48152

UNITED NATIONS

ECONOMIC AND SOCIAL COUNCIL

Distr.
LIMITED

E/CN.14/EP/3 Part II
30 August 1963

Original: ENGLISH

ECONOMIC COMMISSION FOR AFRICA
African Electric Power Meeting
Addis Ababa, 21-31 October 1963

THE SITUATION, TRENDS AND PROSPECTS OF ELECTRIC POWER SUPPLY IN AFRICA

(Report by the secretariat)

(To facilitate early distribution, Parts I - III of this study are being issued separately as they are prepared. Part II, containing chapters IV and V and the appropriate Annexes, is attached herewith).

63-3497
GE.63-12831

TABLE OF CONTENTS

TABLES OF CONTENTS (continued)

ANNEXES

(relating to Part II)

LIST OF TABLES

PART II

LIST OF TABLES (continued)

LIST OF ILLUSTRATIONS[a]

(a) A bilingual text relating to notes appearing on maps and diagrams can be found in the French version of the document.

(b) Based on a Map in a Paper by G. Hamden, - Geogr. Rev., July 1963 - (see list of references).

(c) Based on a Map in a Paper by B.S. Hoyle - Geogr. Rev., July 1963. (see list of references).

PART II

ELECTRIC POWER SUPPLY IN AFRICA - THE PRESENT SITUATION AND ITS RECENT DEVELOPMENT

CHAPTER IV

CONSUMPTION OF ELECTRIC ENERGY

A. Introduction

1. The preceding Chapters have touched on various influences which affect the development of electricity consumption in different countries of Africa. On the one hand economic growth leading to higher total national output - in mining, manufacturing, agriculture, transport and services - presupposes a rising consumption of kWh per unit of product and per worker employed. On the other hand this higher average output per head of population, reflected in terms of gradually rising purchasing power per family unit, means that there is a demand for more light and power in the average home. Rising population and a growing number of family units also means that the number of potential household consumers is increasing. At the same time public lighting; public services such as water supply, hospitals and transport systems; and commerce, administration and other special requirements of urban life - all will tend to expand as the economy grows.

2. Today a growing supply of electricity is everywhere recognized as essential if such a development is to proceed. In African countries, as has already been shown in Chapter I, the levels of national income per head and of kWh consumed per inhabitant do in fact tend to go hand in hand. Nevertheless, when conditions in many different countries of the world are compared, the actual rate at which electricity demand can rise is seen to bear some relation to the level of existing consumption. Particularly during the early stages, this is largely because "... prosperity awaits power and power awaits prosperity". To gain the advantages of productive efficiency and low-cost distribution a certain concentration of demand of reasonable size is required. On the other hand, consumers cannot afford power until a certain degree of economic growth already exists. Low densities of population, long distances between centres, a lack of diversified natural resources and a shortage of easily exploitable energy reserves - these and several other limiting factors may all militate against consumption growth.

3. In Africa it is in fact often difficult to separate the aspect of consumption from that of production and distribution. Nevertheless, because electric power cannot readily be stored, it is finally the demands of consumers which determine the scope of the productive system. For that reason it is convenient to analyze the tendencies of electric energy consumption in African countries before reviewing the characteristics of power production and transmission.

B. Characteristics of Electricity Consumption

(a) General tendencies

4. For Africa as a whole the trend of consumption over the last twenty-five years has broadly resembled the world trend, though in some recent years the actual rate of growth has been a little higher. The main details can be seen from a study of Table 27, which covers the evolution of consumption since 1938. Africa's total electric power requirements are currently growing at a rate which implies a doubling of consumption in 8-9 years. Average use per inhabitant is now a little below the world level as it existed in 1938.

5. These average figures conceal the very great dispersion between different African countries. In fact, as can be seen from Table 28, the actual volume of production varies from country to country in a ratio of 2700 to one. The Table presents data covering total gross and net consumption in 1961. For certain countries these remain provisional, notably as concerns some indices of development since 1955 and 1960 respectively.

6. Pursuing the analysis, it is necessary to gain some idea of the average use in different countries in terms of kWh consumed per inhabitant. This is shown in Table 29. The different territories are arranged in increasing order of gross consumption per head in 1961. At the same time average annual percentage rates of consumption growth for the five-year period 1956-1961 (and also for the decade 1948-1958) have been calculated for comparative purposes. Reference should also be made to Map 4, which shows consumption in the different territories by circles proportionate in area to kWh per inhabitant. The more densely populated areas are also delineated on the Map, as are all towns with populations above 100,000.

7. Consumption per head in 1961 varied in the different countries within the range of 750 to one. Many of those with (for Africa) relatively high population densities, as in parts of West and East Africa, are still characterized by low specific consumption. The countries of North Africa fall broadly within the middle range, while the southern part of the Continent includes adjoining regions of very high and very low average use. In various territories of the interior consumption per inhabitant tends to be very low.

8. Because average consumption per head for Africa as a whole is greatly influenced by the highest levels reached it does not reflect the general situation very closely. The median value for the different countries is some 35 kWh/head only, while the upper

quartile value is only 90 kWh and the lower quartile as low as 10 kWh per inhabitant. For countries using 20 kWh per head or under, the average rate of increase in consumption between 1956 and 1961 was 14.5 per cent. Between 20 and 40 kWh/head the corresponding average growth rate was 13.8 per cent, while for countries using over 80 kWh per inhabitant the mean rate of increase fell to 6.2 per cent.

9. The figures may be set out as follows:

Range of consumption/head in 1961	Average annual growth rate (1956-1961)
Under 20	14.5 per cent
20 - 39	13.8 " "
40 - 79	8.8 " "
80 and over	6.2 " "

10. There is thus in Africa a tendency - though with many exceptions - for consumption per head and average rates of consumption increase to be inversely correlated - a fact that may be noted in some high-consumption regions of Europe but which cannot be explained by the same factors under conditions obtaining in Africa.

(b) Some characteristic examples

11. Closer study of consumption in different parts of Africa brings out the existence of some characteristic types of development. Entirely different conditions and rates of increase may also exist within the areas of separate main supply systems in the same territory. Frequently up to 90 per cent of total consumption may be concentrated around one main town. Natural energy reserves and relative economic prospects due to non-energy natural resources of economic interest are involved in the assessment. The same applies to population density, rate of population growth and average income per head. In part, limited production possibilities hold back consumption in some areas. Differences in methods used by undertakings to assess consumption prospects may help to explain some of the departures from normal trends.

12. To analyze electric power consumption in the setting of the various economic determinants which influence it in different areas the reader is referred in the first instance to data presented in the Tables included in Part I of the present study - for example, in respect of population density and growth, natural resources, primary energy use etc. Here attention will simply be drawn to some characteristic type of growth which, from the data available, appear to exist in certain groups of territories.

13. Reference to Table 29 (columns 2 and 3) shows that, owing to differences in growth of consumption and population respectively, the number of kWh consumed per inhabitant has risen at very different rates between 1956 and 1961. Moreover, in some countries figures are greatly inflated in the latter year (though not always in the former) by heavy industrial consumption which may suffice to transform a low average use into one apparently much higher. This is true, for example, of the Cameroon Republic (up to 90 per cent used in bauxite reduction in 1961) or of Northern Rhodesia, among other countries.

14. Countries may be broadly grouped in various ways i.e. according not only to kWh used per head but in respect of exploitable energy reserves, energy-intensive natural resource potential etc. In practice one may for various reasons distinguish territories possessing characteristically low rates of consumption growth; those showing higher rates which have of late been tending to decline; others again where consumption is accelerating or seems likely to accelerate; and yet a further group where high but fairly constant growth rates seem to prevail.

15. Examples of the first group (around 0 - 7 per cent per year) include Dahomey, Somalia, Madagascar, Ghana, Tunisia and Morocco (5 - 86 kWh per head respectively) where the highest characteristic growth rate appears to be around 7 per cent. It would appear, rather surprisingly, that there is no particularly close correlation between low growth rates and low population density.

16. At the other extreme a number of territories show more or less constant growth rates maintained at a high level (9 - 20 per cent annually). Most of the countries of North Africa, with medium consumption per head (51 - 140 kWh) fall in this group, i.e. Algeria, Egypt, French Somaliland and Libya. The same group includes Senegal, Reunion and the Sudan (15 - 17 per cent annually) of which only the last has a lower consumption (6 kWh/inhabitant).

17. Between these extremes a certain number of countries, including Ethiopia, Nigeria and Togo (6 - 17 kWh/head in 1961) appear to be characterized by an actual or potential acceleration of electric power demand towards high rates of increase. This seems to be due as much to general expansion as to special industrial requirements. On the other hand a further group has shown some tendency for the annual increase in consumption to slow down, though in some cases this probably heralds a re-acceleration when incipient or impending economic growth can come fully into play. This situation appears to characterize the Cameroon Republic, Liberia, Mali, Tanganyika and Uganda - territories among others, which possess hydro-electric resources and a sizeable industrial potential based on mineral reserves, but where present consumption varies between 4 and over 200 kWh/head.

18. As an example of a territory where quite different trends exist in separate regional power supply areas, Gabon, with its divergent trends in the Libreville and Port Gentil - Lambarene regions, may be cited. In the one, possessing a maximum load of 1.6 MW and a 30 per cent growth rate for consumption, there is promise of an expanding network and studies in progress for paper pulp and cellulose industries. In the other the maximum load is at present 2.3 MW and there are projects for a petrol refinery, a cement works and other new industries. The forecast growth in consumption is here put at 7 per cent annually. Gabon as a whole falls within the area of medium consumption (48 kWh per inhabitant, and possesses a slackening annual growth rate of 18-20 per cent.

(c) The separate sectors of consumption

19. Examination of the breakdown of electricity use in Africa throws some further light on consumption characteristics. Available information relative to 1961 has been analyzed in Table 30 in terms of the three main consumption categories - industrial; domestic and other low-voltage consumption; and use for transport purposes, respectively.

20. In Africa there is a general tendency for industry to account for a smaller percentage of total net consumption than in many other areas, where 70 per cent would be regarded as a normal contribution. Only six countries in Table 30 approach this level and in eight industry's role is nearer 30 per cent. Information on transport consumption is scanty. In Europe around 5 per cent of total requirements are commonly used in this way. In the three African countries for which information is available and for which significant consumption exists - the Malagasy Republic, Morocco and Tunisia - transport uses between 3.5 and 7.5 per cent - a normal figure.

21. The balance of total requirements is taken by the low-voltage sector, which includes public lighting, public services and administration - including hospitals, water supply, etc. - commercial requirements, agriculture and, of course, consumption by households. In Africa this sector is often predominant, particularly in countries where total consumption is low, because various essential public services such as water pumping take a prominent role, while small-scale handicraft consumption, which is classified within the same group, is also of some potential importance. It is only after large-scale industries have taken a firm hold that industrial demand can be expected to predominate.

22. Comparison between Tables 29 and 30 confirms the existence of this situation in Africa. It is in the countries with above-average consumption per head where the relative contribution of industry is high. It is also in some of these where declining rates of increase have tended to occur.

23. These three main consumption sectors will next be discussed separately.

24. (i) Industry: Mining for copper, iron and tin ores, gold and various other important minerals, including coal, already plays a large part in African output, though commonly it does not predominate in the total national product of the countries concerned. Smelters and mineral processing are becoming increasingly important and usually require large quantities of low-cost power. The products of cement works, textile factories and paper works are three key requirements for economic advancement and all require relatively important quantities of electricity in their manufacture, as also do those of petroleum refineries. Sugar processing is already important locally. A number of African countries, particularly those such as Liberia which possess important iron ore reserves, are at present interested in setting up domestic iron and steel industries. Apart from countries where metallurgical coke is already available, such as the Federation of Rhodesia and Nyasaland, Algeria, Cameroon, Ghana, Guinea, Liberia, Morocco, Nigeria, Tanganyika and the UAR (Egypt) are among interested countries in this field. Conditions in respect of location and raw materials are in principle favourable in some countries where consumption is at present comparatively low for introducing what would in fact be a major energy-consuming industry.

25. Some specific consumption figures for various energy-intensive products, certain of which could be but are not at present of importance in Africa, were given in Part I, Chapter I. The possibilities and trends of primary aluminium production will be discussed in Part III. The electrolytic plant established in 1957 at Edea in the Cameroon (52,200 tons production in 1962) already accounts for 90 per cent of total electricity consumption in that country. Bauxite extraction potential is also great in Guinea, among other countries, and this source of power demand seems certain to loom larger in the near future. Apart from the ancillary demands that they in turn create, the immediate importance of these various industrial requirements for power is that additionally they often furnish electric power for public supply in areas where generation is lacking as well as making possible improved water supply and other essential amenities.

26. Information on the detailed breakdown of industrial electric power consumption is at present scanty for many parts of Africa. Table 31 shows the development in some main sectors between 1955 and 1960 for two contrasted countries - the Malagasy Republic and Tunisia. The data shows fairly typically the relative importance of various special and general categories of demand pertaining to countries with differing industrial structure.

27. (ii) Transport: There are in Africa no fewer than fourteen land-bound or inland states - more than in the rest of the world together - which in all comprise nearly one quarter of the continent's total land area and over 14 per cent of its population. Map 1 shows the distances of these from the coast. For this reason, and because of the great distances in many cases between consuming centres and points of production, the development of low-cost means of surface transport and adequate transport capacity for economic development is a matter of primary importance in many areas. A number of inland states, such as the Central African Republic, Chad, Niger and Mali, have no rail services. In other cases, as with the states of the Federation of Rhodesia and Nyasaland, most outgoing freight must travel over considerable distances, in this particular case through running rights across Mozambique to the ports of Beira or Laurenço Marques. Between 25 and 30 per cent of Rhodesian coal supplies are used by rail services. At the same time adequate means of large-scale and low-cost transport are essential to the further development of electric power production itself, not only to assist the transfer of fuel but also to make possible the easier moving of large items of power-generating equipment.

28. In various parts of the world diesel traction is introduced as a precursor of electrification. Diesel locomotives are currently being supplied for use in Nyasaland and elsewhere in Africa where conditions would already make for improved working with them. Electrification of railways has been strongly justified in various countries outside Africa for a number of reasons when the density of traffic becomes sufficient. Electric traction is efficient in dealing with severe gradients; it avoids the need for coal where this is not easily available and where hydro power is present; and, finally, it is ideal for flexible and rapid transport where dense traffic is involved since it can increase line capacity by greater speed and the avoidance of halts for water, etc. Despite the heavy initial capital expenditure, there is also an economic incentive due to lower costs when the density of traffic exceeds a necessary minimum, particularly, it has been found in some areas, where higher specifications are possible - i.e. 25 kV AC single-phase as against 1500-3000 V DC.

29. An outline survey of railway track and freight carried in Africa is presented in Table 32. It can be seen that the amount of electrification at present is limited except in N. Africa, particularly in Morocco, where 35 per cent of the track is electrified with overhead lines at 3000 V DC; and in S. Africa (16 per cent with similar specifications). Despite the comparatively limited freight traffic in the

Conga (Leopoldville), some 10 per cent of track there has electric traction with overhead lines at 25 kV AC. Over Africa as a whole only some 7.3 per cent of track is so far electrified, although freight traffic in parts of East Africa (particularly Kenya), Nigeria, Angola and the Sudan might be approaching the point where electrification would perhaps be feasible. In Africa it seems likely that this form of surface transport would be particularly economic in view of the conditions to be satisfied and the presence of abundant hydro power.

30. (iii) Household and other low-voltage consumption: Despite the vast potential market for household use of electricity, the subject is difficult to appraise realistically in terms of population owing to the existence, in nearly all countries of Africa, of socio-economic groups which may be entirely different in character from one another. If the problem of measuring the demand-promoting characteristics of actual and potential domestic consumers remains a major and costly source of difficulty in Europe it is enormously more complicated still in most African countries.

31. Cash incomes per head of population commonly remain for the mass of the population too low at present to support any home use of electricity which, relatively speaking, is still costly. In Uganda, to take one not untypical example, average annual cash income per head, even in the more densely populated areas of the country, varies from about £8 to £19. The average cost per kWh to the consumer there - though relatively very favourable for Africa - is about 1.7 pence. Under these conditions, and with wage rates in some countries remaining stable for many years despite changes in the cost of living, it is not surprising that the number of consumers of electricity, through rising, remains very low. In Guinea, for example, where consumers have increased very rapidly since 1951, there were still, in the Conakry area, only some 7,720 by 1958 in a total population of around three million, as against 1,235 in 1951. After 15 years operation and promotional activity by the Electricity Board of Uganda, the number of consumers still amounts to some 34,000 in a population of 7 million. Assisted wiring schemes and hire purchase have been used to encourage consumption. Unit installations have been supplied (1 amp. and 5 amp.) at a constant charge to avoid metering and wiring, despite the possibilities of abuse. The charge made under this arrangement is 8/50 shillings per month for the one amp. unit and 20 shillings for the five amp. unit.

32. Provision for consumption in rural areas for agricultural and household purposes raises problems in all countries unless very large consumption per farm is possible.

Figures 1 and 2 show the recent development and relative importance of consumption by various consumer-groups in Southern Rhodesia, the second illustrating the relationship between growth of farming consumers and their requirements.

33. Rates of growth in the number of family units are normally more significant than data for population growth as indicators of domestic demand for electricity provided they reflect the demand for housing units. In fact, however, there appears to be great variability in African countries in the rates at which new residential building construction is proceeding. In part this probably reflects short-term fluctuations in the economic situation, a question discussed in Chapter I; while variations in statistical data also contribute to the uncertainty surrounding this subject. However, Table 33, which sums up the data available in terms of building authorizations or units constructed between 1956 and 1961, shows very great variation from one territory to another, as can be seen from the indices for activity in 1961 relative to that in 1956 as base. Particularly in parts of North and West Africa and for some areas of very low population density, it would seem that the potential market for domestic electricity requirements is increasing very rapidly. It appears that it might be useful if more attention were given than is at present the case to trying to assess characteristics of household and other forms of low-voltage demand - actual and potential alike - for very simple levels of consumption and equipment so that ways could be sought to raise the use of electricity from all sources in the more populous areas as quickly as possible.

34. Percentages of population served or connected in some main towns and urban areas of Africa appear not to differ too widely from those elsewhere, to judge from some scattered data brought together in Table 34 - to which information relating to a non-African country - France - has been added for comparison. It is outside the principal towns that the problem of economic distribution or isolated generation has everywhere to be solved. One means of reducing the difficulty while awaiting fuller development of an expanding area of effective demand is that of using small mobile diesel generators, a subject that is discussed further in the next Chapter.

C. <u>The Cost of Electricity to the Consumer</u>

35. In nearly all African countries the cost per kWh to the consumer is high. In general this reflects of course an inadequate scale of production, insufficient overall density of consumption plus low load factors. It also reflects very high fuel costs and very high costs of maintenance and operation. Generating plant are frequently old and there is insufficient capital and demand alike to justify introducing new high-efficiency equipment.

36. This, however, is only a generalized picture. Reference to Table 35, which attempts a comparison (expressed for convenience in mills, or tenths of a U.S. cent, per kWh) between the average revenue received per kWh sold in a selection of 18 widely-distributed territories, shows how wide is the range of cost of the average kWh to the consumer. With one exception the ratio between the highest and lowest specific costs included is as 1 : 7, with a rough median at a little below 50 mills (4.3 pence) per kWh. Where supply systems are large and interconnected, with a substantial and well-diversified demand which can be satisfied from large-scale hydroelectric production (Federation of Rhodesia and Nyasaland and Uganda) charges are comparatively moderate. In other cases where costs may reach up to 100 mills (8.5 pence) per kWh or more, consumption can average as low as 4-7 kWh/head (Mali and Togo) and diesel fuel charges may be very high.

37. Average revenues per kWh shown in Table 35 approximate to mean charges per kWh for a variety of different types of use. Tariff structures employed by most African electricity undertakings are highly sophisticated. A selection of various types of tariff in use in some fourteen supply areas is summarized in Annex IV. These are mainly of degressive form, commonly with a fixed annual charge corresponding to the power taken plus an energy charge inversely proportionate to hours of use.

38. The normal tariffs are usually strongly promotional in that there is a considerable reduction for higher rates of consumption, with special off-peak and night tariffs for high-voltage and low-voltage consumers, the latter commonly being specially designed for air-conditioning, water heating etc. While tariffs commonly comprise a fixed item and a proportional item, in some cases there is also a component proportional to average hourly wages. In such cases, as in Tunisia for example, there is thus a relationship, adjusted at 3-monthly intervals, between the cost of energy and that of materials and labour. Tariffs are generally weighted considerably in favour of industry in respect of low rates per kWh, as is normal elsewhere, those for low-voltage use being often high by comparison except where consumption is considerable. In certain cases there is a flat-rate charge for lighting. In Ghana this is on the basis of separate monthly charges for 40 watt and 60 watt lamps.

39. There are sometimes important differences, as is understandable, in tariffs applied to different regions within a country. In Tunisia the area of supply is divided into tariff zones, a coefficient of between 1.0 and 1.3 being applied, of which the maximum

figure relates to isolated networks supplied by diesel plants. This particular system is at present under review, however, with a view to modification.

D. The Further Development of Consumption

40. For its further development in Africa, consumption by industry is due to increase very rapidly wherever suitable natural resources exist in close conjunction (see also Annex V, containing summaries of prospects for 20 selected countries). Widespread sources of bauxite for aluminium, iron ore, copper, tin and various ores which can be used to produce ferro-alloys, plus phosphates, nuclear fuel sources and many basic vegetable products, are associated with low-cost hydro power, natural gas and accessible coal and oil. There is thus an early prospect of developing basic industries, including in some cases iron and steel as well as large electro-chemical complexes, and in addition the possibility of setting up associated groups of light industries for manufacture of finished products required both for internal needs in Africa and for export. In varying degree some limiting factors at present, in different countries where suitable natural resources occur, are the existence of an energy supply (notably an adequate public electricity system) a sufficient source of suitably skilled labour and appropriate means of surface transport. Where these needs can be met it seems likely that the principle of setting up carefully planned industrial estates has much to recommend it. Although the specific consumption per unit of product would be much lower on such estates for manufacturing purposes than the thousands of kWh per ton required for certain primary products, experience elsewhere shows clearly that a high and increasing number of kWh would be needed per worker employed (often many thousands of kWh per worker and per year)[1] to ensure the viability of the enterprise and augment the productivity of skilled labour available. Prospects in certain fields are discussed further in Part III of this study. Map V also presents an example of a current development.

41. In all except a few countries of the world there remains enormous scope for household use of electricity, which everywhere is still growing steadily. This can be seen by comparing different levels of household consumption per head (not per consumer) in

1/ Independently of industrialization and degree of electrification and living-standards, industrial consumption per wage and salary earner in industry of all kinds in Europe was at least 4000 kWh in 1961, and many times more where hydro resources are plentiful.

different European countries with similar social and economic structures and living standards. While in countries such as Turkey and Cyprus (with total gross consumption of 100 and 460 kWh per inhabitant respectively in 1961) household use was from 16 to 81 kWh per head, it varied from 160 to 700 or more in another group with (among themselves) similar though much higher levels of per capita national income and a comparable economic structure.1/

42. In Africa the vast potential demand for home use of electricity is, at the initial stage, often a matter of supplying current (and possibly equipment) for little more than lighting purposes for a few hours during the evening, and for radio. From the point of view of an economically well-balanced supply, therefore, the initial household demands of the average African consumer tend to be characterized by high peaks with maximum demands which may coincide with system peaks, and are thus not easily assimilated. Nevertheless, household consumption is rising rapidly in some areas (requirements per African household in Salisbury, S. Rhodesia have of late trebled in seven years, for example) and is almost certain to become more diversified on a wide front as average income begins to rise. Again to judge by experience elsewhere, this last is largely a function of higher labour productivity induced by increased electrification in industries requiring mass production.

43. Transport consumption, the third main source of expanding demand in Africa, offers more scope there than elsewhere since its improvement would remove a bottleneck in many areas and have a "multiplying effect" on economic activity in general. Moreover, suitable natural sources of power already exist, although the necessary capital does not.

44. Population in most parts of Africa is growing very rapidly - on the average by over two per cent per year. But total national product must increase far more rapidly than population if economic growth is to occur. Everywhere it has been found that a rising national product requires in addition a more rapidly rising use still of electric energy, so that kWh per unit of total product should also increase steadily. How do African economies stand on this basis?

45. Some fairly conservative population projections2/ for certain countries are given in Table 36. In contrast with those for Europe, for instance, projections for many

---

1/ Higher levels of household use than this do of course exist in certain countries, though house heating is a non-comparable factor in some of these.

2/ Based on the United Nations report on the subject referred to in the list of references.

African countries are already in need of revision, as they tend to be overtaken by events. Even so, it is clear that growth-rates for electricity consumption almost everywhere are far higher than those for population.

46. When present kWh consumption is related to national income (expressed in common currency) it is possible to take the measure of the development problem more clearly. The following figures show gross electricity consumed in kWh, expressed first in terms of kWh per inhabitant and second in terms of kWh per dollar of national income in 1961:

Country	kWh/inhabitant (1961)	kWh/US dollar of national income (1961)
Sudan	9	0.15
Nigeria	17	0.25*
Tanganyika	15*	0.25
Ghana	56	0.30
Tunisia	61	0.37
Uganda	36	0.57
Kenya	59	0.67
Morocco	86	0.67
Algeria	119*	0.60-0.70
UAR (Egypt)	140	1.17*
Fed.Rhodesia & Nyasaland	469	2.97

47. To evaluate these figures reference may be made to a similar analysis for European countries, covering also trends in kWh per unit of national product over the period 1950-1958.[1] By comparison the above figures indicate fairly normal ratios of relative electrification at the higher African levels of consumption per head (the lowest European data show about 0.5 kWh per dollar of product, at 100 kWh/head in a few countries about 1950, rising smoothly to nearly 4 kWh/dollar where consumption is 3000 kWh/head. The comparison suggests that the African ratios in column 3 corresponding to

1/ See document ST/ECE/EP/2 (particularly Figure 2), United Nations, Geneva, 1960.

the lower levels of consumption/head will probably rise rapidly, perhaps doubling in under ten years.[1/]

48. To sum up this discussion, Table 37 presents some official estimates of average rates of consumption growth for the immediate future. In Figure 3 an example of expected development is illustrated for a selected country - Ethiopia. Most of the rates foreseen are higher than those experienced in 1961, but do not appear excessive. In certain cases, in fact, the estimates may appear somewhat conservative. This would not be surprising, since recent experience outside Africa, in regions highly electrified, has shown that factors which make for higher kWh requirements have of late been generally underestimated - an error likely to prove more costly than that due to over-optimism.

E. Observations

49. Electricity consumption in Africa is in most territories not merely very low (the median is under 35 kWh per head) and often concentrated round a few towns, but is also well below the average for the continent as a whole. Of late consumption overall has been doubling about every eight years.

50. In many regions, and particularly in various inland states, there is an urgent need to raise the use of electricity in order to increase the output of goods and services of all kinds. While in many parts of the continent the latent demands which must arise from the presence of rich natural resources now appear to be on the point of gathering momentum, there are a number of regions where there is so far little evidence of this. These are generally areas where there is special difficulty in breaking the vicious circle of high cost per kWh (as exemplified by Table 35) and low levels of average income plus costly and insufficient means of transport.

51. Levels of electricity use appear to be developing satisfactorily in a majority of African countries when considered in relation to existing national income. There has of late been a fairly clear inverse relationship also between average consumption per head and the rate at which consumption is increasing. It is the rate of growth of real national income, however, that commonly remains insufficient. If this is to rise more rapidly, use of electricity must grow even more swiftly than it is growing at present. It would seem that detailed study of the future medium-term perspective of electric power demand is needed in many African countries in order to evaluate more clearly the need for capital expenditure.

1/ The actual consumption per inhabitant in African and European countries should not be directly compared, since large groups within the African populations do not yet consume electricity. European and African ratios discussed above would be roughly comparable if sections of non-consuming African populations were not included.

Table 27

Gross consumption of electric energy in Africa and in the World - 1948-1961

	WORLD			AFRICA		
YEAR	Gross consumption (10^9kWh)	Index of increase (preceding year listed=1)	kWh per inhabitant	Gross consumption (10^9kWh)	Index of increase (preceding year listed=1)	kWh per inhabitant
1	2	3	4	5	6	7
1938	460.0	-	210	7.5		45*
1948	809.7	1.76	350	13.4	1.79	66*
1950	962.0	1.19	400	16.0	1.19	77
1955	1544.0	1.60		26.4	1.65	
1956	1694.9	1.10	610	28.8	1.09	125
1957	1804.5	1.06		31.5	1.09	
1958	1908.0	1.06		33.8	1.07	
1959	2098.2	1.10		36.7	1.09	
1960	2299.9	1.10		40.0	1.09	
1961	2453.3	1.07	800	43.1	1.08	165

Table 28

Development of electric energy consumption and of its main constituents - 1955-1961 (provisional)

Country	Total available for consumption	Total net consumption	Generating, transmission and transforming losses	Indices of net consumption for 1961: Industry 1955=100	Industry 1960=100	Domestic etc. 1955=100	Domestic etc. 1960=100
1	2	3	4	5	6	7	8
North Africa:							
Algeria	1435(a)	..	..	..	..	..	..
Libya (b)	101.0	..	..	..	..	..	..
Morocco	1030	874.0	156.0	110	..	141	..
Tunisia	280	240*	40*	116*	102*	132*	102*
Sudan (c)	103.1	93.0*	10.1*	230(d)	116(d)	230(d)	116(d)
UAR (Egypt)	3722	..	..	..	..	..	..
West Africa:							
Cameroon	950*	924.2*	25.8*	458	102	242	110
Central African Republic	9.4(e)	7.1	1.0*	274	122	272	119
Gabon	21.7	..	..	..	..	..	..
Chad	9.0	..	..	..	..	..	..
Congo (Brazzaville)	30.9	..	..	..	..	..	..
Gambia	5.1	4.3	0.8	181(f)	..	153(f)	..
Ghana	389.6	350*	39.6	162(g)	104(g)	162(g)	104(g)
Liberia	112*	102	10	350*	..	..	..
Nigeria (h)	(662)434.1	354.1	83.0*	..	..	..	..
Sierra Leone	48.0	..	..	..	..	..	..
Togo	10.0	9.5	0.5	..	..	..	..
Guinea	27.0*	25.0*	2.0*	..	..	..	..
Ivory Coast	92.8	85.2	7.6	..	..	..	..
Dahomey	10.5*	9.6	1.0*	-	-	344	100
Niger	9.2	..	..	..	..	..	..
Senegal	152(a)	138	14	237(d)	119(d)	237(d)	119(d)
Mali	15.7	13.1	2.6	204	..	198	..
Upper Volta	10.0	..	..	..	..	..	..
North-East Africa:							
Ethiopia	124.4	108	16.4	318	..	220	..
French Somaliland	10.7	9.7	1.0	..	..	..	..
Somalia	12*	11	1*	140(i)	106(i)	140(i)	106(i)
Central Africa:							
Angola	142.6	..	..	..	..	..	..
Congo (Leopoldville)	2137*	1987*	150*	..	..	..	..
Kenya	429.0	356.6	72.4	176	..	191	..
Tanganyika (a)	140.0*	121.0	19.0	..	..	..	..
Ruanda-Urundi (j)	18.7	..	..	..	..	..	..
Uganda	243.3	209.2	34.6	391(k)	104	153(k)	101
Zanzibar & Pemba	11.9	..	..	..	..	..	..
Fed.Rhodesia & Nyasaland	4000	3697.6	302.4	165	103	199	106
- N. Rhodesia	2273.7(l)	2103.7	170*	..	104	..	109
- Nyasaland	35(l)	31.9	3.1	..	143	..	113
- S. Rhodesia	1691.3(l)	1562.0	129.3*	..	102	..	105
Southern Africa:							
Mozambique (j)	88.1	..	..	..	..	..	..
Madagascar (j)	(113.2) 107.3(m)	94.2	13.1	400	..	129	..
Reunion	46.1	43.2	2.9	243(n)	..	277(n)	..
South Africa	24556*	21456*	3100*	..	..	..	..
South-West Africa	208.0*	..	..	..	..	..	..

(a) Does not include self-producers output.
(b) Refers to 1960 and public supply only.
(c) Refers to public supply only.
(d) Based on production only.
(e) 1.3 million kWh of production not accounted for in consumption.
(f) Based on 1956 = 100.
(g) Refers to total consumption.
(h) Refers to supply from Electricity Corporation of Nigeria (year beginning 1 April). Total available for consumption stated to be 662 million kWh.
(i) Based on estimated production.
(j) Refers to 1960.
(k) Refers to 1956 = 100.
(l) Figures refer to generation (including Kariba) plus net imports. For the actual totals available to consumers see Table 42.
(m) Corresponding figure for 1961 is 113.2
(n) Not including self-producers.

Table 29

Average annual rates of increase in gross consumption of electric energy in Africa (1948-1961) and gross consumption per inhabitant in 1956 and 1961

(territories arranged in increasing order of consumption per head in 1961 - column 3)

Country	Gross consumption in kWh per inhabitant)		Mean annual percentage rate of consumption growth		Annual rate of consumption growth 1960-1961 (1960 = 100)P
	1956	1961	10 year average (1948-1958)	5 year average (1956-1961)	
1	2	3	4	5	6
Upper Volta	1	2	..	32.0	128
Chad	1	3	..	24.6	112
Mali	2	4	..	16.9	102
Dahomey	2	5*	..	24.0	100
Ethiopia	4	6	6.5	13.3	124
Somalia	5	6*	..	6.2	106
Togo	2	7	14.3	32.0	124
Rwanda-Urundi	6	7*	..	6.2	..
Central African Republic	5	8	..	12.1	116
Sudan	5	9	14.9	16.1	116*
Guinea	..	9*	..	..	..
Nyasaland	3	12	..	31.5	124
Mozambique	13	13	7.8	1.6	.. (a)
Tanganyika	14	15*	17.0	2.5	107 (a)
Nigeria	10	18	12.5	16.9	118
Gambia	17	19	20	..	112
Madagascar	14	20	9.8	11.2	105
Sierra Leone	17	20	15.4	6.5	..
Ivory Coast	7	28	..	36.0	138
Angola	17	29	17.4	13.2	..
Congo (Brazzaville)	10*	33*	..	37.3	117
Uganda	16	36	20	21.1	103(a)
Zanzibar & Pemba	19	38	13.4	16.6	106
Gabon	24	48	20	18.1	111
Libya	37	51	10.1	8.5	..
Senegal	33	51	16.9	15.4	119
Ghana	49	56	6.2	11.1	104
Kenya	38	59	13.7	11.7	108(a)
Tunisia	53	61	7.0	4.4	102*
Morocco	..	86	9.6	1.9	104*
Liberia	41	87*	20	18.5	113*
Mauritius	72	96	11.8	9.0	..
Algeria	86	119*	9.2	8.5	108
Reunion	24	133	20	..	17.5
UAR (Egypt)	78	140	..	19.5	..
Congo (Leopoldville)	136	148*	17.6	4.3	.. (a)
French Somaliland	78	157	20.1	15.1	119
Cameroon	70	229	20	20	104*
Fed. Rhodesia & Nyasaland	..	469	..	..	105(a)
S. Rhodesia	451	537	15.3	6.5	116(a)
N. Rhodesia	590	917	..	12.1	83(a)
South Africa	1240	1512*	8.1	6.7	105
Total Africa:	125	165	9.6	8.5	108
World:	610	800	8.9	7.8	107

(a) Refers to production.

Table 30

Consumption of electric energy by main consumer-groups in 1961 (provisional) - 10^6 kWh

Country	Net consumption by: Industry 10^6 kWh	Industry: As percentage of Col.6	Domestic and allied low-voltage consumers	Transport	Total net consumption
1	2	3	4	5	6
North Africa:					
Algeria	..	..	..	-	..
Libya(a)	..	..	..	..	..
Morocco	484.0	55	324.0	66.0	874.0
Tunisia	123*	51*	105*	12*	240*
Sudan(b)	5	5	88*	-	93.0*
UAR (Egypt)	..	..	..	..	..
West Africa:					
Cameroon	876	95	48.2	-	924.2
Central African Republic	2.2	31	4.9	-	7.1
Gabon	..	..	..	-	..
Chad	..	..	..	..	..
Congo (Brazzaville)	..	..	..	..	..
Gambia	2.0	47	2.3	-	4.3
Ghana	50*	14*	300*	-	350*
Liberia	66*	65*	36*	-	102
Nigeria(c)	203	57	151.1	-	354.1
Sierra Leone	..	..	..	..	..
Togo	3.1	31	6.4	-	9.5
Guinea	..	..	..	-	25.0*
Ivory Coast	..	..	..	-	85.2
Dahomey	..	-	9.6	-	9.6
Niger	..	..	..	..	..
Senegal	110*	79*	28*	-	138
Mali	7.2	54	5.9	-	13.1
Upper Volta	..	..	..	..	..
North-East Africa:					
Ethiopia	50	46	58	-	108
French Somaliland	2.9	30	6.8	-	9.7
Somalia	3*	27*	8*	-	11
Central Africa:					
Angola	..	..	..	..	..
Congo (Leopoldville)	..	..	..	..	1987*
Kenya	111.9	31	244.7	-	356.6
Tanganyika (d)	..	..	..	-	121.0
Ruanda-Urundi(e)	..	..	..	..	..
Uganda(d)	140.7	67	68.5	-	209.2
Zanzibar and Pemba	..	..	..	..	..
Fed. Rhodesia and Nyasaland	2748.3	74	949.3	-	3697.6
- N. Rhodesia	1889.8	90	213.9	..	2103.7
- Nyasaland	17	53	14.9	-	31.9
- S. Rhodesia	841.5	54	720.5	..	1562.0
Southern Africa:					
Mozambique(e)	..	..	..	..	..
Madagascar(e)	37.2	39	53.7	3.3	94.2
Reunion	31.7	73	11.5	-	43.2
South Africa	..	..	..	..	21456*
South-West Africa	..	..	..	..	..

Footnotes: (Table 30)

(a) Refers to 1960 and to public supply only.
(b) Refers to public supply only.
(c) Refers to supply from Electricity Corporation of Nigeria (year beginning 1 April). Total available for consumption stated to be 662 million kWh.
(d) Does not include self-producer's output.
(e) Refers to 1960.

Table 32

The state of electrified railways in Africa as at 1961-62[a]

Country	Electrified track	Width of gauge (m)	Length of track in km: Total[b]	Length of track in km: Of which electrified	Electric system and type of conductor	Freight (million ton/km carried)[b]
1	2	3	4	5	6	7
North Africa:						
Algeria	Bone-Le Kouif	1,450	5,239	322	3,000 V d.c. OH	1,570.0
Morocco	Marrakech - Casablanca - Fez	1,435	2,591	919	3,000 V d.c. OH	1,848.4
Tunisia		1,435	2,098	-	-	513.6
Libya		950	174	-	-	-
UAR (Egypt)	Cairo - Helvan	1,435	5,782	33	1,500 V	898.3
Sudan		1,067	5,054	-	-	1,683.0
	TOTAL		20,938	1,274		6,513.3
West Africa:						
Mali		1,000	640	-	-	-
Senegal		1,000	1,035	-	-	132.3
Guinea		1,000	701	-	-	-
Sierra Leone		762	558	-	-	25.0
Liberia		1,067	80	-	-	204.0
Ivory Coast		1,000	1,318	-	-	338.3
Upper Volta		1,000	-	-	-	-
Ghana		1,067	1,222	-	-	204.6
Togo		1,000	490	-	-	8.0
Dahomey		1,000	648	-	-	105.6
Nigeria		1,067	3,583	-	-	2,680.0
Cameroon		1,000	504	-	-	123.4
Congo (Brazzaville)		1,067	624	-	-	238.0
	TOTAL:		11,403	-	-	4,059.2
East & South Africa:						
Ethiopia		1,000	1,175	-	-	178.0
East Africa		1,000	6,765	-	-	2,753.6
Fed. Rhodesia (N. & S.)		1,067	5,138	-	-	8,177.8
Nyasaland		1,067	555	-	-	119.0
Mozambique		1,067	2,732	-	-	164.9
Angola		1,067	3,849	-	-	1,647.3
Madagascar		1,000	990	-	-	131.2
Congo (Leopoldville)	Elizabethville region	1,067	5,967	580	25,000V 1/50 OH	1,839.0
South Africa	Capetown & Johannesburg regions: Johannesburg & Durban	1,067	29,163	4,656	3,000 V d.c. OH	21,100.0
	TOTAL	-	56,334	5,236	-	36,110.8
	GRAND TOTAL:	-	88,675	6,510	-	46,683.3

(a) Based on data from World Railways.

(b) Data are not on the same basis as those in Table 5.

Table 33

Development of residential building construction in selected African countries

(authorizations, in 000m^2 or number of units)

Country	1956	1959	1960	1961	Index for 1961 (1956=100)
1	2	3	4	5	6
North Africa:					
Algeria (a)	16,128	31,862	39,320	31,554	197
Libya (b)(c)	66	55	65	78	118
Morocco (c)(d)	893	898	1,009	894	100
Tunisia (c)	184	201	283	375	204
West Africa:					
Cameroon (c)(f)	..	18	15	19	106 (e)
Central African Rep. (f)	22	16	23	20	91
Gabon (c)(f)	13	31	49	66	508
Togo	..	38	41	46	121 (e)
Guinea	72	..	..	..	..
Ivory Coast (c)	35	69	201	326	931
Senegal (c)(g)	83	134	106	166	200
North-East Africa:					
Ethiopia (c)	20	55	54	56	280
Central Africa:					
Kenya (b)(c)	281	217	195	43	15
Uganda (b)(c)	68	38	29	12	18
Tanganyika (b)(c)	95	74	71	45	47
Southern Africa:					
Mozambique (b)(c)	58	90	112	77	133
South Africa (a)(b)(d)	18,458	10,075	10,662	9,706	..

(a) Figures refer to number of dwelling units.
(b) Refers to dwellings completed.
(c) Total floor area.
(d) Series partly modified from 1959.
(e) Based on 1959 = 100.
(f) Refers to total construction.
(g) Prior to 1957, buildings completed.

Table 34

Occupation of types of private dwelling in selected countries and degree of equipment with electricity and gas

Country	Date of latest survey	Total number of occupied dwellings of type considered (thousands)	Type of dwelling	Average number of: Rooms per dwelling	Average number of: Persons/room	Percentage of dwellings with: Electricity	Percentage of dwellings with: Gas
1	2	3	4	5	6	7	8
ALGERIA	1954	308.5 (a)	European type (urban only) (b)	2.3	..	83.9	57.1
MOZAMBIQUE	1950	19.2	Total	4.4	..	57.3	91.1
FED. RHODESIA AND NYASALAND	1956	48.9	Urban in 16 towns	4.2	0.8	..	..
SENEGAL	1955	11.5	Total European type in Dakar	2.3	1.5	96.4	..
SOUTH AFRICA	1951	564.2	Urban	3.7	..	..	..
UNITED ARAB REPUBLIC	1960	1532.2	Urban	3.6	1.6	18.7	0.1
ZANZIBAR	1958	20.3	Urban	..	1.8 (c)	..	..
FRANCE	1954	7846.0	Urban	2.8	1.0	95.4	77.6
		5555.5	Rural	2.3	..	89.5	49.8
		13401.5	Total	2.9	..	93.0	66.1

(a) Urban dwellings only. Total including rural = 386.9.
(b) Represents 21.5 per cent of total dwellings.
(c) Kitchens not included.

Table 35

Average revenue per kWh sold in selected countries (provisional)

Country	National currency unit	Average revenue per kWh sold in 1961		Remarks (relating to col.3)
		National currency unit per kWh	Mills per kWh	
1	2	3	4	5
Cameroon	Fr. CFA	16.69	69.5	Cost of supply at Yaoundé (excluding depreciation and interest)
Central African Rep.	Fr. CFA	21.25	85.0	-
Ethiopia	Eth.cent.	8.9	35.8	11.1 excluding off-peak consumers
Fed. Rhodesia & Nyasaland	Pence	1.22	14.24	-
Gabon	Fr. CFA	16.86	67.4	At Port Gentil & Lambaréné
Gambia	Pence	4.0	46.7	Of which lighting 9d., domestic 3d., and commercial 6d. and 4d.
Ghana	Pence	4.5	52.5	-
Kenya	E.A.cent	20.59	28.8	-
Mali	Fr. CFA	25.51	102.0	-
Morocco	Dirham	0.099	19.6	-
Nigeria	Pence	3.8	44.4	Refers to 1960/61.
Reunion	Fr. CFA	20.3	81.2	-
Senegal	Fr. CFA	5	20.0	Approximate and refers to industry.
Somalia	Som.cent.	110-120	154-168	Refers to industry and domestic use respectively at Mogadiscio.
Sudan	L.Sud.	..	60	Of which 45 for agriculture and 115 for public lighting.
Togo	Fr. CFA	25.02	100.1	-
Tunisia	Mill.Din.	20.70	49.29	-
Uganda	EA cent.	10.4	14.6	Refers to 1960.

Table 36

Population projections for selected African countries to 1975, based on medium assumptions

Country	Projection (thousands)		
	1965	1970	1975
ANGOLA	4 730	5 000	5 310
BASUTOLAND	741	827	937
BECHUANALAND	404	455	517
CONGO (Leopoldville)	15 200	16 500	17 600
GAMBIA	323	340	360
LIBERIA	1 370	1 440	1 520
LIBYA	1 340	1 500	1 700
MADAGASCAR	5 900	6 360	6 810
MAURITIUS	727	797	855
MOZAMBIQUE	6 780	7 200	7 660
NIGERIA	36 800	39 600	42 300
SOUTH AFRICA	17 000	19 200	21 900
SWAZILAND	288	329	375
E. & S. TANGANYIKA	9 620	10 300	11 000
TUNISIA	4 600	5 180	5 900

Table 37

Actual and future rates of increase in annual consumption of electric power as planned or forecast for selected African countries

Country	Actual percentage rate of increase in consumption (1960-1961)	Planned or forecast mean annual rate of consumption growth: Per cent per year	Planned or forecast mean annual rate of consumption growth: Period 1963 1964 1965 1966 1967 1968 1969 1970 1980
1	2	3	4
Central African Republic	16	19*	- - - - - - - - - - - - - -
Cameroon	4	12	——————————————————┘
Dahomey	0	1-5*	- - - - - - - - - - - - - -
Ethiopia	24	22	——————————┘
UAR (Egypt)	12(a)	11.5	————————————————————┘
French Somaliland	19	18.8	- - - - - - - - - - - - - -
Gabon	11	(30.0(b) (7.0(c)	- - - - - - - - - - - - - -
Ghana	4	15-20	————————┘└——31——┘└—6.5—┘
Ivory Coast	38	35*	- - - - - - - - - - - - - -
Kenya	8	7.5-15	—7.5—┘└—10—┘└——15——┘
Liberia	13	20*	- - - - - - - - - - - - - -
Madagascar	5	7.2	- - - - - - - - - - - - - -
Mali	2	15	- - - - - - - - - - - - - -
Morocco	4*	14	- - - -
Nigeria	18*	17*	—21—┘└——14——┘└——10——┘└—8—┘
Reunion	17.5	17.5	- - - - - - - - - - - - - -
Fed. Rhodesia & Nyasaland	6	5(d)	———————————————————┘
Somalia	6	3-6*	- - - - - - - - - - - - - -
Sudan	16	15*	- - - - - - - - - - - - - -
Tanganyika	7	7-10	- - - - - - - - - - - - - -
Uganda	3	10	- - - - - - - - - - - - - -

(a) 10-year annual average ending 1961.
(b) Refers to Libreville.
(c) Refers to Port Gentil and Lambaréné.
(d) Earlier Federal Power Board estimates gave 7.2% which for various reasons has lately exceeded actual growth experienced.

CHAPTER V

ELECTRIC POWER SUPPLY SYSTEMS IN AFRICA

A. Introduction

1. This Chapter surveys various basic aspects of power supply in Africa - the organizational arrangements, types of generating plant and their mode of operation, output, transmission and distribution of electric energy to meet the needs of consumers. In Africa particularly, these different aspects of the supply situation are closely interrelated. Various separate problems encountered in developing production to meet the growing needs of consumers as economically as possible can sometimes be made less intractable if they are considered together as an integrated whole. Problems encountered and possibilities open on opposite sides of a common frontier may complement one another in such a way as to make possible mutually advantageous solutions through co-operation. Not only the present administrative, technical and economic problems of production, therefore, but their further development in relation to all factors involved, should be taken into account in planning for an adequate and secure supply of electricity.

2. The present Chapter sets out some basic data and considerations for a first examination of Africa's problems of electricity production and supply. This Chapter should, however, be studied in conjunction with those of Part I, particularly Chapters II and III, as well as with Chapter IV.

B. Organization of Electricity Undertakings and System Operation

3. The organization of undertakings is considered here only briefly and insofar as it may be linked with the approach to questions of financing and capital expenditure; balancing of costs and revenue on a regional basis; choice of different types of plant; and other similar considerations which influence the economy of production and planning to meet statutory requirements.

a) Organization and financing

4. Power supply undertakings are organized in Africa in many different ways. In certain countries one or more Ministries possess overall responsibilities for electricity, either simply as a public utility or in conjunction with water supply or gas. Private authorized companies or undertakings are then responsible for production and distribution

alike. Various types of indpendent service ensure public supply on this pattern under government concession in, among other countries, Dahomey, French Somaliland, Gabon (responsibility for electricity and water in some areas and electricity only in others), Kenya, the Malagasy Republic, Reunion, Senegal, Tanganyika and Togo (two companies). Within this group some variations of structure exist.

5. One variant is to separate the functions of production and distribution, the latter being assured by undertakings, possibly private, which purchase the power in bulk from the undertaking responsible for generation. This system is followed in Morocco, where ten companies purchase some power from the single company responsible, under the Ministry of Public Works, for generation and transmission, and distribute it to consumers in their areas of operation.

6. With a number of differences on points of detail, the principle of a public authority, set up by special Charter or Act of Parliament, has been adopted by several countries. This may have replaced earlier private bodies, as in the Sudan, or these may continue to exist to serve certain outlying areas, as in Ethiopia. The Ethiopian Electric Light and Power Authority is a public corporation responsible for generating, transmitting and distributing electric energy and produces nearly 60 per cent of the country's total output, the remainder being supplied by private companies with similar functions or produced by private industrial enterprises.

7. In the UAR (Egypt) there is an Electricity Commission for the whole country which, through its Technical Bureau, undertakes planning and design for the interconnected power system separately from the special administration set up to deal with the Aswan Dam and other hydro schemes. Of a number of undertakings which produce and supply power the largest (that for Cairo) is also a publicly-owned enterprise under the central Government. In Ghana also the public supply of electricity is assured by a government service for production, the Electricity Division of the Ministry of Communications and Works, which operates throughout the country. Most of Liberia's public supply is also under government control, through the Monrovia Power Authority, much of the remainder being generated for iron ore mining and rubber production. The Electricity Corporation of Nigeria is another public body of relatively long standing which was set up for the generation and public supply of electricity. In Tunisia and Uganda too there are public bodies - the Société Tunisienne de l'Electricité et du Gaz and the Uganda Electricity Board respectively - which are responsible for electricity production and distribution throughout these territories.

8. In other cases overall control over the development of supply is exercised in various ways. Thus in the Cameroon Republic, where both public and private organs exist which serve respectively towns supplied from diesel plants or those supplied from the large hydro plant on the Sanaga River used for aluminium reduction, capital expenditure for public supply by the former is made through the appropriate Ministry. Municipal authorities also supply separate individual communities from diesel or small hydro plants. At the other extreme, under the Federal system of the Federation of Rhodesia and Nyasaland, there is a Federal Power Board which was set up initially in 1956 to construct the Kariba Dam, furnish power to other undertakings and, in conjunction with the Electricity Supply Commissions for Southern Rhodesia and Nyasaland respectively, to investigate development of further facilities for bulk supplies within the area. The separate Electricity Supply Commissions themselves generate, purchase and transmit electricity within their respective territories. In addition, private undertakings, local authorities and licensed bodies may all exist either for purposes of public supply or to furnish power to meet special industrial or other requirements. Further details on these and other organizational arrangements in force in different areas are summarized in Annex VI. It should also be noted that in several countries - including Ethiopia, Gabon, Mali, Morocco, Nigeria and Tunisia - separate public bodies exist for the development of water resources, commonly for hydro-electric power and multi-purpose use.

9. The importance of the administrative structure in force as power supply develops arises from several contrasting considerations. Private undertakings may be able to tap sources of capital or expertise not otherwise available. On the other hand central Government control - through a Ministry, a separate power authority or through control over natural resources plus a central body for generation and main transmission to local undertakings - also raises issues of public management and policy. A public service is in a position to frame an overall tariff system which can seek to balance or compensate the differences in cost of supply in different areas. It can consider and plan for the overall use of different natural power sources, taking into account the respective advantages of high-voltage transmission, possible cross-frontier supplies of power,

isolated generation from different types of plant, fuel import considerations and the role of power in the different sectors of the national economy. The planning of a gradual transition to an integrated system can be pursued in the light of all necessary economic, technical and demographic data and considerations. On the other hand there is a strong case for independent powers allowing for the exercise of sound commercial practice in administration, particularly in such fields as tariffs and depreciation, in order to place the industry on a sound financial basis. Where the raising of the necessary capital is of paramount concern, this point gains special weight.

10. Some details on the capital expenditure undertaken in recent years for electric power development in eleven selected territories are presented in Annex VII. The information does not allow any calculations to be made of <u>specific</u> capital costs for plants or transmission lines. In a number of cases, however, a breakdown is made between expenditure on thermal plants, hydro plants, transmission lines and distribution respectively. As in regions outside Africa, transmission and distribution have commonly accounted for nearly half the total in recent years.

b) <u>Mode of operation</u>

11. The various types of generating capacity, production, transmission and other characteristics of the different power systems in use are discussed in later sections of this Chapter. Here it is only some main principles of operation that are considered.

12. Apart from those states - fewer than ten in all - where large-scale production is already in force, operating conditions are mainly imposed by the limited volume of total demand, its concentration in a few major consuming centres (which are often widely separated) and the wide dispersal of such further demand for power as may exist. Production in plants operated by industrial self-producers may also suffice, as in the Cameroon Republic, to make available substantial contributions to public supply. As in the island of Reunion and elsewhere, back-pressure plants operated for sugar refining may be in a position to supply some power to meet public requirements. In many of the industrial installations plants are operated at a fairly even load, in contrast to the variable load diagram characteristic of public supply plants working more or less independently. Nevertheless the reliance on capacity from industrial plants must be regarded as a temporary measure in view of the rapid rate of load growth. In any case it is essential to build up an adequate public supply service as quickly as possible.

13. In these circumstances areas where small communities requesting public power supply are far removed from existing plants - as for example in areas of Chad, Niger, Mali and many other territories in West Africa and elsewhere - a use of small-scale isolated generating capacity is inevitable. This can be, and is, usually furnished by diesel generators. In practice five types of development with diesel generating equipment can be distinguished, as may be seen from the example of Ghana. Here diesel sets are used to supply large towns such as Accra, Takoradi and Kumasi. They are also installed to supply a number of small centres surrounding the city of Accra. On the other hand, diesel generators are used to provide power for separate outlying centres of population and they also provide the means of production for private mining concerns, as at Tarkwa. Finally, a number of outlying rural communities are also supplied with power from small diesel generators.

14. Other solutions are in principle available, however, particularly mobile diesel plants, very small hydro plants and, in some cases, gas turbines. In such cases there is often a logic of development which allows an optimum solution to be reached. Expenditure on mobile diesel generators may allow potential local demands to be satisfied until new large-scale generating capacity is brought into service, after which it can be transferred to other areas. Such plant can be moved to points where transmission facilities exist. This type of installation is more economic in capital cost than large and heavy units for permanent siting. The same type of consideration may apply in principle to mobile gas turbine units where peak loads have to be satisfied. On the other hand permanent diesel sets may serve for standby or supplementary use after large hydro plants have been brought into operation, as has often been the case in recent years.

15. In the relatively large consuming centres steam generating capacity, large concentrations of diesel plant and, in suitable cases, hydro-electric plants (industrial or for public supply) are the means of production. In most cases, however, and even though demand is usually growing rapidly, the scale of production is such that relatively small and often partly obsolete steam-generating units remain in service and further units, or diesel sets, are added as demand passes the limits of existing output.

In the case of Tunisia, for example, one steam generating plant - the La Goulette thermal station of 70 MW - carries the bulk of the national load, including 74 per cent of the total peak demand on the interconnected system (57 MW in 1961). From such producing centres in the different countries transmission lines of comparatively low voltage (commonly around 30-60 kV) are usually spreading gradually over limited distances to secondary demand centres. It is evident that generating costs will often be high under such plant and operating conditions. On the other hand, when sizeable new plants are introduced the increment of capacity is commonly in excess of immediate needs, so that requirements can be met for some years ahead from the capacity available or from the addition of new generating groups for which provision may have been made.

16. In these circumstances fully integrated operation to take advantage of diversity in daily load diagrams, possible diversity in flow characteristics of hydro plants, and differences in operating efficiency and cost of thermal plants so as to arrive at a near-optimum use on the load diagram of the generating capacity available, is restricted to comparatively few areas. Even in Egypt, where the maximum interconnected load in 1961 (excluding the existing Aswan plant) reached 461 MW (over 500 MW in 1962) and the annual load factor was as high as 67 per cent, it has been found quite feasible to operate the system according to a load programme, with telephone contacts as necessary, without recourse to central load dispatching. In this particular case, however, careful studies of load growth in relation to industrialization, irrigation and reclamation and domestic load demand for 15 years ahead are being made. These have shown the likelihood of a peak demand rising very rapidly - to 2460 MW by 1978.

17. In two other countries of North Africa - Algeria and Morocco - a considerable degree of interconnexion already exists. In the latter over 90 per cent of production is met from hydro plants with substantial storage, so that only one 25 MW steam generating plant using waste coal is kept in service while the other - the 34 MW Roches Noires station of unusual design - is kept as a cold reserve. There are considerable 150 kV and 60 kV transmission networks. It has been found useful to retain four 5 MW alternators and the electrical equipment of the obsolescent Casablanca steam plant in use purely to improve the power factor and the transport capacity. In this country work is now under way to instal a central load dispatching system.

18. A modern load dispatching service, operating continuously with highly sophisticated equipment, already exists in Algeria's nationalized and mainly thermal power system, although the maximum peak demand (greater than at present) has reached only 280 MW. Large new increments of thermal and hydro-electric capacity (200 and 114 MW respectively) are coming into service by 1964, however. In this particular case advanced methods of frequency control are in use in the interconnected network, this being achieved through co-ordination between a remote 95 MW hydro plant with appropriate storage and the modern Alger Port thermal plant, the latter supporting the voltage but remaining free to work at optimum efficiency in relation to the load.

19. The interconnected system of the Federation of Rhodesia and Nyasaland's Federal Power Board offers a further example of well-integrated supply. A lengthy spine of main transmission at 330 kV exists from Kitwe in N. Rhodesia southward through the key Kariba hydro plant (now 700 MW as a first stage, with possible extension to 1500 MW) and thence southward to Salisbury and Bulawayo in S. Rhodesia. The Board's maximum non-simultaneous load in 1961/62 was 480 MW out of a total interconnected maximum for the Federation of 1007 MW and Kariba, at very low costs, generated 90 per cent of the Board's total output. A further 400 MW of thermal plant is interconnected to this network in the southern industrial areas, but other blocks of power, as at Livingstone, Wankie etc. in the west, are not linked to it. The system is, however, interconnected in the north with the adjoining plants of the Congo (Leopoldville), with which large quantities of power can be interchanged. The Electricity Supply Commission of S. Rhodesia, which also operates plants and lines throughout its area for bulk supply to most of the municipal electric systems, is interconnected on the east (at Umtali) with neighbouring Mozambique at 110 kV and, at low voltage, with S. Africa over the Limpopo River at Beitbridge in the south.

20. Other emerging areas of interconnexion include the extending networks of Kenya and Uganda. In the latter, in addition to the 132 kV line linking the two countries for the supply of power from Owen Falls under a long-term agreement (Kenya is also linked with neighbouring Tanganyika) lines at 33 and 66 kV are rapidly extending from the area of Jinja and Kampala towards the northern and western frontiers of Uganda at Gulu, Kasese and Hoima. Every incentive exists to stimulate consumption in this particular country, since the available capacity of Uganda's Owen Falls plant still remains in excess of present demand.

21. These various instances of types of supply and system development in progress in different countries serve to introduce the analysis of generating plant, production and transmission in African countries that is comprised in the following sections.

C. Generating Plant Characteristics

a) Existing plant capacity

22. A complete breakdown of the generating capacity installed in African countries is fraught with some difficulty and, as is normal in many parts of the world, certain of the data must be regarded as provisional. In Table 38 an attempt is made first of all to bring together information on the installed thermal and hydro-electric capacity in different countries at the end of 1961 and its development since 1955. In principle a distinction is made between generating capacity in service for public supply and that owned by industrial and other self-producers generating entirely or mainly for their own use. Many of the latter, however, often contribute some power to public networks, while they may equally take power from it. Information on the maximum hourly peak demand in 1961 is included for interconnected systems in various countries. In certain cases the data refer, however, to non-simultaneous demand.

23. Thermal generating capacity is mainly concentrated in South Africa, the UAR (Egypt), S. and N. Rhodesia, Algeria, Nigeria and Ghana. The last-named has until now relied entirely on diesel plant. Diesel generators provide the entire non-hydro output in a number of territories, including the Central African Republic, French Somaliland, Gambia, Liberia, the Malagasy Republic and Mali. In most of these the diesel equipment is divided fairly equally between public supply and self-producers. Free piston gas turbine sets have been installed in various countries - four in Algeria, two in the Congo (Leopoldville), five in Egypt, eighteen in the Ivory Coast, eight in Nigeria and fourteen in Tunisia. Some extensions of this type of plant, which is particularly useful for meeting small-scale peak-load requirements since it is very quickly brought on load and is comparatively inexpensive in capital cost, are being made in some areas. The Electricity Corporation of Nigeria, for example, is installing a 5.56 MW simple cycle plant for peak load duty at the Ijora power station in Lagos, where it will also contribute to the base load of the existing steam generating sets.

24. Hydro-electric generating capacity is mainly concentrated at Le Marinel and other plants in the Congo (Leopoldville); in the Federation of Rhodesia and Nyasaland (particularly the Kariba scheme); in Egypt (existing Aswan Dam, completed in 1961); in Morocco (El Ouidane and Al Fourer); in the Cameroon Republic (at Edéa); in Algeria (Agrioun, etc.); and in Uganda (Owen Falls). Elsewhere much smaller plants are generally in service. Although no hydro-electric capacity is included in the Table for South Africa, a small plant has been installed comparatively recently by the Electricity Supply Commission (ESCOM) at Sabie, which generated 2.9 million kWh in 1962. Much larger multi-purpose developments for the conservation of water resources, including irrigation and industrial use, are now envisaged, more particularly in upper reaches of the Orange River, and on the Fish River (both outside the present ESCOM area).

25. Apart from the Cameroon and Congo (Leopoldville) plants, and some capacity in N. Rhodesia, most of the hydro capacity is operated for public supply. Very rapid advances have been made in hydro-electric construction in recent years and as a result the situation has changed completely between 1955 and 1961, as can be seen from the indices shown in columns 12 and 13 of Table 38. Most of the larger plants did not in fact exist in the earlier year.

26. The development of hydro-electric production potential is most clearly expressed by information on the aggregate producibility of such plants under normal operating conditions and in an average year - i.e. a year characterized by stream-flow conditions near the long-term mean. Availability of seasonal storage capacity expressed in terms of energy storable in existing reservoirs is an equally vital index in most parts of Africa. Details for certain countries on these two indices are brought together in Table 39 for the years 1955 and 1961. Although they remain in need of completion the figures, together with those in the preceding Table, give an idea of the typical operating economy of hydro plants in Africa.

b) <u>Development projects</u>

27. Schemes already under construction or actively projected to increase hydro-electric production, transmission or thermal generating facilities include some important developments which should serve to provide an underpinning needed to assist rapid economic growth.

28. Hydro-electric construction is especially noteworthy. It includes the successive stages of the Aswan High Dam project in Egypt which, by 1970, should reach its full capacity of 2100 MW, thereby supplementing the existing Aswan Dam (345 MW) so as to supply about 12 milliard kWh yearly in all. Main transmission lines at 500 kV (2 x 900 km) are envisaged to transfer power to Cairo, with a further 1000 km of branch lines at 220/132 kV. A number of important steam-generating plants and extensions are also provided for, including the Cairo West plant (3 x 87 MW in single block units).

29. Other important schemes in varying stages of implementation include the Akosombo plant (768 MW) in Ghana; the Niger Dams project (320 MW) in Nigeria (where a number of large gas turbine units are also due to be installed); the Hale plant in Tanganyika (21 MW) which, with suitable transmission, is due for completion in 1964 to supply industrial development in Tanga and Dar-es-Salaam); the Djen-Djen scheme in Morocco (114 MW) also due for completion by 1964; and the Roseires dam in the Sudan, which has as its main purpose irrigation in the Gezira region but which may also supplement at a later stage the new 15 MW Sennar scheme. The latter, together with 30 MW of new steam-generating capacity and 15 MW of diesel plant, will provide a further 60 MW in all in the area of the Sennar dam.

30. These, among other new plants and transmission networks, by no means exhaust the major projects actively envisaged but which may not be due for immediate construction. Thus, to develop aluminium reduction from rich bauxite reserves, plans exist for the 330-360 MW Souapiti project on the Konkouré in Guinea, which would produce 3.2 milliard kWh per year. Rich bauxite reserves in Mali could justify construction of two plants near Kayes on the Senegal and another nearby at Bakoy. In Kenya the Seven Forks scheme, which would give 240 MW plus a further 130 MW downstream, allowing a production of 1900 million kWh in all, is actively projected for construction after immediate possibilities have been fully absorbed. The existing Kariba and Owen Falls schemes (on the Zambezi in Rhodesia and the Victoria Nile in Uganda respectively) could be greatly extended - the first to 1500 MW and the second to 150 MW, plus a further 180 MW downstream, when demand conditions make this necessary. Similarly, in the Ivory Coast, the capacity of Ayamé I plant, which can produce 100 million kWh, will be doubled through

the building of a second plant. In Liberia, in addition to a 10 MW scheme which is due to be completed by 1965, further extension to 40 or 50 MW will be possible on the St. Paul River. As an example of a project requiring international assistance, the development of the Mono River for use by Dahomey and Togo has been the subject of a joint application for Special Fund assistance.

31. These details merely illustrate a few of many possibilities which already exist but which may in some cases be held back by questions of financing. Further details on these and other schemes are also summarized in Annexes III and V. Annex V brings together in outline certain aspects of the immediate development situation in some 20 countries. Information presented in Chapter I, and in Maps 2, 3 and 4, also allow the development perspective to be evaluated more clearly as a whole.

D. Production of Electric Energy

32. An analysis of the main features of electric power production in Africa has provided information which is brought together in Tables 40 - 43. In order to follow on logically from the Tables on plant capacity Table 40 first examines the use made of the generating capacity in service. This has been done by comparing the output obtained in 1955, 1960 and 1961 from the installed capacity, the result being expressed in hours of operation per year.

33. Table 40 shows in most cases a steady increase in the "utilization factor". Exceptions in some countries, as in N. and S. Rhodesia, arise from the introduction of new large-scale hydro plant, leading to a reduced use of thermal plant where fuel-saving is important or where there is a temporary excess of capacity. Except where hydro-electric plants are used by industrial enterprises average use of plant is fairly low. This is inevitable in many African territories at present in view of the preponderance of production in separate or inadequately interconnected plants and because of a lack of widespread water storage. It should be borne in mind however that by definition the figures refer to installed or name-plate capacity, which is likely to be some ten per cent in excess of capacity actually operating, so that the figures tend to understate the use made of capacity.

34. Tables 41 and 42 serve to complement one another. The first shows the details of production and cross-frontier exchanges; while the second presents information on total availability of energy for consumption, its origin and its development since 1955.

35. In more than half of the 23 countries showing hydro-electric output the importance of this form of production has increased between 1955 and 1961. In thirteen countries it takes a preponderant role while in five - Central African Republic, Cameroon, Congo (Leopoldville), Morocco and Uganda - between 90 and 100 per cent of total output has for some years been from hydro power. Angola, Ivory Coast, Kenya, Mozambique and S. Rhodesia constitute a further group of territories where this form of generation is already substantial relative to total production.

36. Although natural conditions are basically favourable, cross-frontier transfers or exchanges of power have not yet been developed in Africa to play a role comparable to that which they play, for example, in Europe. Of the seven territories which imported or exported energy in 1961, all use hydro power to a relatively large extent. Although details are discussed in the Section dealing with international interconnexion it can be seen that large contributions were made to consumption in Kenya and in the area served by the Federal Power Board in the Federation of Rhodesia and Nyasaland by Uganda and Tanganyika, and by Congo (Leopoldville) and Mozambique respectively. On the whole the countries importing or exporting power are among those where rates of increase in consumption have been comparatively moderate in recent years.

37. An important index in the evolution of supply undertakings where total consumption is still at an early stage is that showing the part played by public supply production in a country's total power generation. Self-producers play an important role in highly industrialized countries, particularly in industries where back-pressure generation can supply energy in addition to steam required for special processes, and it is clear that in Africa industries based mainly on large quantities of low-cost hydro power are among those where industrial self-production is destined to play a greater part than it does at present. In addition industry frequently contributes useful amounts of power to public networks. Although the requirements of self-producers tends to increase in line with industrial output their rates of growth are usually less than that of total power consumption, however. As a result the percentage of self-producers in the total production tends to fall even though the number of kWh produced continues to increase.

38. Table 43 confirms that in Africa there is a tendency for public supply production to take an increasing part of the total output. This is partly because of its very high rate of increase in many areas. It is also a consequence of the fact that as public supply becomes less costly, better integrated and therefore more reliable, there is a greater incentive for many industries to take their power from the public network rather than to invest in independent generating plant. This is an important factor in the approach to public supply load-building.1/

a) Interconnected systems

39. Information on daily load conditions is not so far available for many African countries. Figure 4 shows however a typical week-day load diagram for the interconnected system of the Federation of Rhodesia and Nyasaland (Federal Power Board). This illustrates a fairly normal distribution and amplitude of peak demand but it represents a well-diversified load. In certain other interconnected systems in Africa annual load factors are comparatively high. Thus in Uganda, where exports to Kenya are made under long-term contract, the average annual load factor2/ is over 70 per cent - a very high figure.

40. Annexes VIII and IX present some details on selected individual steam generating and hydro-electric plants in service in particular countries. Annex VIII shows that the most advanced steam power plants in service at present in Africa are those of Alger Port and Cairo South (with 84 - 89 kg/cm^2 and 500 - 540°C). Elsewhere steam conditions are in general considerably less advanced and many plants have comparatively old units in service, so that generating efficiency is not particularly high. Details are not included for stations in S. Africa, but the average generating efficiency in the steam plants of the ESCOM system varied in 1961-62, according to age, from 30.9 per cent (generated) - 28.2 per cent sent out - down to 9.9 per cent.

41. Principal features of generating capacity and production in various mainly interconnected power systems referred to earlier in this Chapter, and their recent development, can be studied in the information presented in Tables 38 - 43.

1/ It should be remembered that the data in Table 43 are intended to give only summary general indications. Many details are incomplete and the absence of an intermediate figure may sometimes be due to incomplete information.

2/ Hours of use of maximum capacity expressed as a percentage.

b) Production in isolated areas

42. Operating costs of diesel generators, which are the principal sources of production where needs must be met from isolated plants, are commonly at least five times as great as where efficient and integrated fuel-burning plants are in use. Some details of selected diesel plants in service in a few of the many countries where they are employed are set out in Annex V.

43. Study of Map 6 (which shows the main distribution of electric power plants in Africa) in conjunction with a map of main communications indicates that, as would be expected, a large proportion of the plants in use are sited along principal railways, highways or along the coast. Study of the seasonal regime of production in many countries shows also a comparatively even distribution of power requirements throughout the year in many areas. (While in a number of countries of West and Central Africa maximum output tends to occur about the month of May, production in North Africa is particularly concentrated to meet peak requirements during the winter months).

44. Nevertheless, as can be seen from the figures included in Table 24, fuel costs vary largely in relation to the geographical situation of the plant. Study of Table 40 also shows how comparatively low annual use of capacity is a frequent characteristic of territories with a large proportion of isolated generating equipment. In certain countries where production costs are high, the cause has been attributed to a combination of many factors - including high fuel costs (due not only to transport charges but to import duties, taxes, handling charges, etc.); high operating and maintenance costs (due to large supervisory staffs and methods of using distilled cooling water); large fixed charges (due to high depreciation expenses; and an incomplete payment of accounts.

E. Transmission and Distribution

45. Transmission and sub-transmission networks in African territories are necessarily of a voltage consistent with the loads to be carried. In most cases they radiate from a few principal towns to surrounding districts, though in some systems they serve to link hydro-electric plants with consuming centres - either within the country, as in Morocco and Egypt, or also beyond the frontier, as in Uganda and Rhodesia.

46. Systems at 132 kV or above exist so far in ten different territories - in Morocco and Egypt in the north and in Ethiopia, Kenya, Nigeria, Tanganyika, Uganda, the Federation of Rhodesia and Nyasaland, South Africa and the Congo (Leopoldville). Only the systems of the Federal Power Board in N. and S. Rhodesia and of ESCOM in South Africa possess extra HV lines, the voltages being 330 kV (5070 km) and 275 kV (645 km) respectively. Tunisia, Senegal and Sudan have some hundreds of kilometres of line at between 90 and 110 kV, but in the remaining territories transmission is commonly at 66 kV or below.

47. The details of transmission systems for which information is available are set out in Table 44. They show that in terms of total length the most extensive high voltage networks - outside those of the Federal Power Board in Rhodesia and of ESCOM in S. Africa - appear to exist in Morocco, Tunisia and Kenya - all over 1000 km - plus Kenya and Ethiopia.

F. International Interconnexions

48. The cross-frontier links at present in existence in Africa include those between Uganda, Kenya and Tanganyika on the one hand, and the links already referred to between the Federation of Rhodesia and Nyasaland and Congo (Leopoldville), Mozambique and (of local importance only) South Africa. In addition, Morocco and Algeria and Algeria and Tunisia have each been linked by connexions at comparatively low voltage although transfers do not appear to be made at the present time. The main details of cross-frontier lines in service in 1961 are set out in Table 45.

49. Study of Maps 3, 4 and 6, together with the data contained in Table 10 and other appropriate Tables, would suggest a number of areas where possible development of exchanges could take place due to contrasts in availability of power, in appropriate natural resources, or in consumption. In the case of Uganda, for example, there is at present an excess of producibility in the Owen Falls plant - a temporary situation so far as existing plant is concerned which will inevitably arise wherever large blocks of power are brought into service to meet an emerging load. In this particular case a considerable amount of power is already exported under a 50-year contract to Kenya. Other adjoining countries (Rwanda and Burundi, Sudan, Tanganyika and Congo (Leopoldville) are not at present receiving supplies. The many possibilities which may already exist in Africa, or which will undoubtedly arise as systems extend and consumption increases, are likely to offer scope for mutually beneficial co-operation the economic advantages of which for operating purposes may well be out of proportion to the quantities of power actually exchanged.

G. Observations

50. It would seem that productive facilities in African countries are at present fairly well adapted to existing levels of electric power use but that by increasing the spread of productive potential in regions with low consumption, much incipient new demand can probably be stimulated which would serve in turn to improve the overall economy of supply where special industrial demands do not exist. High fuel costs are one factor which inflates production costs in many inland areas but other causes - high maintenance costs and depreciation charges, high import duties for fuel, an inability to reap the benefits of interconnexion owing to insufficient load density, among others - may together be almost equally important. In addition fuel-using plants operate at comparatively low levels of generating efficiency in some areas.

51. On the other hand careful attention to the alternatives available to make the best use of scarce capital can help to overcome initial difficulties. Use of mobile diesel sets (possibly mobile gas turbines also) and small automatic hydro plants in areas where time must be given to build up an initial load are among the measures which may prove useful in order to secure a maximum return from a minimum of expenditure.

52. While these considerations apply particularly to the less electrified areas, interconnected systems also need to be extended as rapidly as useful load can be stimulated in order to reduce the overall cost of electricity to all types of consumer.

Table 38

INSTALLED THERMAL AND HYDRO-ELECTRIC GENERATING CAPACITY IN SELECTED COUNTRIES AT THE END OF 1961

Country	Installed thermal capacity at 31 December 1961 (MW)				Total thermal capacity (MW)	Indices of total thermal capacity at 31 Dec. 1961		Installed hydro capacity at 31 Dec. 1961 (MW)		Total hydro capacity (MW)	Indices of total hydro capacity at 31 December 1961		Annual hourly peak demand in 1961 (MW)
	Steam		Diesel										
	Public supply	Self-producers	Public supply	Self-producers		1960=100	1955=100	Public supply	Self-producers		1960=100	1955=100	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
North Africa:													
Algeria[a]	253		..		253	..	112	186	..	186	..	100	..
Libya[a]	30.4	..	..[b]	..	30.4	..	129	-	-	-	-	-	..
Morocco	..	..	..	..	367 P	90 P	100	290	..	290 P	100	100	216.1[c]
Tunisia	70.3	..	17.7	(18.2)	88.0[d]	99[d]	103[d]	25.4	..	25.4[d]	103[d]	150[d]	57(interc.)
Sudan	30		15		45[s]	118[d]	290[d](s)	6		6	118[e](s)	290[e](s)	..
UAR (Egypt)	620	212	..[f]	..[f]	832	109	149	350	-	350	100	5800	461
West Africa:													
Cameroon	8				8	100	114[g]	162		162	100	249[g]	..
Central African Republic	-		1.43		4.93[h]	..	..167[i]	3.5	..	..	..	..	..
Gabon[d]	12.9				12.9	126	167[i]	-	-	-	-	-	..
Chad	2.8				2.8	103	215[g]	-	-	-	-	-	..
Gambia	-	-	2.77	-	2.77	100	182	-	-	-	-	-	1.3
Ghana	-	-	55.46	65.39[j]	120.85	117	151	-	-	-	-	-	31.2(Dec.)
Liberia	-	-	15.19	18	33.19	..	317[k]	-	4	4.0	..	134[k]	10.3[l]
Nigeria	182.76				182.76	123	286	18		18	91[m]	92[m]	95[n]
Sierra Leone[o]	11.6	9.6	..[f]	..[f]	21.2	103	193	-	-	-	-	-	..
Togo	-	-	2.16	6.00	8.16	..	..	1.6	-	1.6	..	..	1.9
Ivory Coast	10.0	..	16.00	..	26.00	..	..	19.2	-	19.2	..	..	..
Dahomey	..	..	..	..	4.5[h]	180[p]		..	..	..	180[p]		..
Niger[q]	2.9				2.9	138	263	-	-	-	-	-	..
Senegal	51	..	17	..	68	121	195*	-	-	-	-	-	..
Mali	-	-	7.63	1.57	9.20	..	..	0.5	-	0.52	..	..	4.3
Upper Volta[q]	4.4				4.4	137	366	-	-	-	-	-	..
North-East Africa:													
Ethiopia	5.0	-	10.00	4.00	19.00	107	149	30	..	30.00	106	650	30
Somalia	7.9[r]				7.9[r]	..	100	-	-	-	-	-	..
French Somaliland	-	-	5.25	.40	5.65	-	175[d]	-	-	-	-	-	..
Central Africa:													
Angola[t]	13.5	60.8	..[f]	..[f]	74.3	..	217	24.3	3.2	27.5	..	234	..
Congo (Leopoldville)[u]	65.8		13.5		79.3	..	136[v]	68.1	694.9	763	..	234[v]	..
Kenya	16.5	-	45.82[w]	-	62.32	100	137	25.9	-	25.9	100	102	21.8
Ruanda-Urundi[q]	7.2				7.2	100	133	8.3		8.3	635	1380	..
Tanganyika[d]	26.3				26.3	127	162	20.2	..	20.2	100	105	..
Uganda[d]	11.3				11.3	100	64	121.2	..	121.2	100	202	..
Zanzibar & Pemba	3.6				3.6	100	157	-	-	-	-	-	..
Rhodesia (Northern)	35.3[x]	205.5[x]	..	..	240.8	100	113	11.1	32	43.1	100	116	..
Nyasaland	11.7	-	8	5	11.7	123	202	0.6	-	0.6	100	200	1007[z]
Rhodesia (Southern)	480	21[x]	..	..	501	100	140	563	-	563	188	56300	..
Southern Africa:													
Mozambique[q]	36.8	37.7	..[f]	..[f]	74.5	128	175	47.4	-	47.4	100	378	..
Malagasy Rep.[y]	-	-	21.50	30.54	52.04	100	151	30.4	-	30.44	114	186	26.7[z]
Réunion	-	27.2[y]	4.6	0.40[y]	32.2	..	131[a]	3.7	0.2[y]	3.9	..	..	4.2
South Africa[u]	4193				4193	108[u]	108[u]	-	-	-	-	-	..
S.W. Africa	38	46	..[f]	..[f]	84	131	191[g]	-	-	-	-	-	..

Note: values printed spanning several columns (e.g. Algeria 253 across Steam; Cameroon 8 across Steam and Diesel; Dahomey 180[p] across both index columns) are placed in the first column of the span.

Note: Rhodesia (Northern), Nyasaland and Rhodesia (Southern) are bracketed together in columns 4, 5 and 14.

(a) Figures refer to public supply in 1960.
(b) Included in col. 2.
(c) Maximum simultaneous demand during 1961. At 31 December the corresponding figure was 149.6 MW.
(d) Refers to public supply only.
(e) Estimate and based on public supply only.
(f) Included in steam generating capacity.
(g) Based on 1957 = 100.
(h) Refers to total plant capacity of all kinds.
(i) Refers to 1961 (1957 = 100).
(j) Installed in mines.
(k) Estimated and referring to 1956 = 100.
(l) Refers to maximum demand for Monrovia in 1962.
(m) Refers to plant under controlled in S. Cameroons (to September 1961 only).
(n) Year ending 31 March 1961.
(o) Refers to 1960 and to index in col. 8 based on public supply in 1955.
(p) Refers to 1960 (1957 = 100).
(q) Refers to 1960 and to 1959 and 1956 = 100 respectively.
(r) Refers to 1959. Does not include self-producer's installations.
(s) Refers to hydro and thermal capacity combined.
(t) Refers to 1960.
(u) Refers to 1957 for Congo (Leopoldville) and, for S. Africa, to 1956 (with indices in cols. 7 and 8 based on 1955 = 100).
(v) Refers to 1957 (1955 = 100).
(w) Including 2 x 2.2 MW gas turbines.
(x) Refers to total thermal capacity.
(y) In kVa (KVA for Réunion) except for column 14.
(z) Refers to non-simultaneous demand.

Table 39

Total production potential of hydro-electric plants already in service (selected countries) in 1955 and 1961

Country	Mean annual producibility (yearly production potential under average conditions in 10⁶ kWh)				Seasonal storage energy capacity (10^6kWh)			
	Public supply		Self-producers		Public supply		Self-producers	
	1955	1961	1955	1961	1955	1961	1955	1961
1	2	3	4	5	6	7	8	9
Cameroon	..	..	..	..	..	..	..	..
Central African Republic	..	..	..	..	–	–	–	–
Congo (Leopoldville)	..	..	..	2000*	..	..	..	1500*
Ethiopia	75	200	20	30	15	150	–	–
Ghana	–	–	–	–	–	–	–	–
Ivory Coast	..	100	..	..	..	..	..	..
Kenya	145	145	–	–	–	–(b)	–	–(b)
Madagascar	–	175.9	–	–	–	83	–	–
Mali	0.7	1.0	–	–	–	–	–	–
Morocco	777	951	..	..	..	1100	..	..
Nigeria	..	..	..	..	..	..	..	..
Reunion	1.2	2.3	..	0.4	–	–	–	–
Fed. Rhodesia & Nyasaland	13	2229	205	243	..	..	..	..
Tunisia	–	26	..	..	–	45	..	..
UAR (Egypt)	..	..	..	..	..	..	..	..
Uganda	..	430	..	..	..	..	..	..

(a) Refers to total supply.

(b) Diurnal storage only.

Table 40

Hours of annual utilization of public supply hydro and thermal installed capacity in selected African countries

Country	1955		1960		1961	
	Hours of annual use		Hours of annual use		Hours of annual use	
	Thermal plants	Hydro plants	Thermal plants	Hydro plants	Thermal plants	Hydro plants
1	2	3	4	5	6	7
North Africa:						
Algeria	2,622	1,548	3,862	1,871	..	..
Libya	2,619	-	3,322	-	..	-
Morocco	..	2,652	..	3,210	..	3,279
Tunisia	2,668	..	2,562	1,787	2,982	..
Sudan	2,563	-	1,692	-	2,018	-
UAR (Egypt)	..	1,167(d)	3,080	777	3,273	2,891
West Africa:						
Cameroon (a)	..	..	..	5,543	..	..
Gabon	..	-	1,922	-	1,682	-
Chad	..	-	2,963	-	3,214	-
Gambia	1,733	-	1,500	-	1,700	-
Liberia (a)	5,000(b)	4,666(b)	3,375(c)	5,300(c)	..	..
Nigeria (a)	2,540	3,744	2,937	5,280	2,940	5,611
Sierra Leone	2,000	-	2,672	-	..	-
Togo	2,300	-	..	-	..	-
Dahomey	1,680(d)	-	2,133	-	..	-
Niger	2,273(b)	-	2,724	-	..	-
Senegal(e)	1,762(b)	-	2,268	-	2,235	-
Upper Volta	2,083(b)	-	1,773	-	..	-
North-East Africa:						
Ethiopia (a)	1,722	3,286	1,569	916	1,553	1,254
French Somaliland	1,700	-	3,000	-	..	-
Somalia	983	-	1,250	-	..	-
Central Africa:						
Angola	..	1,933	..	3,486	..	..
Congo(Leopoldville) (a)	..	4,080	..	..	..	..
Kenya	1,245(b)	6,834(b)	1,330	5,676	1,472	5,097
Tanganyika	2,154	4,031	2,951	4,653	2,700	4,619
Uganda	-	1,322	-	3,283	-	3,587
Zanzibar & Pemba	2,130	-	3,111	-	3,306	-
Fed.Rhodesia & Nyasaland						
- Nyasaland	931	4,333	2,632	5,333	2,829	3,167
- N. Rhodesia	2,900	2,600	2,756	1,982	1,190	2,252
- S. Rhodesia (a)	3,113	2,000	2,651	3,487	1,050	3,918
Southern Africa:						
Mozambique	1,699	..	1,146	..	..	..
Madagascar (e)	2,158	1,763	1,858	1,475	1,830	1,485
South Africa (e)	4,254	-	..	-	..	-
South-West Africa	..	-	2,467	-	2,263	-

(a) Refers to utilization of total capacity.
(b) Refers to 1956.
(c) Refers to 1959.
(d) Refers to 1957.
(e) Refers to total public supply production.

Table 41.

Total production and exchange of electric power in Africa in 1961. (10^6 kWh)

Country	Production				Cross frontier transfer	
	Thermal	Of which percentage from diesel plants	Hydro	Total	Import	Export
1	2	3	4	5	6	7
North Africa:						
Algeria (a)	1091	..	344	1435	-	-
Libya (b)	101.0	..	-	101.0	-	-
Morocco	79.0	-	951.0	1030.0	-	-
Tunisia	261	10	19.0	280.0	-	-
Sudan (a)	103.1	25*	-	103.1	-	-
UAR (Egypt)	2710	..	1012	3722	-	-
West Africa:						
Cameroon	12*	100	938*	950*	-	-
Central African Republic	0.1	100	9.3	9.4	-	-
Congo (Brazzaville) (a)	..	..	..	30.9	-	-
Gabon	21.7	31*	-	21.7	-	-
Chad	9.0	..	-	9.0	-	-
Gambia	5.1	100	-	5.1	-	-
Ghana	389.6	100	-	389.6	-	-
Liberia	91*	100	21*	112*	-	-
Nigeria (c)	427.2	26	6.9	434.1	-	-
Sierra Leone (d)	48.0	..	-	48.0	-	-
Togo	10.0	100	-	10.0	-	-
Guinea	..	..	..	27.0	-	-
Ivory Coast	19.4	10*	73.4	92.8	-	-
Dahomey	10.5*	100	-	10.5*	-	-
Niger	9.2	..	-	9.2	-	-
Senegal (a)	152	10*	-	152*	-	-
Mali	14.7	100	1.0	15.7	-	-
Upper Volta	10.0	..	-	10.0	-	-
North-East Africa:						
Ethiopia	55.8	50*	68.6	124.4	-	-
Somalia	12*	100	-	12*	-	-
French Somaliland	10.7	100	-	10.7	-	-
Central Africa:						
Angola (d)	31.4	..	111.2	142.6	-	-
Congo (Leopoldville)	100*	..	2500*	2600*	-	463
Kenya	83.2	70*	131.8	215.0	214 (e)	-
Tanganyika (a)	71.0	..	93.3	164.3	-	25*
Uganda (a)	-	-	434.8	434.8	-	191
Zanzibar & Pemba	11.9	..	-	11.9	-	-
Fed. Rhodesia & Nyasaland	1000	..	2475	3476	524	-
- N. Rhodesia	426	..	233	659.0	463	-
- Nyasaland	33	..	2	35	-	-
- S. Rhodesia (f)	576	..	2206	2782.0	61	-
Southern Africa:						
Mozambique (d)	47.1	..	100*	147.1	-	59
Madagascar	46.8	100	66.4	113.2	-	-
Reunion	43.4	26	2.7	46.1	-	-
South Africa (g)	24553	..	3	24556	..	..
Ruanda-Urundi (d)	13.1	..	5.6	18.7	-	-
South West Africa	208.0	..	-	208.0	..	..

FOOTNOTES (Table 41).

(a) Refers to public supply only.
(b) Refers to 1960 and to public supply only.
(c) Production of Electricity Corporation of Nigeria for year beginning April. Total production stated as 662 million kWh.
(d) Refers to 1960.
(e) This import, from hydro-electric production in the Katanga area of the Congo (Leopoldville), rose to 498 million kWh in 1962.
(f) Including Federal Power Board, Kariba.
(g) Refers to about 95 per cent of total production.

Table 42

Electric energy available for consumption in Africa in 1961 and its development since 1955

(10^6 kWh)

Country	Total available for consumption (1961)	Of which net import balance in 1961 (+ or -)	Hydro production as percentage of total production		Availability for consumption in 1961 as an index P	
			1955	1961	1955=100	1960=100
1	2	3	4	5	6	7
North Africa:						
Algeria(a)	1435	-	32	24	163	108
Libya(b)	101.0	-	-	-	164	..
Morocco	1030.0	-	88	92	..	104*
Tunisia	280	-	-	7	119	102*
Sudan(a)	103.1	-	-	-	230	116*
UAR (Egypt)	3722	-	-	27	261	..
West Africa:						
Cameroon	950*	-	74(c)	99	2380(c)	104*
Central African Republic	9.4	-	98	99	230	116
Congo (Brazzaville)(a)	30.9	-	..	..	..	117
Gabon	21.7	-	-	-	271	111
Chad	9.0	-	-	-	450	112
Gambia	5.1	-	-	-	215	112
Ghana	389.6	-	-	-	162	104
Liberia	112*	-	35	19*	368*	113*
Nigeria(d)	434.1	-	30(e)	15(e)	230(f)	118*
Sierra Leone(g)	48.0	-	-	-	..	..
Togo	10.0	-	-	-	270(a)	124(a)
Guinea	27.0	-	..	..	..	..
Ivory Coast	92.8	-	-	79	500*	133
Dahomey	10.5*	-	-	-	344	100
Niger	9.2	-	-	-	368(f)	116
Senegal(a)	152*	-	-	-	237	119
Mali	15.7	-	8	6	194	102
Upper Volta	10.0	-	-	-	400(f)	128
North-East Africa:						
Ethiopia	124.4	-	45	55	177(h)	124(h)
Somalia	12*	-	-	-	140*	106*
French Somaliland	10.7	-	-	-	177(i)	119

Table 42 (continued)

1	2	3	4	5	6	7
Central Africa:						
Angola(g)	142.6	-	42	78	278	..
Congo (Leopoldville)	2137*	-463	92	96*	180*	..
Kenya	429.0	+214	68	61	188	108
Tanganyika(a)	140*	- 25*	69	57	125*	107
Ruanda-Urundi(g)	18.7	-	30	30	217(g)	..
Uganda(a)	243.8	-191	99	100	545	103
Zanzibar & Pemba	11.9	-	-	-	243	106
Fed.Rhodesia & Nyasaland	4000	+524	10	71	175(j)	105
- N. Rhodesia	1122.0(k)	+463	18	35	55(j)	83
- Nyasaland	36.0	-	19	6	522(j)	124
- S.Rhodesia	2843.0(k)	+ 61	-	79	254(j)	116
Southern Africa:						
Mozambique(g)	88.1	- 59	..	68	280(i)	..
Madagascar	113.2	-	75	59	182	105
Reunion	46.1	-	19*	6	271(a)	..
South Africa	24556*	..	-	-	149	105
South-West Africa	208.0*	..	-	-	137(l)	109

(a) Refers to public supply only.
(b) Refers to 1960 and to public supply only.
(c) Based on 1956.
(d) Production of Electricity Corporation of Nigeria for year beginning 1 April. Total production stated as 662 million kWh.
(e) Based on total hydro and thermal production.
(f) Refers to 1956 = 100.
(g) Refers to 1960.
(h) Refers to 12 months ending 12 September of year stated.
(i) 1960 (1955 = 100).
(j) Based on production only.
(k) Owing to imports to N. Rhodesia from S. Rhodesia actual consumptions were 2274 and 1691 respectively.
(l) Refers to 1957 = 100.

Table 43

The part played by public supply in total electric power production and in total hydro-electric production respectively - 1955-1961 (provisional)

Country	1955		1961	
	Percentage of public supply output:		Percentage of public supply output:	
	In total production	In total hydro production	In total production	In total hydro production
1	2	3	4	5
North Africa:				
Algeria	100	100	100	100
Libya	100	-	100	-
Morocco	100	100	100	100
Tunisia	92	-	90	100
Sudan	100	-	100	-
UAR (Egypt)	57	100	82	100
West Africa:				
Cameroon	80*	100	7	4
Central African Republic	100	100	100	100
Congo (Brazzaville)	..	..	..	..
Gabon	100	-	100	-
Chad	..	-	..	-
Gambia	100	-	91	-
Ghana	24	- (a)	45	- (a)
Liberia	33	0	33	0
Nigeria	95	100	98	100
Sierra Leone	33	-	80	..
Togo	100	-	100	-
Guinea	..	..	..	..
Ivory Coast	..	..	..	..
Dahomey	..	..	..	..
Niger	100	-	100	-
Senegal	..	-	..	-
Mali	..	..	..	..
Upper Volta	100	-	100	-
North-East Africa:				
Ethiopia	82	100	84	90*
Somalia	85	-	90*	-
French Somaliland	..	..	..	..
Central Africa:				
Angola	60	100	69	77
Congo (Leopoldville)	4	4	12	11
Kenya	..	..	..	..
Tanganyika	..	..	..	..
Uganda	..	..	..	..
Zanzibar & Pemba	100	-	100	-
Fed. Rhodesia & Nyasaland				
- Rhodesia (Northern)	4	6	11	10
- Rhodesia (Southern)	96	100	97	100
- Nyasaland	100	100	100	100
Southern Africa:				
Bechuanaland, Bas. & Swaziland	..	..	..	..
Mozambique	40	-	77	100
Madagascar	92	100	72	100
Mauritius	38	100	38	100
Reunion	..	..	36	..
South Africa	..	-	..	-
Ruanda-Urundi	58	..	48(b)	..
South-West Africa	32(c)	-	41	-

(a) The total output is from self-producers.

(b) Refers to 1960.

(c) Refers to 1957.

Table 44

Main Specifications of Transmission Networks in service in 1961 (selected countries)

Country	Total length of internal transmission networks (circuit km)						Total Length (km)
	Below 70 kV		70-110 kV		Over 110 kV		
	Length	Voltage	Length	Voltage	Length	Voltage	
1	2	3	4	5	6	7	8
North Africa:							
Morocco	5885	20-60	-	-	1194	150	7079
Tunisia	2172	20-60	290*	90	-	-	2462*
Sudan	..	..	180	110	-	-	180
U.A.R. (Egypt)	..	63	..	..	..	132	..
West Africa:							
Cameroon	..	..	-	-	-	-	..
Central African Republic	88	63	-	-	-	-	88
Gambia	29	11	-	-	-	-	29
Ghana	..	Below 20	-	-	-	-	..
Liberia	145	69	-	-	-	-	145
Nigeria	..	..	674(a)	100	210(b)	100-200	884
Togo	-	-	-	-	-	-	-
Guinea	..*	60	..	..	-	-	..*
Ivory Coast	350	90-30	-	-	-	-	350
Dahomey	288*	..	-	-	-	-	288*
Senegal	400	30	150*	90	-	-	550*
Mali	57	15-30	-	-	-	-	57
Upper Volta	..	..	..	..	..	..	..
North-East Africa:							
Ethiopia	220	36-70			418	121-135	638
Somalia	..	..	-	-	-	-	-
French Somaliland	-	-	-	-	-	-	-
Central Africa:							
Congo (Leopoldville)	..	..	..	..	285(c)	300(c)	..
Kenya	820	33-66	-	-	400	132	1220
Tanganyika	70*	33	-	-	..	132	
Uganda	..	33-66	-	-	265(d)	132	..
Zanzibar & Pemba	..	..	..	..	..	..	..
Fed. Rhodesia & Nyasalaland	2590	33-66	1030	88-110	1450	330	5070
N. Rhodesia	..	..	..	..	..	330	..
Nyasaland	100	33	-	-	-	-	100
S. Rhodesia	1390	33-66	920	88-110	..	330	2310
Southern Africa:							
Malagasy Rep.	174	20-60	-	-	-	-	174
Réunion	274	15-63	-	-	-	-	274
South Africa	4350	33-66	3670	88	2645(e)	132-275	10665
S.W. Africa	..	..	..	..	..	..	..

(a) Includes 480 km under construction in 1960 at less than 100 kV.
(b) Includes 65 km under construction in 1960 at between 100 and 200 kV.
(c) Sited in Congo but owned by Rhodesian authorities.
(d) Relates to 132 and 66 kV combined.
(e) Of which 645 circuit-km at 275 kV.

Table 45

Main Specifications of International Interconnexions in service in 1961
(selected countries)

Country	Cross-frontier interconnexions			
	Territory with which connected	Voltage (kV)	No. of circuits	Year of entry into service
1	2	3	4	5
North Africa:				
Morocco	Algeria	22	..	..
Tunisia	Algeria	90	2	1953-1956 (2)
Sudan	-	-	-	-
UAR (Egypt)	-	-	-	-
West Africa:				
Cameroon	-	-	-	-
Central African Rep.	-	-	-	-
Gambia	-	-	-	-
Ghana	-	-	-	-
Liberia	-	-	-	-
Nigeria	-	-	-	-
Togo	-	-	-	-
Guinea	-	-	-	-
Ivory Coast	-	-	-	-
Dahomey	-	-	-	-
Senegal	-	-	-	-
Mali	-	-	-	-
Upper Volta	-	-	-	-
North-East Africa:				
Ethiopia	-	-	-	-
Somalia	-	-	-	-
French Somaliland	-	-	-	-
Central Africa:				
Congo (Leopoldville)	N. Rhodesia	220	1	1956
Kenya	Uganda	132	2	1958
	Tanganyika	33	1	1950
Tanganyika	Kenya	33	1	1950
Uganda	Kenya	132	2	1958
Zanzibar & Pemba	-	-	-	-
Fed. Rhodesia and Nyasaland				
- N. Rhodesia	Congo (Leopoldville)	220	1	1956
- Nyasaland	-	-	-	-
- S. Rhodesia	Mozambique	110	1	1957
	S. Africa	11	..	..
Southern Africa:				
Malagasy Republic	-	-	-	-
Réunion	-	-	-	-
South Africa	S. Rhodesia	11	..	..
S.W. Africa	..	..	..	..

Annexes I to III
are to be found attached to
Part I of this document

ANNEX IV

STRUCTURE OF ELECTRICITY SUPPLY TARIFFS IN SELECTED COUNTRIES

CENTRAL AFRICAN REPUBLIC: Tariff for Bangui (Francs)

LOW-VOLTAGE

Lighting tariff:

1st rate (35 hours of use)	= 1.00	P = 33.0
2nd " (36-70 hours of use)	= .08	P = 26.4
3rd " (above 70 hours of use)	= 0.75	P = 24.75

Tariff for handicrafts and small industry, air-conditioning and refrigeration:

1st rate (50 hours of use)	= 0.67	P = 22.0
2nd " (51-150 hours of use)	= .5	P = 16.5
3rd " (above 150 hours of use)	= 0.4	P = 13.2
Public lighting:	= .67	P = 22.0
Special night tariff for air-conditioning, water heating (from 9.30 p.m. to 5.30 a.m.)	= 0.4	P = 13.20

HIGH-VOLTAGE

Fixed charge corresponding to 50 hours of use per kW: 50 x 11.55	= 577.50	
Proportional charge	= 0.35	P = 11.55
Additional lighting charge	= 0.25	P = 8.25
Off-peak tariff	= 8.10	

- With rebate of 30% of the proportional charge for each kWh recorded by the off-peak meter.

- If off-peak consumption is below 5 hours the consumer loses any reduction for the month in question.

- Off-peak hours are defined as from 9.30 p.m. to 5.30 a.m.

- The right is reserved to modify off-peak hours according to the needs of operation, but taking into account that this period should include at least 2,920 hours per year.

ETHIOPIA:

The tariff rates are as follows:

1. GENERAL TARIFF

First	100 kWh per month	Eth.cents	15 per kWh
Exceeding	100 kWh per month	Eth.cents	10 per kWh
Service Charge,	single-phase	Eth.doll.	1 per month
	three-phase	Eth.doll.	5 per month

ETHIOPIA: (contd)

2. COMMERCIAL AND INDUSTRIAL TARIFF

First	1000 kWh per month	Eth.cents	10 per kWh
Exceeding	1000 kWh per month	Eth.cents	5 per kWh
Reactive Consumption, below cos φ = 0.89		Eth.cents	1 per kVArh
Maximum Demand Charge, per month		Eth.doll.	5 per kW
Service Charge, three-phase		Eth.doll.	5 per month

Rebate on total charges:

Exceeding	100,000 kWh per month	5%
"	400,000 " " "	10%
"	700,000 " " "	15%
"	1,000,000 " " "	20%

3. OFF-PEAK TARIFF

All Consumption	Eth.cents	5 per kWh
Reactive Consumption, below cos φ = 0.89	Eth.cents	1 per kVArh
Service Charge, three-phase	Eth.doll.	5 per month

Rebate on total charges:

Exceeding	100,000 kWh per month	10%
"	400,000 kWh " "	20%
"	700,000 kWh " "	30%
"	1,000,000 kWh " "	40%

The supply on this tariff is subject to special negotiations and to conditions of discontinuance of supply for certain periods.

FRENCH SOMALILAND:

- Structure of tariffs (in Fr.):	1st rate	2nd rate	3rd rate	4th rate
- Low voltage, domestic use and lighting	22	20	17	13 1/
- Power (general tariff):	18			
- High voltage (basic tariff):	14.5			

GABON (Libreville)

(A) ELECTRICITY:
(Lighting and domestic use)
Three-part degressive tariff:

	Frs.CFA per kWh.
- 1st rate - lighting and domestic use (0-40 hrs. monthly of the capacity subscribed)	33

1/ Reduced to 20, 18, 16 and 13 in 1962.

GABON (Libreville)	Frs.CFA per kWh.
- 2nd rate - 40-130 hours of use	30.5
- 3rd " - beyond 130 hours of use	21.5
Cooking:	
- single charge only	29
- uses other than lighting, domestic use and cooking (single charge only)	22
Industrial use: (high-voltage consumers)	
- single charge	16
Air conditioning: (2 possibilities)	
(1) Connected for lighting and domestic use (degressive):	
- 0-40 hours monthly use	33
- 40-130 hours monthly use	30.5
- beyond 130 hours monthly use	17
(2) Connected on a separate circuit (single charge)	17
(B) WATER:	
Water - per m^3	41

GABON (Port Gentil & Lambaréné)	Port Gentil per kWh	Lambaréné per kWh
Lighting and domestic use, power equal to or above 1 kVA:		
- 1st rate	34	45
- 2nd rate	15.3	30
Lighting for consumers with power below 1 kVA:		
- 1st rate	30.6	40
- 2nd rate	15.3	30
Power (low-voltage):	25.5	35
Public lighting:		
- 1st rate	23	40
- 2nd rate	13.8	40
Power (high-voltage)		
- proportional charge	14.5	22
- fixed payment	(5,830)	(6,000)
Special group:		
- proportional charge	7.6	-
- fixed payment	(12,725)	-

GHANA:

GHANA GOVERNMENT ELECTRICITY SUPPLIES - TARIFFS

Tariff	Class of Consumers	Rate	
1. Lighting	All Commercial and General Lighting Consumers	Accra, Tema, Kumasi and Sekondi-Takoradi ...	11d. per unit.
		All other Stations	1s. per unit.
		Minimum charge	£G1 per month.
2. Domestic	All Private Residences ...	(i) A monthly fixed charge as follows:-	
		Up to 500 sq.ft. of enclosed floor area	6s.
		For each additional 100 sq.ft.	
		Up to 1,000 sq.ft.	Add 1s.per 100 sq.ft.
		From 1,000 sq.ft. to 3,000 sq.ft. ...	Add 9.6d.per 100 sq.ft.
		From 3,000 sq.ft. to 5,000 sq.ft. ...	Add 8.4d.per 100 sq.ft.
		Over 5,000 sq.ft.	Add 6d. per 100 sq.ft.
		(ii) In addition a running unit charge of:- 2d. per unit in Accra, Tema, Kumasi and Sekondi-Takoradi. 3d. per unit in all other Stations. The assessed fixed charge is the minimum charge per month.	
3. Power ...	Commercial and Industrial Power Supplies other than Lighting ...	(i) A monthly fixed charge based on the brake horse-power or KVA installed with a minimum fixed charge of £G2 per month as the following tables:-	
		Up to 50 KVA or b.h.p.	10s.per KVA or b.h.p. or part per month.
		51 to 200 KVA or b.h.p.	8s.per KVA or b.h.p. or part per month.
		201 to 1,000 KVA or b.h.p.	6s.per KVA or b.h.p. or part per month.
		Over 1,000 KVA or b.h.p.	5s.per KVA or b.h.p. or part per month.
		The assessed monthly Fixed Charge is the minimum charge per month.	
		(ii) In addition a running unit charge of:- 2d. per unit in Accra, Tema, Kumasi and Sekondi-Takoradi. 3d. per unit in all other Stations.	
4. Flat Rate Lighting.		Charge per month per Lamp: Up to 40 Watts 4s. 6d. 60 Watts 6s.	

IVORY COAST (Abidjan & Bingerville)

High-voltage tariffs (from 20 April 1961) in Francs:

	0-250 kVA	251-500 kVA	501-1000 kVa	above 1000 kVA
(1) Annual fixed payment per kVA and per consumer	4,100	3,670	3,140	2,950
(2) Charge per kWh effectively consumed:				
Day (6 a.m. to 6.30 p.m.) 1st monthly charge for 0-50 hours of use..............................	10.4	9.9	9.4	9
2nd monthly charge for 51-125 hours of use..............................	9.4	8.3	7.3	7
3rd monthly charge above 125 hours of use..............................	6.2	5.2	4.1	4
Peak hours (6.30 p.m. to 9.30 p.m.)	13.6	13.1	12.5	12
Night (9.30 p.m. to 6 a.m.) 1st monthly charge from 0-25 hours of use..............................	9.4	8.3	7.3	7
2nd monthly charge from 26-70 hours of use..............................	7.8	6.8	6.2	5.8
3rd monthly charge beyond 70 hours of use..............................	5.7	4.7	3.6	3.4

(3) An annual guaranteed use of 1000 kWh per kVA and per consumer is implied for the above high-voltage tariffs.

(4) An increased tariff for users where the mean factor between two readings is below 0.8. This is defined by the reactive energy relationship. Where this is above 0.75 the increase is calculated as follows:

- between 0.75 and 1.00 : increase of 20%
- between 1.00 and 1.16 : increase of 40%
- between 1.16 and 1.35 : increase of 70%

If the relationship is higher than the last figure the Company can suppress completely the supply of energy until the consumer has improved the factor.

(5) Increase of consumption corresponding to transformer losses will be paid by consumers while the metering is in low-voltage.

Low-voltage tariffs

(1) Lighting and domestic use:

(a) For consumers where the factor is below or equal to 0.66 kVA, the energy will be sold at 20.9 Frs. per kWh.

(b) For consumers where the factor is above 0.66 kVA the energy will be sold at 26.2 Frs. per kWh.

(2) Domestic use without hourly restriction:

A special tariff of 12.5 Frs. per kWh will be allowed for air-conditioning, water-heating, electric cookers and washing machines.

(3) <u>Domestic use at off-peak hours</u> (11.30 a.m. to 2.30 p.m., and 8.p.m. to 7.00 a.m.)

A special tariff of 8.3 Frs. per kWh will be allowed to low-voltage users who consume exclusively during these periods for water-heating and air-conditioning purposes.

(4) <u>Public lighting</u>:

The price will be 12.5 Frs. per kWh, for consumption taken between 6.30 p.m. and 6.00 a.m.

(5) <u>Small power and handicrafts</u>:

The energy will be sold at 15.7 Frs. per kWh.

MALI:

At the beginning of 1962 a uniform tariff system has been set up taking into account the different types of use and following that of <u>Bamako</u>, according to the following principles:

- complete equality of treatment for all consumers;
- choice of a tariff system which will be compatible with the interests of small consumers to encourage the largest possible use of energy among the inhabitants;
- increase of the degressive aspects of tariffs by adjustment to the fixed charge.

HIGH VOLTAGE	Two-part Tariff		Fixed annual charge per kW	144 P or 5,760 Frs.
			Charge per kWh 1/ (Peak load	0.825P or 33 Frs.
			(During peak Hrs.	0.60 P or 24 Frs.
			(Off-peak Hrs.	0.45 P or 18 Frs.
	Single Tariff		Per kWh For power not above 25 kW	0.825P or 33 Frs.
LOW VOLTAGE	Lighting and domestic use		The 1st [illegible] month per [illegible]	P or 40 Frs.
			The next 30 hours per month per kWh	36 Frs.
			The remainder per kWh	26 Frs.
	Public lighting		The 1st 120 hrs of use per month [illegible] per kWh	36 Frs.
			The remainder	24 Frs.
	Power	Two-part hourly tariff	Fixed annual charge per kW	5,760
			Proportional Energy Charge 1/ (Ceak Load	36 Frs.
			(During peak hours	30 Frs.
			(During off-peak hours	24 Frs.
		Single tariff	Per kWh	36 Frs.

1/ The period of peak load is between 6 p.m. and 10 p.m. Peak hours are between 6.30 a.m. and 12.30 p.m. and 3 p.m. and 6 p.m. respectively. Off-peak hours are from 12.30 p.m. to 3 p.m. and from 10 p.m. to 6.30 a.m.

MALAGASY REPUBLIC:

The tariffs are of a degressive type with sectors for all high-voltage industrial energy. For low-voltage there are two main types of tariff:

- degressive, with sectors for all domestic uses;
- uniform, separately for lighting and domestic use.

MOROCCO:

The tariffs are two-part (with a fixed charge and an energy charge) per kWh.

REUNION:

The tariff structure is as follows:

Lighting and domestic tariff (Réunion except St. Denis, from 1 Jan. 1962):

Charge (FF.CFA)				Off-peak Tariff	Specifications (public supply)
1st rate	2nd rate	3rd rate	4th rate		1st 15 hours x P per month 2nd " " " " " " 3rd " " " " " " 4th beyond 45 hours per month
33.85 30.47	27.81 25.03	20.90 18.81	12.71 11.44	12.71 11.44	The charges include tax

Other low-voltage uses (Réunion except St. Denis):

Power			Lighting
1st rate	2nd rate	3rd rate	
28.46 25.61 (a)	22.41 20.17 (b)	17.74 15.97 (c)	(1st 600 hours x P per year - power) (2nd 1200 " " " " " ") (3rd beyond 1800 hours per year - power)
28.46 25.61	17.85 16.06	12.71 11.44	30.47 -1st rate with annual use 1,500 hr. 11.44 -2nd rate with annual use above 1,500 hr.

(a) At peak (600 hr).
(b) During peak hours (1,200 hr).
(c) During off-peak hours (above 1,800 hr).

REUNION: (Contd)

High-voltage tariff (Réunion, except St. Denis):

Fixed Annual Charge	At Peak	Single tariff During peak hours	Single tariff During off-peak hours	1st part	2nd part	3rd part
kVA						
4 824	19.73	13.20	7.59	18.88	14.70	7
1 296	-	13.20	7.59			
1 044	19.73	13.20	7.59			
324	-	13.20	7.59			
4 344	17.76	11.88	6.83	16.99	13.23	6
1 164	-	11.88	6.83			
936	17.76	11.88	6.83			
288	-	11.88	6.83			
5 868	22.19	13.97	8.29	22.19	16.45	8
2 340	-	13.97	8.29			
5 280	19.97	12.57	7.46	19.97	14.80	7
2 100	-	12.57	7.46			

TOGO:

The tariff structure is as follows:

Domestic lighting:

- from 0-100 hours — 35.7 Fr. CFA per kWh
- above 100 hours — 28.6 Fr. CFA per kWh
- Small users — 30.3 Fr. CFA per kWh

Low-voltage power:

- from 0-100 hours — 25.0 Fr. CFA per kWh
- from 100-300 hours — 21.4 Fr. CFA per kWh
- above 300 hours — 17.9 Fr. CFA per kWh
- Air-conditioning — 21.4 Fr. CFA per kWh

High voltage:

- Monthly charge for 35 hours per kW installed — 16.1 Fr. CFA per kWh
- Proportional charge — 16.1 Fr. CFA per kWh
- Supplement for high-voltage lighting — 17.9 Fr. CFA per kWh

---

TUNISIA:

The tariffs at present in force in Tunisia are an extension of those which were drawn up in connexion with the authorization given to the main Company for the production and distribution of electric power. The price of electric energy includes in general two elements:

- a fixed charge which applies to the subscribed power;
- a proportional charge per kWh.

Consumption is divided in several parts in which the magnitudes are related to the subscribed power. The tariffs for these parts are degressive in character. Each price is composed of three factors including a fixed item, a proportional item and an item proportional to average hourly salaries. There is thus a relationship between the cost of energy and that of basic materials and labour. Adjustments are made in principle every three months in agreement with the Control Administration.

Tunisia is divided into tariff zones for each of which a coefficient is allotted:

1. North region (Tunis, Cap Bon, Bizerta) - basic tariff with a coefficient of 1.
2. Western region and the region of Sousse - coefficient of 1.1.
3. Region of Sfax - coefficient of 1.15.
4. Region of Gabès and Gafsa - coefficient of 1.25.
5. Isolated networks supplied by local diesel plant - coefficient 1.30.

The tariff for each region is thus obtained by multiplying the basic tariff by the appropriate coefficient.

It would appear that the tariffs in force are not entirely adapted to the conditions of economic and industrial development of the country and could be modified A first study has been carried out by an Expert Commission under a consulting engineer. A detailed study is also being made in collaboration with the appropriate services of Electricité de France.

ANNEX V

SHORT SUMMARY OF PROSPECTS AND SCHEMES FOR ELECTRIC POWER DEVELOPMENT (SELECTED COUNTRIES)

CAMEROON

The future rate of annual increase in overall demand has been estimated at 12 per cent. Of the installed capacity of the hydro plant at Edéa 20 MW has been reserved to meet the general demand of Douala and Edéa. Another 30 MW from this plant is available for the needs of new consumers (15 MW guaranteed).

For the production of aluminium 105 MW of the Edéa plant have been reserved for that particular purpose. While electricity requirements were increasing rapidly up to 1959 for aluminium processing they have been somewhat more stabilized since 1960. The increase in requirements of the Youandé region, which are estimated at a similar rate to those for the Cameroon as a whole, will have to be satisfied by continuing to instal new diesel groups, as it will not be possible to build hydro plants or to connect the region to other networks with a sufficient capacity.

CENTRAL AFRICAN REPUBLIC

No economically exploitable mineral deposits have so far been discovered, although diamonds occur in some of the river beds. The only industrial plant is the Textile Mill at [illegible] near the Boali Falls, although there is also the Mocaf brewery in Bangui.

Most of the inhabitants cannot afford to use electricity and those that do restrict their consumption to a few electric light bulbs and possibly one radio. The rate of increase (19.4% in 1961) has, however, been very rapid. In view of the fact that local markets are too small to justify industrial plants and non-industrial demand so far is low, any scheme for overall electrification seems premature at the moment and demand is therefore continuing to be met by isolated power plants.

DAHOMEY

It is not considered probable that energy requirements will increase rapidly over the next 10 years or so. Dahomey relies entirely on the import of oil for the production of electricity and it is not considered that in the foreseeable future generation requirements will exceed 10 MW. The only important non-domestic demand is that of the port installations of Cotonou. Two new diesel plants (900 kVA each) will be installed to meet these requirements.

Although there is no plan to exploit fuel or hydro-electric resources it is intended to study the possibilities of building a barrage on the Mono for the double purpose of irrigation and electricity production.

ETHIOPIA

Iron ore deposits might contribute considerably to the consumption of electric energy. Investigations are being carried out for other mineral resources but their impact on electricity consumption cannot be forecast.

A rate of increase in consumption of at least 22 per cent is forecast by the Ethiopian Electric Light and Power Authority up to about 1967. To meet this rate of increase the Authority expects to put into service at least 95 MVA of hydro capacity and at least 5 MVA of thermal capacity. The grid system, operating at 132 kV, will be increased by at least 130 km. If any major industry were to be developed earlier than anticipated this would alter the situation completely.

In Asmara, SEDAO has under construction 10 MVA of steam capacity to meet the growing load. The corresponding network is at 50 kV.

The standardization and electrification of neighbouring countries can probably benefit from the abundance of hydro power in Ethiopia, in which case the financing of any projects would require international co-operation. There is much scope for investigations in connexion with mineral resources as potential users of electric power.

FRENCH SOMALILAND

The rate of increase of production at Djibouti has been 18.8 per cent between 1960 and 1961. The installation in 1963 of a new diesel group of 2.4 MW at the Djibouti plant is envisaged.

GABON:

With regard to the town of Libreville the forecast rate of increase in consumption is of the order of 30 per cent annually on the average. For the towns of Port Gentil and Lambaréne the annual increase is estimated as of the order of 7 per cent, corresponding to the normal increase of demand by consumers. This estimate is independent of special industrial development mentioned below. Studies for the development of paper pulp and cellulose industries are not yet complete. The same applies to projects for an oil refinery, a cement works and other new industries. There is also a possibility for development at Haut Ogooué for the direct reduction of iron ore in the Massif of Boka-Boka. This might necessitate international co-operation.

There is a project for the hydro-electric development of Kinguélé. A transmission network of around 100 km is also envisaged at 90 kV.

At Port Gentil and Lambaréné there is a project for an increased capacity of 3 MW, either by gas turbine or by three generating units using gas.

GAMBIA

No definite development plan yet exists and no special energy-intensive mineral or other resources are known. In respect of projects requiring international co-operation the import of electric power from Senegal to neighbouring villages up-river might be envisaged.

GHANA

The main mineral resources include bauxite, manganese, gold and diamonds, of which the processing of bauxite in the proposed smelter at Tema will be by far the most important, a maximum demand of 310.8 MW, at a load factor of around 99 per cent, being likely when the smelter is completed.

The Volta River Authority will also be involved in future development. From the present composition of the industrial and domestic load the expected rate of increase amounts to 15 - 20 per cent per year, the load being expected to rise to a gross total of 102.6 MW by 1966, before the smelter begins operation. The corresponding figure by 1970, including the smelter, is estimated to be 372.7 MW and by 1980 682.5 MW.

To meet this increase the Akosombo dam and power station, with a capacity of 768 MW - to which can be added, if necessary, 200 MW from Bui on the Black Volta and various smaller stations in the western region - is being developed.

The smelter project is already the result of international co-operation but the Ministry of Industries may have further plans of this type.

KENYA

There are no known mineral resources of special importance such as bauxite.

From past and recent trends, and bearing in mind experience in Nigeria and Tanganyika after independence with due weight for local conditions, the estimated rates of increase in net consumption are as follows:

1963:	7.5%
1964:	10%
1965:	10%
1966 to 1968:	15%

To meet this demand it is intended to instal additional oil-fired steam plant at Kipevu on the coast. It is expected to draw another 15 MW of hydro power from Uganda Electricity Board for the main areas of the highlands, afterwards developing the major Seven Forks scheme on the Tana river (240 MW), filling any gaps with peak-lopping thermal plants using oil and based on Nairobi. At the same time minor towns, newly electrified in areas remote from present transmission lines, will be equipped with small diesel plants until their development justifies their connexion to a grid system. The only major grid in use is the double-circuit Tororo - Nairobi 132 kV line, but 33 kV and 11 kV transmission is used extensively to link minor centres with main transmission centres. Any major grid linking the main supply areas of Kenya, and also linking Uganda and Tanganyika with Kenya, will need to be of the order of 275 or 330 kV. Considerable local load development is needed before such a grid could be economically justified.

Kenya imports bulk supplies from Uganda Electricity Board at Jinja under a 50-year agreement. Further co-operation has been considered.

MADAGASCAR

Mineral reserves likely to require an important consumption of electric power include:

Chromite: deposits of Ranomena (reserves of 100,000 tons at surface and 150,000 tons sub-surface). Also deposits of Ambodiriana and Andriamena.

Nickel: deposits of Valogora, giving 70,000 tons of nickel.

Bitumin: deposits of Bemolanga, giving one milliard tons of bitumin.

The principle adopted for future growth of consumption assumes a doubling every 10 years (7.2 per cent per annum).

The plan for Madagascar is in course of preparation and numerous preliminary plans have been studied. The present programme, as follows, has a limited objective:

- hydro-electric plant of Beantsy, installed capacity 525 kW, giving 4 million kWh per year, with lines of 35 kV linking the plant to the town of Tuléar (Cost: 128 million CFA);
- power line Tananarive-Antsirabe (60 kV), with a link of 135 km and costing 400 million CFA;
- hydro plant of the Little Namorona, with an installed capacity of 1.8 MW and giving 14 million kWh. There will be a 50 km line at 35 kV costing 300 million CFA.

Any of the projects relating to the exploitation of chromite, nickel and bitumin already referred to would be likely to require international assistance. It would be useful if ECA could assist in the study of sites on the rivers Ikopa (5 developments) and the Betsiboka (2 developments).

MALI

Rich bauxite deposits are known in the regions of Satadougou and Kita (800 million tons with an Al_2O_3 content of between 40 and 45 per cent and silica content below 4 per cent).

It is therefore the intention to study conditions for establishing an electro-metallurgical complex in relation with hydro-electric development. Near to Kayes on the Senegal the two adjoining sites of Gouina and Galougo appear interesting in this connexion since the cost of hydro power appears to be competitive for industrial purposes if part of the investment could be allocated to agriculture and navigation. A further possibility for a medium size dam on the Bakoy has also been emphasized.

Independently of these important possibilities the forecast rate of increase for total electric power consumption in the immediate future is considered to be of the order of 15 per cent per year.

NIGERIA

In 1965/66 the energy generated by the Electricity Corporation of Nigeria will rise to 1112 GWh, implying a mean rate of consumption growth of 20 per cent from the figure of 448 GWh in 1960/61 (figures refer to the year beginning 1 April).

However, the rate of development after 1965 will be influenced considerably by:

(a) the availability of loan capital;

(b) the rate of industrial development together with the possible establishment of an integrated iron and steel works and an aluminium smelter.

Among industrial fields of special importance for energy consumption about 50 per cent of the excavating for tin and columbite production is undertaken by mechanical means using electricity, the power being produced at hydro-electric stations. By March 1961 the average daily load was between 13 and 15 MW.

The Embel Tin Smelter at Jos in Northern Nigeria uses electric furnances for smelting tin. At present only two furnaces can be used owing to shortage of electric power but the number may be increased to 8 as soon as possible.

The reserves of tin and columbite are estimated as 137,000 tons and 68,000 tons of ore respectively. At present these reserves would last for some eleven years, but the estimates are probably incomplete and the probable life of mining is considerably greater.

The requirements supplied by the Electricity Corporation of Nigeria are expected to develop from 182.76 MW of thermal capacity and 1.72 MW of hydro capacity as at 1961 (the latter located in the Cameroon), of which 13 per cent was inter-connected, this total of 184.48 MW rising to 223 MW (maximum demand generated) in 1966 (83 per cent interconnected).

By 1965 it is planned to extend the transmission network under 100 kV from 420 miles circuit length to 700 miles; that between 100 and 200 kV from 130 to 430 circuit miles; and above 200 kV 350 miles (plus 480 miles under construction) will be installed.

By 1967 the Afam 80 MW gas turbine plant should be brought into service; also the Ughelli gas turbine plant (60 - 80 MW). The Niger Dams Hydro scheme (initially 320 MW) should also be completed by 1967/68.

MOROCCO

Among the factors leading to a notable increase in consumption of electricity is the prospect for the development of a superphosphate chemical complex at Safi, together with a steel-producing installation foreseen at Nador and an electro-chemical project also foreseen at Meknes, as well as the extension of existing phosphate mines.

Total consumption in 1962 corresponds to a production of 1,088 GWh. Since production possibilities are due to be increased to 1,388 GWh the immediate consumption requirements can be provided for by the existing plants.

REUNION

There are no known mineral resources which would constitute an important source of electric power consumption.

During the last decade public consumption has increased at an average annual rate of 17.5 per cent. It is probable that this rate will be maintained for some years although it is thought that it might decline a little later on.

Detailed studies for the Takamaka scheme on the Marsuran river, which would give 16.5 MW and 78 million kWh annually, would allow future needs to be met over the next ten years. However, this plant cannot be brought into service before the beginning of 1967 and existing means of production are likely to be insufficient after 1964. A new diesel group of 3.3 MW is, however, in course of installation at the St. Denis plant.

TOGO

No mineral or other resources are known which would constitute an important source of electric power consumption.

Development of the river Mono has been the subject of an application (Togo - Dahomey) to the UN Special Fund. Development of the basin of the Oti is also possible but has not yet been envisaged.

FEDERATION OF RHODESIA & NYASALAND (N. Rhodesia, Nyasaland and S. Rhodesia)

The hydro power of the Zambezi allows increased production of copper, zinc and lead to be envisaged in Rhodesia.

In N. Rhodesia increased production of electricity would be particularly developed for meeting mining requirements. In the three territories the four main sources of demand to be met may be summarized as:

- the local needs, which are growing, of the most important urban areas;
- the encouragement of industrial growth;
- the increase in production and modernization of agricultural output; and
- the need to give favourable conditions for the development of surface transport facilities.

SENEGAL:

The Bel-Air thermal plant at Dakar (12.8 MW) is expected to be able to satisfy the increase in demands for power until 1965-66. It is expected that there will be an 80 per cent increase in consumption in the 5-year period ending 1964. Most of the increased requirements will be required for setting-up industries requiring large amounts of power including the phosphates installation of Taiba and a textile industry, as well as for the extension of cement production.

Most of the increased requirements are likely to occur in the region of Thiès. In order to improve the security of power supply it would be useful to extend the high voltage inter-connexion network to the areas of Fatick, Kolack and Bambey.

SOMALIA

Substantial deposits of iron ore have been confirmed in the southern area of the country and some prospecting for oil has of late been in progress. Transport facilities are not plentiful and the demand for electric power seems for the present likely to continue to be met by small scale scattered generating units requiring relatively small quantities of fuel, which is costly to transport.

SUDAN

There appears to be no long-term plan so far for the development of consumption requirements. A petroleum refinery is envisaged at Port Sudan and other factories, including a sugar refinery, are planned. The rapidly growing demand for electric power appears to be covered until 1964. There are in all some nine projects for developing hydro power in conjunction with irrigation, but apparently large-scale development in this field is not so far envisaged for the immediate future. Large-scale projects of 100 MW or more appear to be possible.

In conjunction with deposits of copper ore, small quantities of uranium have been found in the region of Darfur and Bahr-el-Ghazal. A considerable amount of electricity production appears to be possible from sugar cane and cotton wastes.

TANGANYIKA

There are some 250 million tons of coal reserves in the Southern Highlands but at present no known reserves of liquid or gaseous fuels.

Low-cost energy is available from the hydro-electric project of Hale, near Tanga, which should be available by 1964 to supply two main industrial centres of Tanga and Dar-es-Salaam. This scheme would give 21 MW and 95 million kWh per year. From 1967 the rising demand in these areas is expected to absorb the capacity of the Pangani Falls and of Hale, and a further source of supply will have to be developed. Other schemes which would be available include the Moshi No. 2 project (13.5 MW), giving 55 million kWh per year, and a further hydro potential giving up to 8 MW, or around 33 million kWh per year, would allow supplies to meet the industrial requirements of Arusha and Moshi and to further irrigation.

In the more distant future a development of the Roufiji river could give 500 MW. On the river Malagarasi, at 160 km from Mpanda, a hydro-electric scheme may be necessary to supply the exploitation of lead in the area.

In the industrial region south of Lake Victoria and the Southern Highlands where, in addition to coal and iron, diamonds exist and cotton production and a paper factory could be set up, the cost of energy is at present higher than elsewhere owing to transport charges.

UGANDA

Although it has been estimated that demand might increase at 10 per cent per year, requirements can be covered for a certain time by the output from the Owens Falls plant, which in case of necessity could be extended to 150 MW. There is a possibility for the construction of a 180 MW scheme downstream from Owen Falls and other possibilities exist on the Victoria, Nile and other rivers. The transport system is well developed and low-cost energy is available within the country.

The present interconnected supply system serves the main towns in the areas around Lake Victoria, the Nile, the Elgon and Mbarara regions, including the cities of Kampala, Entebbe and the industrial centre of Jinja. It is planned to extend the transmission system in order to further electrification and to increase the total market for power. Although at the moment there is a temporary excess of supply, the power sold under a 50-year contract to the Kenya Power Company is the only export at present. The neighbouring countries of Congo (Leopoldville), Rwanda, Burundi, Tanganyika and the Sudan are not so far supplied with energy from Uganda's hydro-electric resources.

ANNEX VI

SHORT SUMMARY OF ORGANIZATION OF ELECTRIC POWER SERVICES (SELECTED COUNTRIES)

ALGERIA

Electric power questions fall under the Ministry for Industry and Energy, in which there is a Department for Energy and Fuels.

The organ responsible for electricity supply is the EGA (Electricité et Gaz d'Algérie) with headquarters in Algiers.

CAMEROON

The Régie d'électricité et d'eau, which falls under the Ministry of Public Works, is responsible for production, transmission and sale of electricity in the three towns of Yaoundé, Nkongsamba and Maroua, all with diesel production. All investments are made through the Government.

L'Energie électrique du Cameroun (Enelcam), a private Company, supplies electricity to Edéa, Douala, and the aluminium plant of the Compagnie camerounaise de l'aluminium (Alucam) through the hydro plant on the Sanaga and from diesel plants.

Other towns (except Dschang, which possesses a small hydro plant) are supplied by small diesel plants utilized for the most part by the appropriate municipal authorities.

DAHOMEY

The production and distribution of electric power for the regions of Cotonou, Porto-novo and Ouidah are assured by the Compagnie coloniale de distribution d'énergie électrique (CCDEE), a private Company operating under government concession.

ETHIOPIA

(a) Ethiopian Electric Light and Power Authority, Addis Ababa is a government-owned corporation created by Imperial Charter in 1956. The Authority is responsible for generating, transmitting and distributing electrical energy in Ethiopia. At present its activity extends over most of the important provincial towns.

(b) SEDAO is the biggest privately-owned shareholder's company, address Asmara, Ethiopia; its main activity centres on Asmara and Massawa. The Company is responsible for the generation, transmission and distribution of electrical energy.

(c) There are a number of privately-owned enterprises generating their own electricity for industrial purposes.

In 1961 Ethiopian Electric Light and Power Authority produced 59% of the total, 24% was produced mainly by SEDAO in Eritrea and the remaining 17% was produced by private industrial enterprises.

(d) The Awash Valley Authority is responsible for multi-purpose development of the Awash river basin.

UAR (Egypt)

The Ministry of Public Works is responsible for electric power development. There is also an Electricity Commission for the UAR.

This Commission has set up a Technical Bureau for the Study and Execution of UAR Electrification Projects, with headquarters in Cairo. This body undertakes planning, design and implementation of Egypt's interconnected power system.

Another separate body is the Hydro-electric Administration, which is in charge of the existing Aswan hydro-electric plant and other hydro schemes.

The largest organization for electric power production, which is a government enterprise, is the Cairo Electricity and Gas Administration.

FRENCH SOMALILAND

Responsible Ministry: Ministry of Public Works, Service des Mines.

Company responsible for production, transport and distribution is Electricité de Djibouti, the public supply undertaking responsible for production and distribution in Djibouti and Arta.

GABON (Libreville)

Ministry responsible: Ministry of Public Works.

Company responsible for production, transport and distribution: Compagnie Centrale de Distribution d'Energie Electrique.

(Port Gentile & Lambaréné):

Competent ministerial department: Ministry of Public Works - Control for distribution of electric energy.

Companies responsible for production, transmission and distribution:

Société d'Energie de Port Gentil. Limited Company dealing with:

- production and distribution of electricity and water at:

Port Gentil
Lambaréné since 1962
Moanda since 1963
Oyem since 1963

- production and distribution of electricity at:

Bitam since 1963
Mouila since 1963

Public body responsible for certain special development projects for multi-purpose water use: Société d'Energie de Port Gentil i.e. for the:

- hydro-electric plant at Kinguélé
- development of Haut Ogooué
- development of the Nyanga.

GAMBIA

The competent Ministry is:

Ministry of Works and Services, Electricity Department, Bathurst.

Corporation responsible for production, transmission and distribution: NIL.

Public bodies responsible for multi-purpose river basin development projects: NIL.

GHANA

Electricity generation for public supply is carried out by the Electricity Division, which forms a branch of the Ministry of Communications and Works. Separate generation is carried out by the mines to a considerable extent, and by private users such as hospitals, certain factories etc. on a very small scale, but there are no details of the amounts generated or the potential load of these smaller plants.

The Electricity Division is responsible for production, transmission and distribution throughout Ghana and has its Head Office in Accra.

KENYA

The competent Ministry and government department is the Ministry of Commerce and Industry, Nairobi.

Corporations responsible for production, transmission and distribution:

East African Power Co. Ltd. (EAP), Kenya Power Co. Ltd.

LIBERIA

Most of the electricity supply in Liberia is from organizations under government control, the controlling authority being the Monrovia Power Authority. In addition, private generating plants are operated by the Liberian Mining Company (Iron ore mines) and a hydro-electric plant is operated by the Firestone Rubber Co.

MADAGASCAR

The responsible services are:

1. Ministère d'Etat Chargé de l'Economie Nationale.
2. Direction des Mines et de l'Energie.
3. Service Autonome de l'Energie.

Companies for production, transport and distribution:

Société Electricité et Eaux de Madagascar (E.E.M.), Paris.

La Société d'Energie de Madagascar (S.E.M.), Tananarive.

MALI

Competent Ministry: (responsible for overall questions)

Ministère des Travaux Publics, des Télécommunications, des Mines, de l'Habitat et des Ressources Energétiques.

Corporation responsible for production, transport and distribution throughout the country:

Energie du Mali, Société Nationale d'Economie Mixte, under Concession.

Various special projects for the multi-purpose development of water-courses, with particular reference to electricity production, have been set up by technical missions and by the local hydraulic services.

MOROCCO

Ministry: Ministry of Public Works

Companies charged with the production and transport of electric energy:

- Energie Electrique du Maroc (E.E.M.) (Paris)

Principal companies responsible for the distribution of electric power and to which l'Energie Electrique du Maroc sells a part of the energy produced:

- S.M.D. : Société Marocaine de distribution - distributes electricity in the towns of Rabat, Sale and Meknes.

- R.A.D. : Régie Autonome de distribution
  Régie Municipale de Casablanca - distribution in all parts of Casablanca.
- S.E.K. : Société d'électricité de Kénitra
  Limited Company charged with distribution in the sector of Kénitra.
- Compagnie FASI d'électricité - Limited Company charged with distribution in the sectors of FES and SEFROU.
- Société d'électricité d'El Jadida - Limited French Company charged with distribution for the village of El Jadida.
- Société d'électricité de Safi - Limited French Company for distribution in the village of SAFI.
- E.E.B.M.: Electric enterprise in the region of Marrakech
  Limited Moroccan Company charged with the distribution in the surrounding area of Marrakech.
- E.E.Z.M.: Electric enterprise of Zénatas Mohammédia
  Limited Moroccan Company charged with distribution in the sectors of Zénatas and Mohammédia.
- S.C.E. : Société Chérifienne d'Energie
  Limited Moroccan Company.
- R.E.I. : Régie des Exploitations Industrielles

The last two organizations provide more particularly for the small centres of the interior.

The organization dealing particularly with hydraulics is l'Office National des Irrigations.

NIGERIA

The information for Nigeria is that supplied by the Electricity Corporation of Nigeria, which began operation in 1951 following Government legislation in 1950. The information given by the Corporation falls under public supply. The Corporation's year begins on 1 April and ends on 31 March of the following calendar year.

REUNION

Competent Ministry:

Ministère français de l'Industrie
Direction de l'électricité

Companies responsible for production, transmission and distribution of electricity are:

Société Anonyme d'Energie Electrique of Réunion at St. Denis, which has authority for the public supply of electricity throughout the island and for the public distribution of electric energy in all communes except that of St. Denis. At St. Denis the public supply distribution is undertaken by the private Company Bourbon-Lumière.

SENEGAL

The "Compagnie des Eaux et Electricité de l'Ouest Africain" (Private Company founded in 1950), is responsible for the production and distribution of electric energy in the western region of Senegal.

SUDAN

There is a Ministry of Irrigation and Hydro-electric Power which has its headquarters in the Gezira region.

The Central Electricity and Water Administration, in Khartoum, is the responsible body and supplies electricity in the Khartoum area and as far south as Sennar. This body was set up in 1959 to replace the Sudan Light and Power Ltd., and the WadMedani Light & Power Co. Ltd.

TANGANYIKA

The "Tanganyika Electric Supply Co. Ltd." (TANESCO), a private Company, is solely authorized by the government for the production, distribution and sale of electric energy.

TOGO

The responsible Ministries are:

The Ministry of Public Works, Mines, Transport, Posts and Telecommunications.

Companies responsible for production, transmission and distribution of electric energy are:

- Union Electrique d'Outre-mer (UNELCO), which covers production and distribution in the urban areas of Lomé and Anécho.
- Energie Electrique du Togo, a Company for the production and transmission of energy at Kpimé.

FEDERATION OF RHODESIA & NYASALAND: (N. Rhodesia, Nyasaland and S. Rhodesia)

The Electricity Act, 1956, as amended, provides the legal framework of the electricity supply industry in the Federation and is administered by the Federal Ministry of Power.

Electricity undertakings in the Federation comprise the following:

(a) the Federal Power Board

(b) private undertakings

(c) licensees, and

(d) local authorities.

All undertakings, except the Federal Power Board, private undertakings and local authorities which supply electric power within the area under their jurisdiction only, require a licence to supply electricity.

The Federal Power Board is a statutory body established in terms of the Electricity Act. Its first function was to construct the Kariba hydro-electric project in order to supply power in bulk to other undertakings. The Board also has the duty of investigating further facilities for bulk supplies of power in the Federation. Power is transmitted from Kariba over a 330 kV system to Lusaka, Kitwe (serving the Northern Rhodesia Copperbelt and Ndola), Norton (serving the Salisbury area), Sherwood (serving the area supplied by the Southern Rhodesia Electricity Supply Commission), and to Bulawayo. The Act empowers the Board to interconnect its main transmission lines with the generating stations of any licensee or local authority. The Board controls the output of such stations and meets the cost of generating electricity at these stations. At present the interconnected generating stations are Salisbury, Umniati, Bulawayo and Lusaka.

Private undertakings do not require to be licensed in terms of the Electricity Act, though the consent of the Minister of Power must be obtained before power can be supplied to other persons. They have to be constructed and maintained in accordance with regulations and private undertakings must comply with any requirements of the Minister for the purpose of facilitating co-ordination with existing or future undertakings. Private undertakings may be divided into two categories:

(a) an undertaking for the generation or supply of electricity for use solely or mainly on the owner's premises or for the purposes of his business, being a business other than a business for the supply of electricity;

(b) an undertaking or undertakings for the generation or supply of electricity operated solely or mainly in the interests of a group of associated companies for the purposes of the businesses of these companies.

The Electricity Act also provides for the establishment of an Electricity Supply Commission in each of the three territories of the Federation. The functions and duties of Electricity Supply Commissions are to generate, acquire or supply electricity within their territories and in consultation with the Federal Power Board to investigate new and additional facilities for the supply of electricity and for the co-ordination of existing undertakings.

The Southern Rhodesia Electricity Supply Commission owns power stations at Umniati, Shabani, Gwanda and Umtali, and a small diesel station at Chipinga. It owns over 7,000 miles of transmission and distribution lines which supply power to a very large area including most of the smaller local authorities in Southern Rhodesia. Larger municipalities such as Fort Victoria, Gatooma, Gwelo, Que Que and Umtali purchase the whole of their electricity requirements in bulk from the Commission and carry out distribution within their respective areas of supply. The Commission also supplies a larger number of mines, farms and domestic consumers.

The Nyasaland Electricity Supply Commission is the successor of the Nyasaland Government Department of Electrical Services. The Federal Government provides the capital requirements for the Commission's undertakings in the Southern Province and at Lilongwe, Fort Johnston and Mzuzu.

An Electricity Supply Commission was not established in Northern Rhodesia and there has, therefore, been no need to re-allocate financial responsibility between the Federal and Territorial Governments for development of electricity distribution there.

As stated above a local authority does not require a licence to supply electricity within the area under its jurisdiction, and no undertaking may supply electricity within the area under the jurisdiction of a local authority without its prior consent. If, however, a local authority supplies electricity outside the area of its jurisdiction it does require a licence. The Territorial Governments of Northern and Southern Rhodesia are responsible for making capital available to local authorities to meet their requirements for electricity development.

The Electricity Act provides for the establishment of an Electricity Council in each territory. The functions of these Councils are to advise the Minister of Power on matters relating to the issue and amendment of licences and on tariffs to be charged by licensees.

TUNISIA

(a) Le Secrétariat d'Etat au Plan et aux Finances is responsible for electric power and controls its production and distribution.
Production and distribution for the whole of Tunisia is undertaken by the Sociéte Tunisienne de l'Electricité et du Gaz, with headquarters at Tunis.

(b) This is a national organization set up by the State and is exclusively responsible for the development of electric energy in Tunisia.

(c) Le Secrétariat d'Etat à l'Agriculture is responsible for development of water-courses for purposes of irrigation. It is responsible for barrage construction and additionally, in cases where it is economic, for associated electric power installations.

UGANDA

The public organ responsible for the production and distribution of electricity is the "Uganda Electricity Board" (UEB) which is situated in Kampala.

ANNEX VII

SUMMARY OF ANNUAL CAPITAL INVESTMENT FOR ELECTRIC POWER SUPPLY BETWEEN 1955 AND 1961. (SELECTED COUNTRIES)

ETHIOPIA

The total figures below exclude expenditures of self-producers. The expenditures - for the Ethiopian Electric Light & Power Authority - are in Ethiopian dollars:

$ 1,538,000	for 1958
$ 1,408,000	" 1959
$35,939,000	" 1960
$ 2,106,000	" 1961

GABON

Refers to the system of Port Gentil-Lambaréné.

Investment for thermal plants amounted to 92 million Frs. This figure refers to plant investment only through the Société d'Energie de Port-Gentil.

GHANA

Including the Tema development project average capital expenditure per year between 1955 and 1961 was £G 782,000. This figure represents the amounts available from development funds, annual votes and covers thermal power plants, transmission and distribution.

KENYA

The fixed assets and annual investment for The East African Power and Lighting Company Limited and The Kenya Power Company Limited, from 1955-1961, are set out in Tables 1 and 2.

MALAGASY REP.

The annual investment between 1950 and 1960 of the various electric power undertakings was as follows:

Companies	Millions of Francs CFA
Electricité et Eaux de Madagascar	2,457
Société d'Energie de Madagascar	1,889
Electricité de la France Australe	80
Others	28
TOTAL:	4,454

Table 1.

The East African Power and Lighting Company Limited

Year		Thermal Plant	Hydro Plant	Transmission Lines	Distribution Lines	Total
1955	Opening Balances	2,475,674	2,768,425	391,820	2,840,622	8,476,541
	Additions/ Deletions	741,503	-2,641,288	303,131	- 440,978	-2,037,632
		3,217,177	127,137	694,951	2,399,644	6,438,909
1956	Additions/ Deletions	789,316	1,819	2,659	378,106	1,166,582
		4,006,493	128,956	692,292	2,777,750	7,605,491
1957	Additions	88,498	1,148	34,017	371,702	495,365
		4,094,991	130,104	726,309	3,149,452	8,100,856
1958	Additions/ Deletions	- 182,049	Nil	69,190	422,097	309,238
		3,912,942	130,104	795,499	3,571,549	8,410,094
1959	Additions/ Deletions	- 254,290	98	380,474	179,736	306,018
		3,658,652	130,202	1,175,973	3,751,285	8,716,112
1960	Additions/ Deletions	166,274	112,041	673,898	- 350,933	601,280
		3,824,926	242,243	1,849,871	3,400,352	9,317,392
1961	Additions	468,386	942	135,663	211,956	816,947
	Closing Balance:	£4,293,312	234,185	1,985,534	3,612,308	10,134,339

Table 2.

The Kenya Power Company Limited

Year		Hydro	Main Transmission	Total
1955	Assets Acquired and Additions	2,800,216	697,220	3,497,436
1956	Additions/Deletions	- 22,557	2,068,418	2,045,861
		2,777,659	2,765,638	5,543,297
1957	Additions/Deletions	- 11,691	1,167,814	1,156,123
		2,765,968	3,933,452	6,699,420
1958	Additions/Deletions	- 9,605	4,609	- 4,996
		2,756,363	3,938,061	6,694,424
1959	Additions/Deletions	7,587	- 5,201	2,386
		2,765,950	3,932,860	6,696,810
1960	Additions/Deletions	687	254,561	255,248
		2,764,637	4,187,421	6,952,058
1961	Additions/Deletions	- 871	- 6,784	- 7,655
	Closing Balances:	£2,763,766	4,180,637	6,944,403

MALI

Gross annual investment for electric power over the period 1955-1961 was as follows:

Thermal plants	35 million Frs. Mal.
Hydro plants	-
Transmission	-
Distribution	15 million Frs. Mal.

MOROCCO

The total annual investment (gross) has been:

111 million dirhams.

NIGERIA

Average annual capital expenditure (1956 - 1961) was:

Plants (thermal & hydro):	£1,034 million.
Transmission & Distribution:	£0,931 million.

FEDERATION OF RHODESIA & NYASALAND

The gross expenditure for the period 1953-1961 in the electricity supply industry (generation, transmission and distribution) was approximately £133,000,000 (Rhodesian).

REUNION

Over the period 1955-1961 investments for public supply production and distribution of electricity have been:

Diesel plants:	59 million Frs. CFA
Hydro-electric plants:	702 million Frs. CFA
Transmission lines (at 63 kV):	115 million Frs. CFA
Distribution network:	405 million Frs. CFA

TOGO

Annual gross investment over the period was:

Diesel plants:	220 million Frs. CFA (1955-1961)
Hydro-electric plants:	310 million Frs. CFA (Kpimé)
Transmission:	170 million Frs. CFA (1955-1961)
Distribution:	134 million Frs. CFA

ANNEX VIII

CHARACTERISTICS OF SOME IMPORTANT INDIVIDUAL THERMAL GENERATING PLANTS (SELECTED COUNTRIES)

Country	Name of Plant	No. of units and unit capacity (MW)	Year of entry into service	Steam conditions: Pressure (kg/cm^2 or lb/in^2)	Steam conditions: Temperature in °C or °F	Maximum load supplied (MW)
ALGERIA	Alger Port	120 (2 x 60)	..	89	540	
ETHIOPIA	Addis Ababa	1 x 6.25 MVA	1957	29	425	5
GABON	Port Gentil	3 (8 MVA)	1950–58	32	400	2.85
GHANA	–	–	–	–	–	–
KENYA	Kipevu	3 x 5	1956–61	450 (lb/in^2)	750 (°F)	12
MOROCCO	Roches Noires Sud	2 x 16	1952	50	460	204 (production in 10^6 kWh)
REUNION[a]	Le Gol	1.55 (MVA)	1958	–	–	2.04
	Ravine Creaze	1.50 (MVA)	1954	–	–	2.84
	La Mare	5.28 (MVA)	..	–	–	6.20
FED. RHODESIA & NYASALAND						
S. RHODESIA	Bulawayo No. 1	10–30 (MVA) 148.5	1939–45	200 (lb/in^2)	600 (°F)	..
	Bulawayo No. 2	20–37 (MVA)	1948–55	600 (" ")	850 (")	..
	Salisbury No. 1	4–10 (MVA)	1934–42	200 (" ")	640 (")	..
	Salisbury No. 2	9.35–25 (MVA) 153	1946–55	375 (" ")	775 (")	..
	Salisbury No. 3	37.5 (MVA)	1957	600 (" ")	865 (")	..
	Umniati	120	1947–55	400 (" ")	800 (")	..
N. RHODESIA	Nchanga	93	1938–55	350–650 (lb/in^2)	750–850 (°F)	..
TUNISIA	Goulette I	70.3 (6–6.4–17.5)	1928–48	12–28	325–400	42
UAR (EGYPT)	Cairo South[b]	147 (2x66–2 x 7.5)	1957	84	500	104 (1961)

(a) Selection from 13 back-pressure plants operated by six sugar refining companies.
(b) Block type, with 2 boilers per turbine and oil fired.

ANNEX IX

CHARACTERISTICS OF SOME MAIN HYDRO-ELECTRIC PLANTS (SELECTED COUNTRIES)

Country	Name of plant and river	Gross head (m or ft.)	Installed capacity (MW) and number of individual units	Year of entry into service	Mean annual producibility (yearly production under average conditions) (GWh)
1	2	3	4	5	6
ETHIOPIA	Koka (Awash)	32-40	43	1960	110
	Aba Samuel (Akaki)	45	7	1939	23
KENYA	Tana (Maragua	248(ft.)	14.4(2 x 2 MW &	1933	
	(Tana	186(ft.)	(2x4-1x2.4 MW)	1955	73
	Wanjii (Maragua	231(ft.)	7.4(1 x 1 MW	1954	
	(Mathieya	345(ft.)	(1x1 - 2x2.7 MW)	1953	53
MALI	Felou(Senegal)	14	650 (kVa)	1927	3.5
MOROCCO	El Oidane (El Abid)	105.5	120.6 (45 MVA units)	1953-55	160
	Fourer	235	94.5 (52 MVA units)	1953-55	390
REUNION	Langevin (Langevin)	130	3.5	1961	17
	St.Denis (St.Denis)	43	0.25	1933-59	..
	Ravine-Greuse	..	0.67 (MVA)	1933-59	0.21
FED. RHODESIA & NYASALAND	Kariba (Zambezi)	101	575 (112.5 MVA units)	1959-61	4400
	Broken Hill (Mulangushi)	358	18 (2.5 - 7.0 MVA units)	1925	143
	(Lunsemfwa)	118	16 (5.5 - 6.6 MVA units)	1945	149
TOGO	Kpimé (Aka)	250	1.6 (2 x 0.8)	1963	5.5
TUNISIA	Fernana Amont (O. El Lil)	170	7.8 (1 x 7.8)	1958	18
	Fernana Aval (O. El Lil)	34	1.5 (1 x 1.5)	1962	3.6
	Nabeur (Mellegue)	60	13.6 (2 x 6.6)	1956	15
	El Aroussia (Medjerda)	12	4.6 (1 x 4.6)	1955	8
TANGANYIKA	Pangani Falls	..	17.5	..	80
UGANDA	Owen Falls	..	120	1958	430

ANNEX X

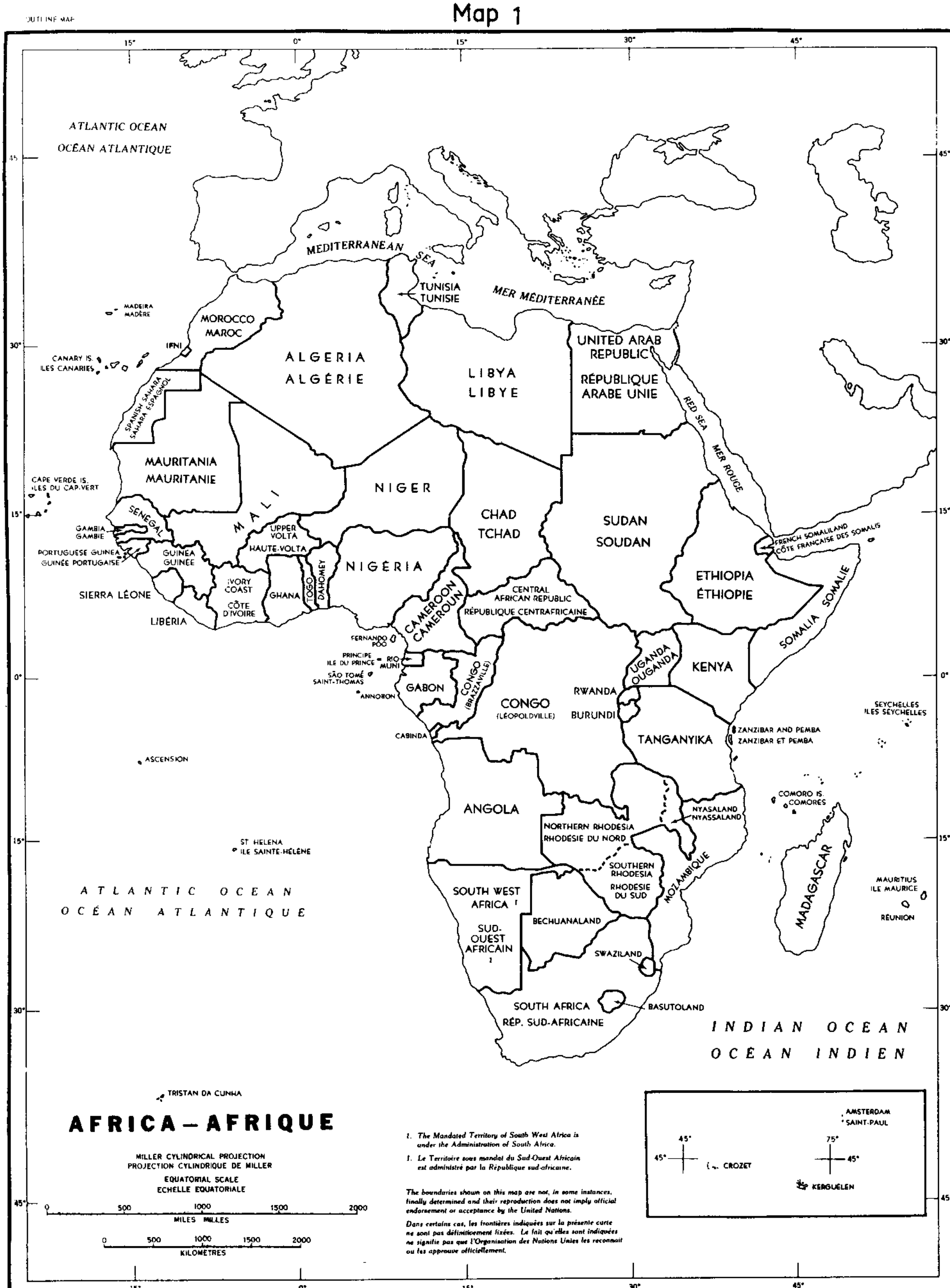
SPECIFICATIONS OF DIESEL PLANTS IN SELECTED COUNTRIES

Country and name of installation	Capacity and number of units	Year of entry into service	Maximum load (kW)
1	2	3	4
MADAGASCAR (a)			
Arsenal Diégo-Saurez	2,400 kVA	..	3,200
Société Rochefortaise	465 kVA	..	855
Société Sucrière Mahavavy Ambilobe	8,168 kVA	..	10,954
C.A.S.N.B., Nossi-Be	2,702 kVA	..	1,660
Cimenterie d'Amboanio	3,900 kVA	..	2,379
Société Filature Tissage Madagascar	1,160 kVA	..	1,613
Sucrerie Marseillaise Madagascar	4,440 kVA	..	3,491
Sucrerie Côte Est Maromary	650 kVA	..	835
Usine Sarpa, Tuléar	740 kVA	..	850
De Heaulme à Berenty	1,290 kVA	..	600
Domaine Pechpeyron Bevala Amboasary	1,162 kVA	..	613
MALI			
Bamako	(3 x 1,000 kVA (2 x 2,500 kVA	1953	3,260
Segou	(2 x 475 kVA (1 x 575 kVA	1929	450
Kayes	2 x 350 kVA	1954	300
Gao	(2 x 80 kVA (1 x 135 kVA (1 x 210 kVA	1953	160
REUNION			
E.E.R. St. Denis	(1 x 1,000 kW (1 x 600 kW (1 x 300 kW	1951	1,900
E.E.R. Le Port	(2 x 255 kW (1 x 1,200 kW	1951	1,710
E.E.R. St. Pierre	(1 x 600 kW (1 x 300 kW (1 x 130 kW	1951	1,030

(a) Figures in column 4 refer to production (kWh)

Country and name of installation	Capacity and number of units	Year of entry into service	Maximum load (kW)
1	2	3	4
TOGO			
Lomé	(2 x 80 kW (450 kW (550 kW (425 kW (550 kW	1936 1951 1958 1960 1961	1870 in 1962
Kpimé	4 x 1,500 kW	1961	-
CAMEROON			
Yaoundé	440 kW	..	..
Nkongsamba	900 kW	1962	..
Maroua	460 kW	..	..
Bassa	2,600 kW	..	..
Garoua	428 kW	..	..
GHANA			
Tema (not including mining companies)	35.2 MW	..	..
Accra	13.0 MW	..	..
Takoradi	7.2 MW	..	..
Kumasi	6.8 MW	..	..

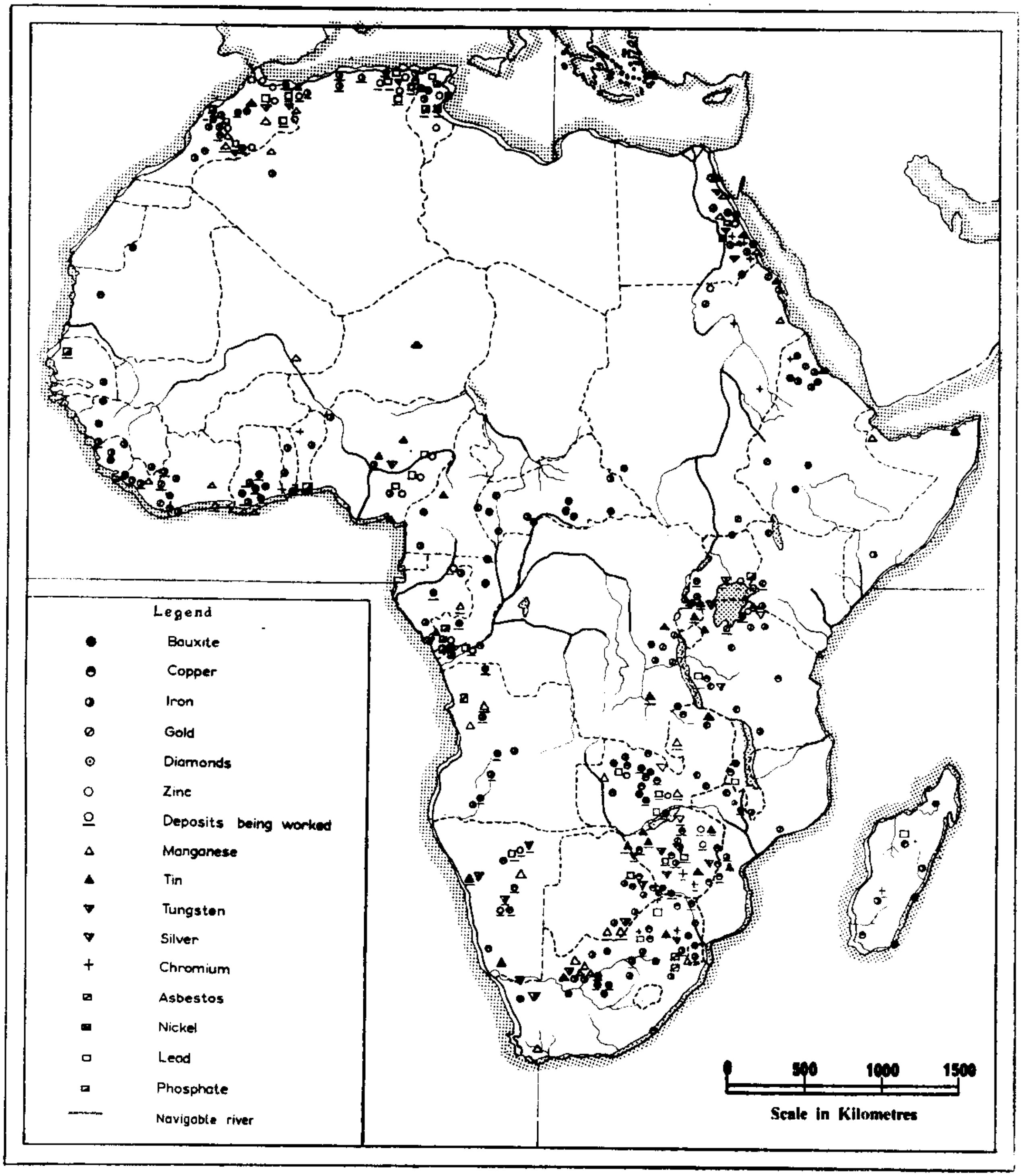
Map 1



MAP NO. 1294 (b) REV.1 UNITED NATIONS
JULY 1962

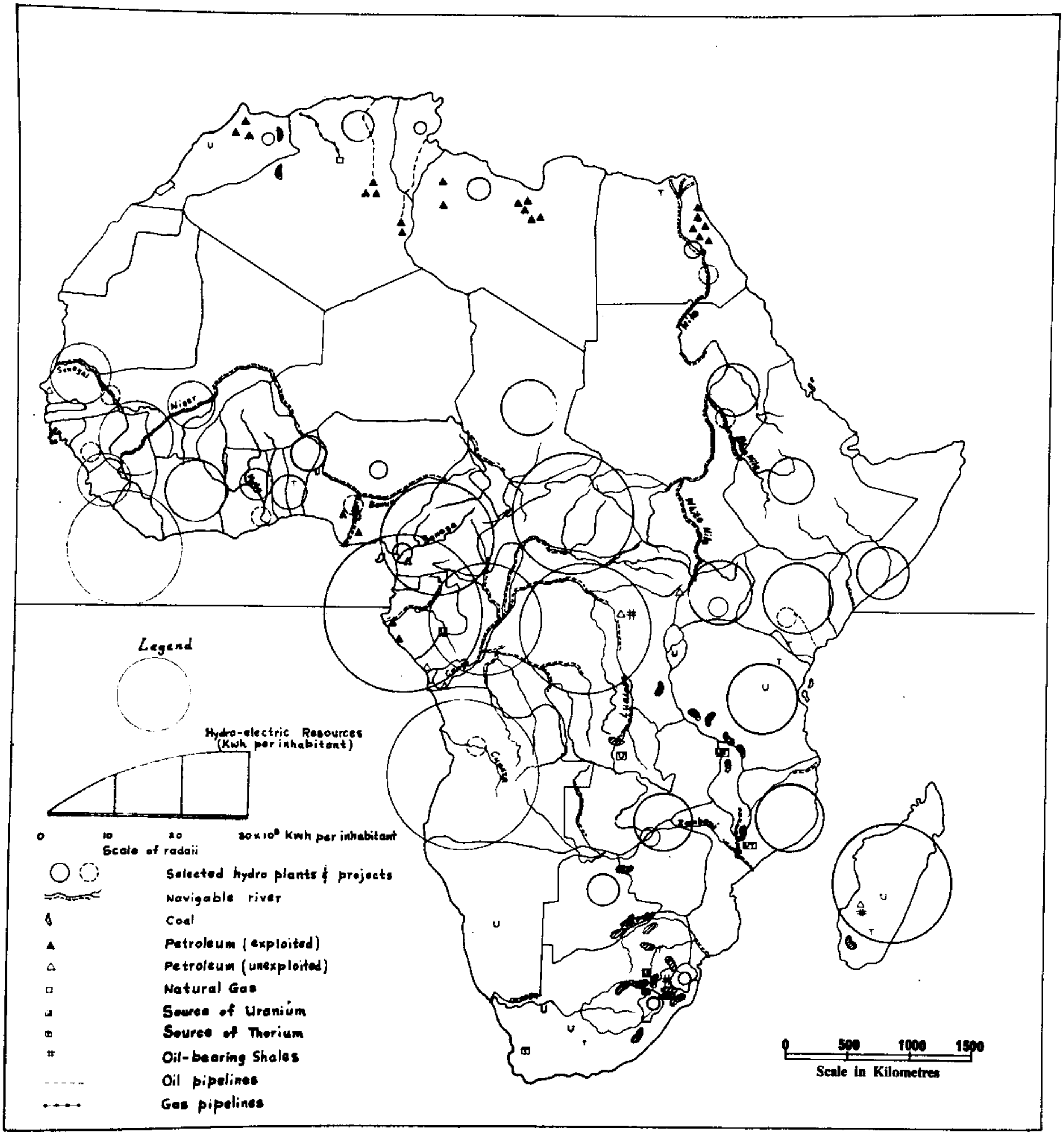
Map 2

Location of some Main Mineral Resources of Economic Interest in Africa



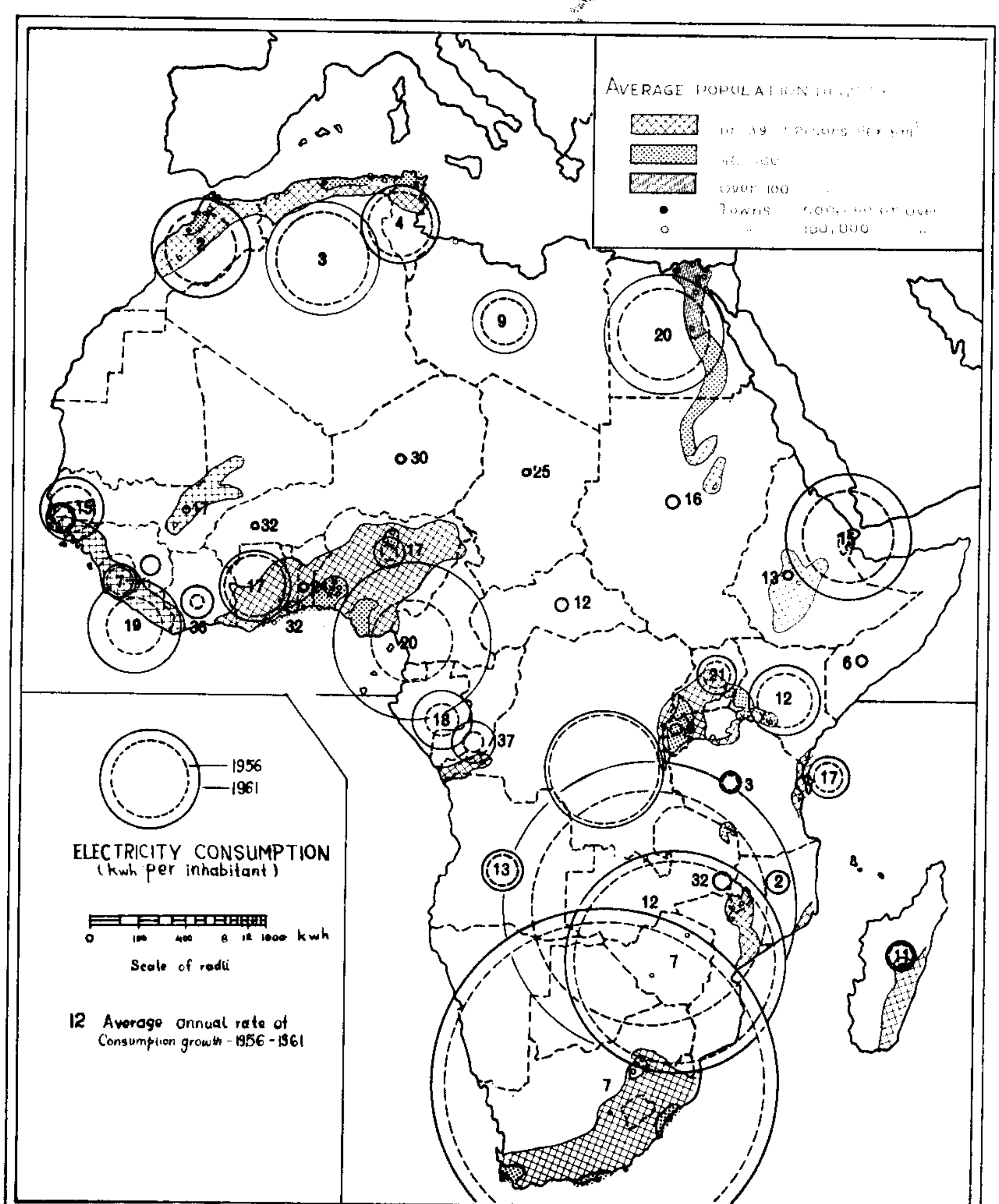
Map 3

Basic Distribution of Hydro-electric Resources and Fuel Reserves in Africa



Map 4

Distribution of Gross Electricity Consumption in Africa relative to population – 1961



Map 6

Some Main Transmission Lines and Electric Power Plants in Africa