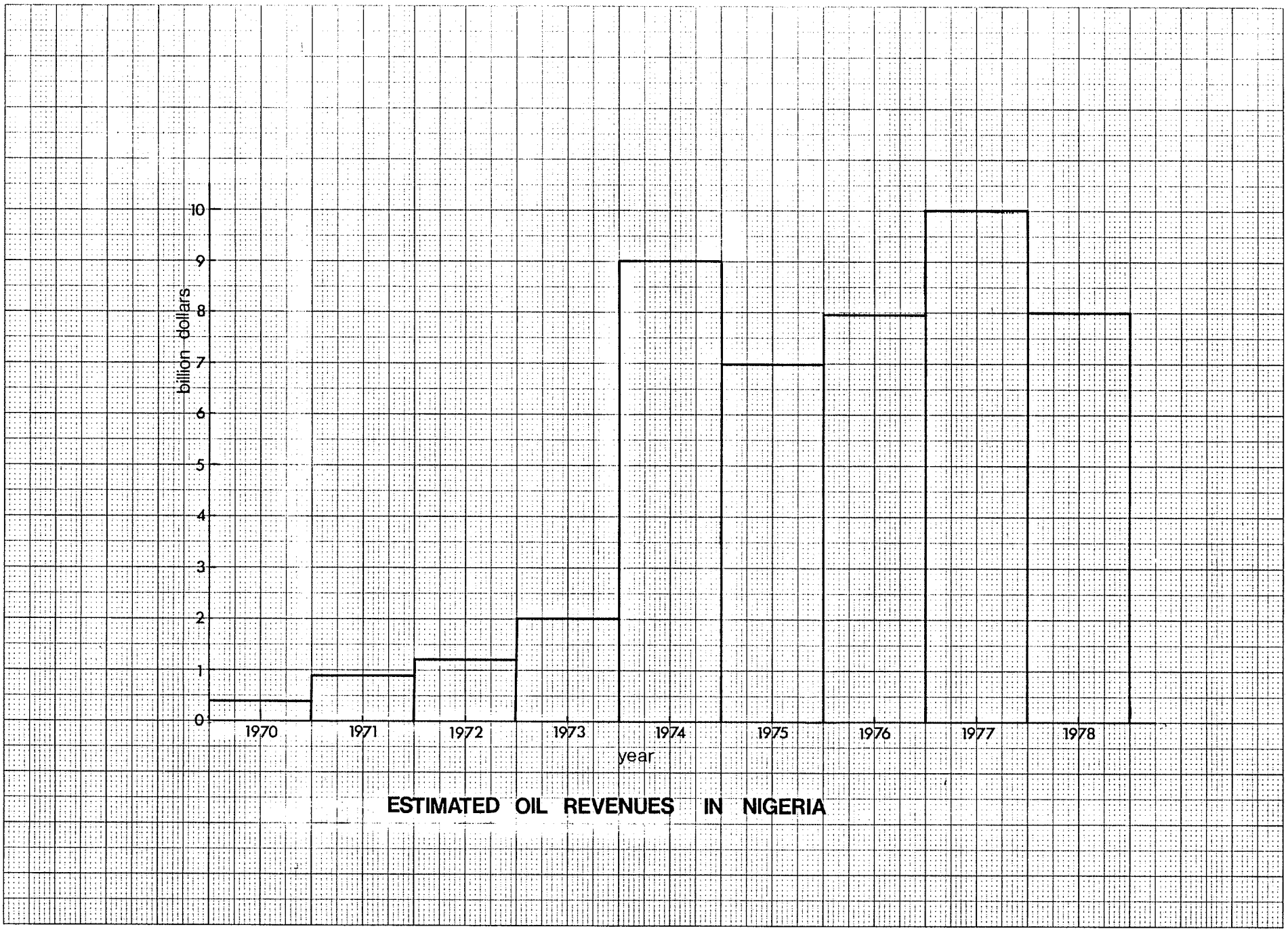
CRUDE OIL PRODUCTION AND EXPORTS



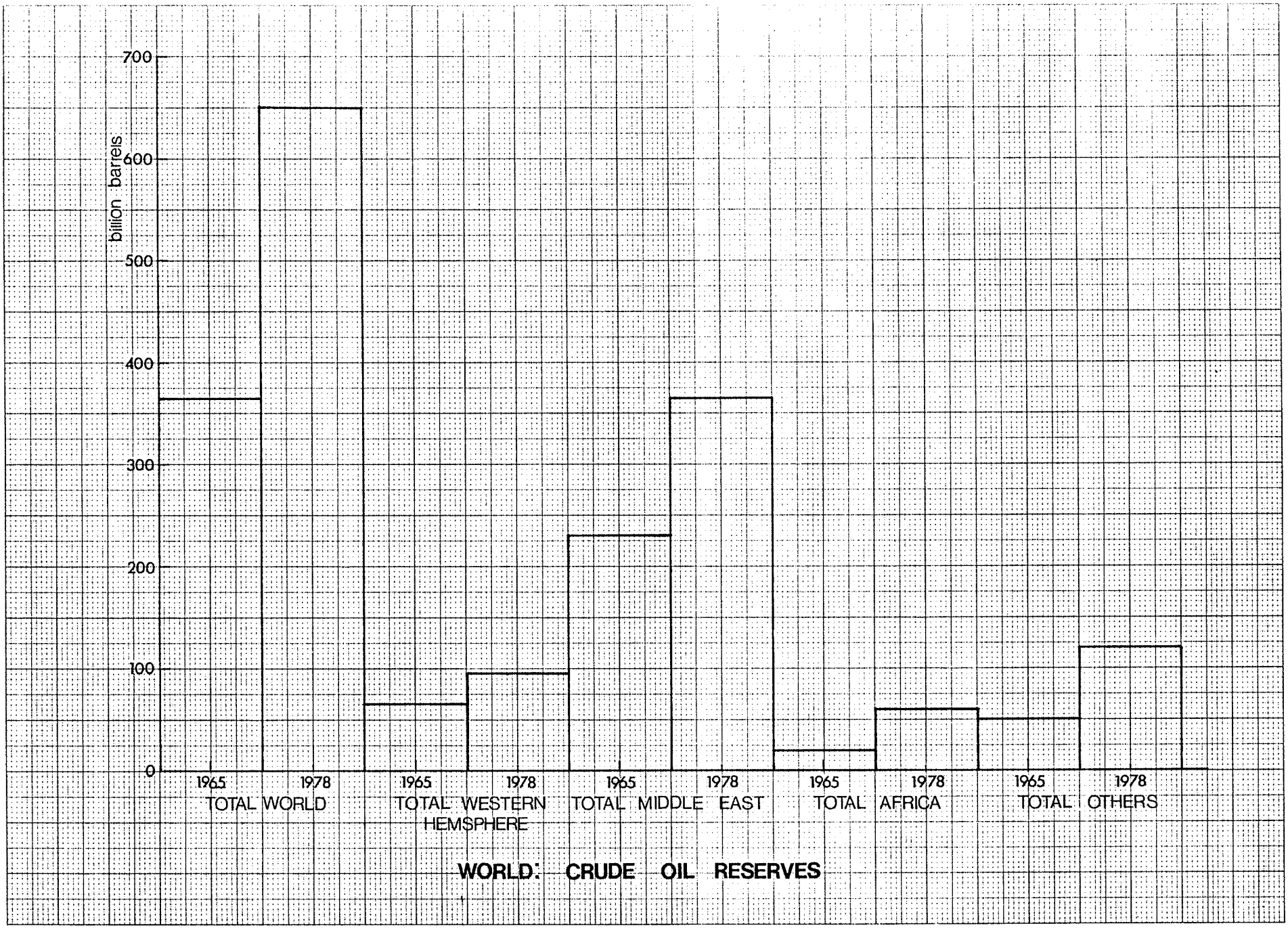
THE CONSUMPTION OF PETROLEUM ENERGY PRODUCTS



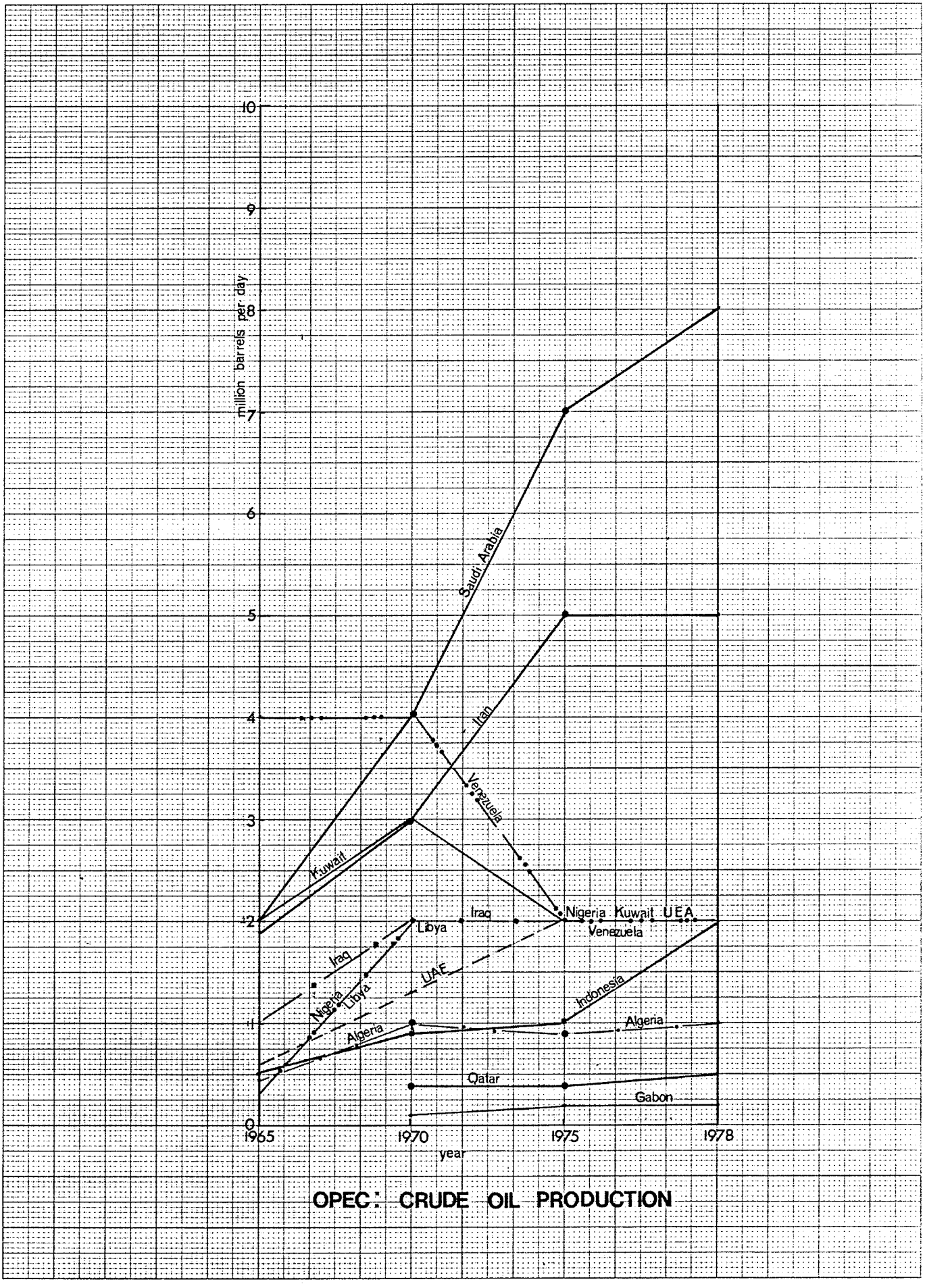
PRODUCTION OF PRIMARY COMMERCIAL ENERGY



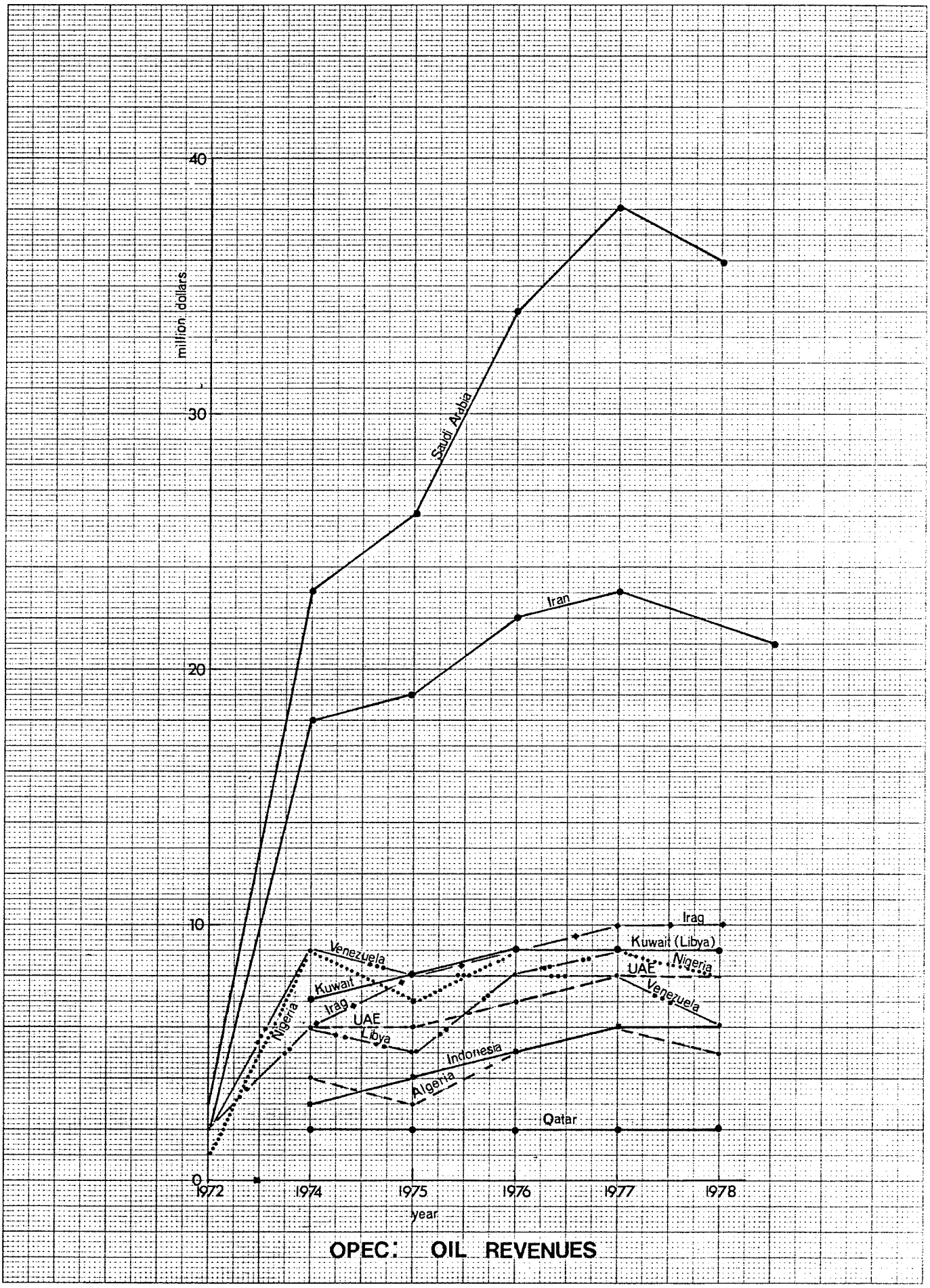
ESTIMATED OIL REVENUES IN NIGERIA



WORLD: CRUDE OIL RESERVES



OPEC: CRUDE OIL PRODUCTION



OPEC: OIL REVENUES

10 X 10 TO THE CENTIMETER 18 X 25 CM.