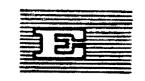
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ENERGY DEVELOPMENT IN THE COUNTRIES OF THE EAST AFRICAN SUB-REGION

18 JAN

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- 1. Primary energy map
- 2. Electric energy map
- 3. List of larger power plants and transmission lines over 70KV

### THE A STATE INTRODUCTION AS IN THE SECOND LIE

The present Energy Paper for the countries of the East African sub-region is based on the draft country papers on energy prepared in May this year and sent to the respective governments for checking and completion of data.

In the final version of the Energy Paper, the answers received by the governments (seven out of thirteen) and other additional information have been taken into consideration.

This Paper deals with primary energy resources and their production, trade and consumption for the period 1959-1963. In the part dealing with electric energy, the existing power installations (capacity, production, trade and consumption), and generation costs and tariffs are discussed in so far as particulars were available. Only a few official data are known on the future development in electric energy.

In the summary for the total of the sub-region, the future consumption of primary and electric energy up to 1975 is estimated mainly on basis of the foreseen industrial development, taking into consideration also the past trends in energy consumption.

The question of covering the future estimated energy demands has not been dealt with in this paper to the extent that would be desirable. With the exception of some new hydropower projects which are mentioned in the country papers, there are no data on new projects for production primary energy.

For the same reason it was not possible to deal with the financial questions of investments necessary for the new primary and electric energy projects,

At the end of the paper, recommendations are given for future work in the energy field so that energy as a constituent factor in the economy would be able to contribute its share to the harmonization of industrial development in the East African sub-region.

Two maps are attached to the **pa**per, one on the primary energy resources and the other on the existing electric energy installations and the known hydropower projects under construction or in plan.

### II. ENERGY SURVEY ON A COUNTRY-BY-COUNTRY BASIS

### **l. ETHIOPIA** Sandania desai neo in neimalisa non mod mogra special nemado pol

### I. Primary Energy Resources (1, 3) where same and the specific because in

### (1) Hydropower

Ethiopia is extremely rich in hydropower resources, the full potential of which is not yet known. The Blue Nile between Lake Tana and the Sudanese border has an exploitable hydropower potential of 25 TWh per annum. This is reported to be about half the total hydropower potential of Ethiopia excluding Eritrea which is estimated at 45 TWh per annum. Present installed capacity is concentrated in a few plants, most of which are located on the Awash River and its tributaries in the region of Addis Ababa.

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nord to the prefered were seen for the escape self office

### (2) Hydrocarbons de lieves can evalveldean se nov en al sesse designation

Two regions of the country are regarded on geological grounds as having prospects of containing economically exploitable accumulations of petroleum, these being the zone of shallow water off the Eritrean coast, including the Dahlak archipelago, and the Ogaden province in the eastern part of the country. The latter has been more extensively explored than the former and several exploratory wells have been drilled, so far without success.

### (3) Coal (3,4)

No coal deposits of economic significance are known in Ethiopia. Low-grade lignites occur in the southern part of the country, but the beds are thin, of the order of 1 metre thick, and laterally discontinuous. The calcrific value is low, of the order of 2,000-3,000 calcries/gramme, and the reserves of individual deposits are small, of the order of 10,000 metric tons. In view of the small amount of systematic geological survey work which has been done in Ethiopia it is possible that larger undiscovered reserves may exist.

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ung ng ma<del>ng pulata kulasan di kula pikasi babu</del>ng bilang panggan di nagura di Sasar di Kabina babin Pr

is the first of the property of the contract of the property of the contract o

In the doc. (4), the following information is given:

Coalfield	Type of coal	Calorific value cal/ $\varepsilon$	Ash content	Reserve million tons
Nejo	. Non-coking	e de la companya de la companya de la companya ( en 1900 ). Establica de la companya de la companya de la comp 	gi-b	10
De <b>bre</b> Berhan	Lignite	etc., fa. 14°, 000	35	1
		4,500	6	2, (201

- (4) Non-conventional sources of energy
- (a) Radio-active minerals: No deposits of uranium minerals are known in Ethiopia at the present time, but these might exist, given the geological constitution of Ethiopia.
- (b) Geothermal: On grological grounds it seems likely that
  Ethiopia possesses considerable grothermal potential. Numerous
  hot springs and functoles occur in the basin of the Awash
  River, notably near Mounts Fantale and Dejan, and near Lake
  Abbe.

### II. Production, Trado and Communition of Privary energy (2, 4, 5, 5a, 6)

### (1) Production

Hydroelectric energy is the only kind of primary energy produced in the country.

A CONTRACTOR OF THE CONTRACTOR	Hydroene	rgy
	in Wĥ	in 1,000 tce (rounded)
1959	2*,8	13.9
1960	11.7	23.3
1961	(!.l	34.0
1962	00.1	46.0
1963	1)3.8	54.4

Conversion ratio: 1 CNh = 500 tce

# (2) Import to at noireurolat petrolici co (0) cost at at

Imports of primary energy in the form of liquid and solid fuels are given below in 1,000 too (rounded):

A service of the serv	-2.4	ago <sub>sa</sub> mmigramissangan vini vedig <sup>a</sup> englishe senja <sup>s</sup> alahanji aterisanda.		Net im	port	exerción de
	1,E	Import	Bunkers	Solid fuels	Liquid	
1959	• • • • • •	190	10	10	170	180
1960		180	30	<b>-</b> 11 1	150	1 50
1961		190	30	10	150	1,60
1962		220	30	10	180	190
1963		230	30	10	190	<u>200</u>

Remark: Quantities mentioned under "Bunkers" are those supplied to foreign-bound ships and aircraft, irrespective of the flag of the vessel or plane. "Bunkers" are not considered as "Export".

### (3) Consumption in 1,000 toe:

as a service of some and	Hydroenergy N	et import	Total
1959	13.9	180	193.9
1960	23.3	150	173.3
1961:	34.0	160	194.0
1962	46.0	190	236.0
1963	54 . 4	200	254.4

MÀ

### Consumption per capita:

1959	9.7	kg coal	equivalent
1960	7.7	11 11	in second
1961	8.7	11 - 1 - 11	and the second of the second o
1962	10.6	11 11	, , <b>, , , , , , , , , , , , , , , , , </b>
1962	11.5	rr Tr	11

. . John Cammor-work

www. Introductions

### III. Electric energy (2, 4-10)

08

(1) Existing power systems

In Ethiopia, electric power is provided by:

- The Ethiopian Electric Light and Power Authority (EELPA), which has electric power installations throughout the country and whose present production is more than 75 per cent of the country's total.
- The Società Elettrica dell'Africa Orientale (SEDAO), which is a private enterprise and is responsible for supply of electric energy in Eritrea.
- Also some industrial enterprises have their own power installations.
- (a) <u>Installed capacities</u> (10): In doc. (10), capacity is quoted in kVA (and not in kW). To get capacity in kW, we suppose an average generator power factor of 0.8. In addition to the stations mentioned in (10), the hydropower station of Tis Abbay went on stream in 1964 with two units and a total capacity of 7,700 kW. In this way we get the present capacity:

11.L

- Hydro ..... 72.862 MVA 60.0 MW
- Thermal ..... 32.489 MVA 26.0 MW
Total: 105.351 MVA 86.0 MW

The above figures include not only the capacities of EELPA and SEDAO, but also of the private industrial enterprises.

EELPA has an inter-connected system, with the Keka hydropower plant as nucleus, and ll self-contained systems. The existing power plants in these areas have the following characteristics:

Inter-connected system

	In	Capacit stalled	<del></del>		ducibility in car's hydrolici	
i e e impili	kVA	₩ ×	Firm kW	Rich	Average	Poor
HE Koka	54,000	45,000	23,000	120	20 110 121	80
Aba Samuel 👵 💯	8,250	6,600	4,750	7 m-27	mag # <b>.23</b> 0000	18
Oursc	525	400	250	2	<b>.2</b> minam	2
HE Sub-total:	62,775	52,000	728,000£	str <b>14</b> 9	30 Loca <b>135</b> 🕾 👵	100
SE Addis Ababa	6,250	5,000	5,000	_	30 4 4	30
DE Alemaya	2,910	2,000	2,000	10	or a verification	10
TE Sub-total:	9,160	7,000	<sup>1.9</sup> 7,000	40	40	40
HE & TE Total	71,935	59 <b>,</b> 000	135,000	<sup>ା</sup> 189	175	140

e in the section that require the control of the

Self-contained systems (A (A)) and been a contained systems (A) and been a contained as

Location	A Company of the Comp	led capacity in kVA	Firm capacity	Producibi	•
	Diesel	ु, ९७ Hydro	. kW	Diesel	Hydro
Jimma	1,125	5.85 170	600a - 3	2.4	0.3
Dessie	1,125	Annual Control of the	600	2.4	,
Hagere Hiwot	÷, 7,4 ±	210	100	***	0.35
Ghien	40	30	50	0.1	0.5
Debre Berhan	. · <del>-</del> (lat	125	್ 1 <mark>00 ಕ್</mark> ಯ	and the second	0.3
Gondar	000	-	100	0.4	
Yrgalem	110	my esta <mark>l</mark> o 1 1	80	0.3	***
Debre Markos		n dona <del>M</del> su⊷.	40	0,15	-
Jigjiga		<u>.</u>	30	0.1	
Neghelli	150	i ma "Isrili	50	0.15	-
Tis Abbay	od <del>-</del> riods s	- 119 <b>,</b> 600	2,400	` <b>_</b>	25.0
Total	2,850	10,135	4,150	6.0	26.4
Grand total	1	2,985	*****	32.	45

<sup>\* -</sup> Estimated.

As at Docember 1964, the following Diesel power plants have to be added:

Location	Installed capacity kVA
Assab ***********	2030
Bahar Dar	865
Shashamane	500
Shashamane Debre Markos (additiona	1)
Lekempts	250
Assella	250
and the second s	otal: 4080 kVA
Na ciiliba air gadh, ga ga ke a	2060 141

For the EELPA's self-contained systems, at the end of 1964, the total installed capacities are estimated as follows:

Hydr	0,		about	8,000	kW	ESOLUTOR TOME	(3)
Dies	el		about	5 <del>,6</del> 00-1	kew-	mayama magi kisa iso seesaayaa hakaa iso ahaa a	and the state of t
	Total		about	13,600 I	kW-	Section of the sectio	di si arestro.
<i>∞</i> • ; <i>A</i> .		4.4 11	4.00	( ) ( ) ( ) ( )	4.3 13.8		· ATOM

SEDAO has a total capacity of 16,525 kVA or, estimated 13,500 kW. The main SEADO's power plants are the following:

- Diesel power plant at Cherar ..... 6,000 kW
- Diesel power plant at Asmara .... 550 kW
- Takan on Hydropower plant at Dorfu ........ 1,100 kW
  - Steam power plant at Belesa .... 5,000 kW

In the final stage, this power station is planned to have 30,000 kW capacity. The second set of 10,000 kW capacity was foreseen to start operation in 1965. The power house is completed to accommodate the 30 MW capacity referred to above.

In Eritrea, the private company CONIEL is also active in the electric utility field, but no detailed information on its activity is available. <u>Industrial</u> diesel power stations have a capacity of 3,954 kVA or 3,200 kW (estimated).

A summary of installed capacities with regard to the ownership and type of power plants gives the following picture (in MW);

	Hydro Thermal Total
ÉELPA	60.0 12.6 72.6
SEDAO	13.5
Industry	3.2
A G G g	60.0 29.3 89.3

With the exception of the steam power plant in Addis Ababa, all the thermal power plants are diesel plants.

# (b) Production in GWh:

Tilitaijas 1

Ownership	1959 1960 1961 1962 1963	1964
	47.1 55.4 71.4 96.5 117.0	145.5
SEDAO	24.1 27.3 31.5 36.1 37.8	?
Industry	17.3 to 119.0 metr 19.0, 120.0 cate? and	?
Total:	88.5 101.7 121.9 152.6	?

The relative importance of the EELPA in supplying the country with electric energy is steadily growing.

EELPA's share in the total production:

AND STREET, AND THE STREET, AN

With regard to the type of energy, we have the following picture:

	그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그	
1959	1960 1961 1962 1963	1964
.27.8	46.7 68.1 92.1 108.8	137
60.7	.55.0 60.5 max 201	?
88.5	101.7 127.9 152.6 ?	?
31	46 53 60.5 ?	?
	그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그 그	5 10 1 5 7 8
	.27.8 60.7 88.5	1959 1960 1961 1962 11963  27.8 46.7 68.1 92.1 108.8 60.7 55.0 59.8 60.5 ?  88.5 101.7 127.9 152.6 ?  31 46 53 60.5 ?

# (c) Sales and losses in GWh:

ermon week of the result of the contraction

For the two utilities EELPA and SEDAO, the following tables show how much of the produced energy was sold and lost:

्नाक्ष्यक्षर १६००	ji prstynsk Hwe		1960	196 <b>1 1962</b>	1963
HELPA	The second secon	A CONTRACTOR OF THE STATE OF TH			(391
Production .		• • • • • • •	55•4	74.4 8.1 96.5	117.0
Sales	******	• • • • • • •	42.9	59.5 83.5	98.0
Power-plants c	onsumption		<u> </u>	. L	
and losses		•••••	12.5 <sub>円</sub>	14.9 13.0	19.0
In % of produc	tion		22.6	20.0 - 13.4	16.2
-08 W 1 08 G \ 08	in series affirm	eming disk			-
<b>Va</b> lores on the second decision				1962	1963
SEDAO					
Production .	• • • • • • • • • • • • • • • • • • • •	• • • • • • •		36.1	37.8
Sales	• • • • • • • • • • • • • •	• • • • • • • •	• • • • • • •	29.2	30.6
Power-plants e	onsumption and	lossės CW	h of the	6.9	7.2
In % of produc	tion:	stras		19.0	19.0
e om was i		***************************************			

There follows a rough breakdown of electric power consumption expressed in percentages of the total production, for 1962:

- Economy ..... 42.5%
- Public consumption and illumination of towns 40.0%
- Power plant consumption and losses...... 17.5%

The average rate of growth of production for 100.0%

the period 1959-1962 was: \_\_\_\_\_

- for the country as a whole ..... about 20%
  - for EELPA ..... about 26.6%

### (d) Transmission and distribution

Only information for EELPA is available:

		Transmiss		and the second s	Distribution	Number
	lin in ko 132 kV			Feeders in km 15 kV	Transformers! capacity kVA	- of consumers
1960		418	129	370	28,100	32,435
1961	••••	418 .	159	408	40,463	37,930
1962	• • • • • • •	418	159	468	47,998	44,184
1963		418	159	595	62,798 MURLO	52,391
1964	•••••	418 🤃	159	662	71,463	60,190

The low-voltage distribution networks employ a 380/220 V three-phase system with a neutral wire. The lengths of these networks are not known.

### (e) Tariffs

# 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

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 phi = 0.89 Eth. cent l per kVArh
Maximum demand charge, per month . Eth. doll. 5 per kWh
Service charge, three-phase Eth. doll 5 per month
Rebate on total charges:
Exceeding 100,000 kWh-per month: 5%
"400,000 kWh " 10%
" 700 000 H " " 35%
" 1,000,000 " " " 20%
3. Off-peak tariff 30.85 4 for got
All consumption Eth. cents 5 per kWh
Reactive consumption, below
cos phi = 0.89 Eth. cent 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 1 20%
700,000 11 11 30%
1,000,000
The supply of this tariff is subject to special negotiations
and to conditions of discontinuance of supply for certain
periods.
(f) Prices of fuel-for power-generation:
- Fuel oil for the steam power plant at Addis Ababa 120 E\$/ton
- Diesel oil in the coastal zone
- Diesel oil far away from the coast 350 "
- Dieser off far away from the coast
On this basis it can be estimated that energy from the diesel
power plants in the self-contained areas costs about Eth. cents
18-30 per kWh, depending, of course, on the amount of energy
produced. In these figures, all expenses are included, e.g.
fuel, operation, depreciation and interest for the power plant
as well as the distribution system.

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### (2) Future development Trings Isias and as I torage ...

(a) Production targets for the period 1963-1967 are given in doc. (8) as follows: (in GWh)

,				Reactive consumption, the					
i de de la colonia. La colonia		entari.	1963	1964	1965	1966	1967		
_				143	•				
	SEDAO		35	55	60	65	70		
	Industry	• • • •	21	22		1857 t 80 2 <b>5</b>			
	Total	L:	190	£220 ±	<sub>∠</sub> 257 <sub>0 &gt;0</sub>	<sub>. ???</sub> <b>31</b> 5	3 <b>5</b> 5		

The average rates of increase forecast for this 4-year period are:

SEDAO's production in CWh, taken from its own documents, seems to be rather different:

Rebese on troud atompes:

Let the received catable out a lagarite of

(b) <u>Investments in electric power</u> for the period 1963-1967 have been as follows:

	<u> </u>					
Group of investment	In 1,000	E\$	In %	7-21		
Interconnected system Self-contained systems	32,000 19,900		38.5 23.8	,		
Tis Abbay system	5,900	House Table .	7.1			
Industrial firms	_		0.5			
Transmission lines, substations and distribution			30 <b>.1</b>			
Total Total	83,450	3.5%. 2.5%.	100:001			
eg.O., 's strond the estations also			. Du Gall 1914			

Pari i use all tot or unital issue i decempe : j' repet. See

# Technical particulars about the investments

- The Tis Abbay hydropower plant went on stream in 1964, with the following producibility:

1967 ..... 25 GWh final ..... 56 GWh

- In the interconnected system, one more hydropower plant, Awash II, is now under construction. Its installed capacity will be 32 MW and its producibility as follows:

1967 ...... 75 GWh final ......... 182 GWh

- The Awash III project is also included in the expansion programme for the immediate future, and will have outputs identical to Awash II.
- In the self-contained systems (besides Tis Abbay), new power plants will be built in Dilla, Makalle, Axum, Asba Teferi, Bonga, Debre Taber, Adua and Dembidollo.
- Expansion of the existing power plants is planned in: Jimma, Dessie, Hagere Hiwot, Debre Berhan, Gondar, Debre Markos, Yirgalem, Negellie Borana, Assab, Jigjiga, Wolamo Soddo, Assella, Lekempte and Shashamane.

Production in the self-contained systems will increase from 9 GWh in 1963 to 25 GWh in 1967.

- During the same period, the following new power capacities will be installed:

9,200 kW diesel electric power, 200 km distribution feeders 15 kV 18 MVA distribution transformer capacity.

- SEDAO will expand its existing generating power by 5,000 kW by construction of the first stage of the thermal power plant at Bellesa.
- Industrial enterprises will build power plants only in those cases when the factory sites render it impossible for them to be supplied by electric power from the public network.
- By 1967, the following 232-kV transmission lines will be constructed:

From Awash II to Koka double circuit ... 25 km
From Koka to Akaki .... 75 km
From Akaki to Sabata and Gafarsa .... 25 km

when your consenses our site of the Total: 125 km

- There will be installed in the interconnected system also:

45 kV transmission lines, ...... about 80 km
15 kV distribution feeder ..... about 400 km
Distribution transformer capacity about 56 MVA

- US AID financed the feasibility survey for a hydropower station on the Fingiar River, the Blue Nile, tributary. The 94 MW project requires an investment of E-70 million or US\$28 million. Specific investment is US\$296 per kW.

మాలాగా ఎదుగా నుండి మేకేటు కున్నాకుండి - శ్రీమున్నాకు మందినా నాట్లు నుండి మేకు ఎక్కువే కుండిన హాగా కారణ్ మహారావ్యేగా నాట్లు కున్నారు. మందినా మహారావ్యామ్ మహారావ్యామ్ మహారావ్యామ్ మహారావ్యామ్ మహారావ్యామ్ కు

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# Abbreviations and symbols used this control to the tile thouse on

- Megawatt = 1,000 kW lipisminus (se las reasinge moinsact will MW
- MVA Megavoltampere = 1,000 kVA
- GWh Gigawatthour = 1,000,000 kWh
- Terawatthour = 1,000 GWh TWh
- tons (metric) of coal equivalent tce
- Hydroelectric power plant HE
- Diesel electric power plant DE
- Steam electric power plant SE
- TE Thermal electric power plant

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### 2. SOMALI REPUBLIC

### I. Primary Energy Resources (3,6)

### (1) Hydropower

Somalia has only two perennial rivers, the Uebi Shibeli and the Juba. Neither has very great potential within Somalian territory. The total hydro-potential is estimated at 200 - 1,000 GWh, but it seems that the specific investments would be considerable. According to Associated Consulting Engineers, the Northern Region has a hydro-electric potential of over 300 MW firm or over 500 MW peak load capacity. For the Shebeli river, no figures are given.

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and project the second of the

LDS 000. E Harring timese

### (2) Hydrocarbons

Much of the territory of Somalia is underlain by sedimentary rocks, principally calcareous and evaporitic in nature, and oil seepages occur at Daga Shabel in the Berbera district. There has been a considerable amount of exploratory activity and a number of deep wells have been drilled, mainly in the coastal regions. Shows of oil and gas have been observed in a number of wells but so far no economically exploitable accumulations have been discovered.

Exploration continues and may ultimately be successful

### (3) <u>Coal</u>

Low grade coal is reported to occur at Durbo, in the northern mountains near the Gulf of Aden. The bed is reported to be about 2 metres thick, but to be lenticular. The coal has the following characteristics: moisture 16 per cent, volatile matter 39.4 per cent, ash content 6.4 per cent, calorific value 5,719 calories per gramme. No estimate of reserves is available. This deposit is reported to have been worked prior to 1939.

### (4) Lignite

Lignite is reported to occur in the territory of former British Somaliland, but it is stated that it is uneconomic to develop these deposits.

- (5) Non-conventional sources of energy
- Geothermal: Hot springs with a temperature of around 40°C are known to occur in the north-eastern part of Somalia. Given the occurrence in this area of major faulting along the southern side of the Gulf of Aden, it is possible that geothermal fields might exist in this area.
- (b) Solar: Much of Somalia is suitable for the utilization of solar energy if this could be developed on an economic basis.
- (c) Wind: The northern mountains provide many sites which would be suitable for the development of wind power, were it not for the fact that the winds in this area are seasonal. Power could undoubtedly be developed during the season of the northeast monsoon, but the potential during the remainder of the year is dubious.

### II. Production, Trade and Consumption of Primary Energy (5, 5a)

With exception of wood and wood charcoal, largely for domestic consumption, there is no production of primary energy in the country and only imported energy in form of liquid fuels is used.

In the period 1959-1963, the following quantities of liquid fuels were imported and consumed: Militaria washing the age of the said of the

the first section of	- 1959	LACTO LA LIG <u>RI</u>		50,000	tce (rou	inded)	(=;
	- 1960	មក ខេត្ត និង ប្រជាជាក្នុង ខេត្ត	. pija d	40,000	tce	$\operatorname{tr}(\gamma_{k,k},\gamma_{k,k}) = \gamma_{k,k}$	
	- 1961	•••••••	• • • •	50,000	tce	<b>0.</b> 4.11.40.440	
	- 1962	*********	žėmy?	50,000	tce	n Victorian in	()
						ff	•

Specific consumption per capita was about 23 kg coal equivalent.

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### III. Electric Energy (2, 4, 5, 6) water to appear to

- (1) Existing power plants
- (a) There are only diesel power plants in the country, the total installed capacity being 7,900 kW in 1962. Self-producers are not included in that figure and their capacity is not na sina ni fama daire migika amban da kan kan kan kan da kan kan kan kan da kan kan kan da kan da kan da kan d known.
- (b) Production of electric energy amounted to somewhat more than 10 GWh per annum in the period 1959-1963. In 1961, it was 12 GWh. For other years, exact figures are not known.
- (c) Consumption: In 1961, the total amount of units sold to consumers was 11 GWh. Power-station consumption and distribution losses were about 1 GWh or some 8.3 per cent of the (事から、つ) (日本 本) (2014年におん) (2044年) total generation.

Only 3 GWh or 27 per cent of the total consumption were used by industry. In the period 1956-1961, the average rate of growth of consumption was about 6.2 per cent, which is Profes To Braziliana penak iki gar rather low. aalfotias

In the period 1959-1963, specific consumption of electric energy was about 6 kWh per capita. AN GENERAL LAND A LANGE DES

- Transmission: No lines existing.
- museum And Terming of Section (e) Distribution networks: In 1961, fifteen twons were electrified. No details are known about the distribution system in the country.
- (f) Generation costs: No data available.
- (g) Tariffs: No data available. For industrial purposes, the average prices of electric energy amount to:
  - . In the Southern Region: So.Sh. 0.60/kWh = 8.5 USø 1 kWh
  - . In the Northern Region: So.Sh. 0.45/kWh = 6.3 USø 1 kWh

(h) Fuel costs: At Mogadiscio, for gas of	<u>il-</u> : ''	. #355 AN	with mile		
. Import cost c.i.f. Mogadiscio	. 17.4	Somali	cents	per lit	re
. Government taxes	. 39.0	11	***	11	
- Distribution costs		***	il Silipoli	tt	
ndrend Sale price were:	. 80.0	11 11	II	***************************************	
(2) Future development (6)			emie	2013 <sup>1</sup>	

The existing and potential demand for electricity in the near future is of rather modest dimensions. Besides, the existing centres of consumption are very far from the possible sites for the generation of hydroelectric power. Thus the very large investments in the generation of hydroelectric power and its transmission over long distances cannot be justified on the basis of the foreseeable demand for electricity. The country will therefore have to depend on thermal stations for quite some time to come. However, the hydroelectric potentialities need thorough investigation, for demand for the utilization of this hydroelectric power may arise as a result of certain future developments, particularly in respect of mineral resources, which it is not possible to foresee at present. The present of the control o

The establishment of a national grid system is not feasible, due to the long distances separating the various centres of consumption and to the relatively small demand at each centre. Capital investment in the transmission system will have to be very high, resulting in high transmission costs. This would tend to raise the unit cost of electricity to the consumer. The country will therefore have to rely on separate thermal power stations for each main centre of consumption. 72) <u>2012a22-01321 2121772444 --24</u>71340

There is no standardization in the electric supplies of the country. It is proposed that, unless otherwise necessitated by the requirements of the existing sets, new generating sets should be standardized and should be designed to supply 3-phase 230 volts 50 cycle per second alternating current. . Property, is the like accounts

In the First Five-year Plan, the following development of electric power is foreseen:

Locality	power	New power kW	Investmen 1,000 So.	
Hargeisa	800	750	600	
Berbera	360	1,420	1,800	a.
Mogadiscio	2,744	,		200
a) Purchase of existing installation	*		5,000	
b) Development			5,800	
Campo Bottego and Afgoi	?	Supply from Mogadiscio	500	2 * 1 m
Kisimayo	310	1,200	1,800	
25 other small towns	4. F	?	9,500	
54 to Total *** *** ****************************	4,214	5,290	25,000	

### Remarks:

Hargeisa .....: The demand for electricity is expected to increase in future at the rate of 20 per cent per annum. The distribution system will be expanded and improved.

Berbera ...... The distribution system will be improved and expanded to take care of the demand of the new port and of the growing demand of the town.

Mogadiscio ....: The existing power installations owned by

Elettro-Industriale Italo-Somala (SEIS), will
be purchased by the Government.

# Campo Bottego and Afgoi ....: The local generation will be discontinued.

The local generation will be discontinued.

A high voltage supply feeder will bring power from Mogadiscio and the local distribution system will be improved.

3/2

Kisimayo .....: As a result of the building of the port, the demand for electric power will increase substantially. The old two 30 kWh units will be removed and two 600 kW units will be added.

Other towns .....: Improvement and/or installation of new capacity and distribution system in twenty five towns is foreseen.

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- 1. African Electric Power Meeting, Addis Ababa, October 1963 E/CN.14/EP/3 Part I.
- 2. Ditto, Part II.
- 3. Ditto, Add. 1. north north newswell : ..... a mid and
- 4. Industries et travaux d'outre-mer, January 1964, No. 122.
- 5. World Energy Supplies, 1959-1962, UN, New York 1964, No. 7.
- 5a " " 1960-1963, " " 1965, No. 8.
- 6. Somali Republic: First Five-Year Plan, 1963-1967, Mogadiscio 1963.

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### Abbreviations and symbols used:

MW - Megawatt = 1,000 kW

GWh - Gigawatthour = 1,000,000 kWh

tce - tons (metric) of coal equivalent

Colored States

### 3. FRENCH SOMALILAND

### I. Primary Energy Resources (1)

almain course saivated (1)

There are no known energy resources, except Lake Assal for hydroelectric power.

There are no data available about the hydro-potential of the country.

### II. Production, Trade and Consumption of Primary Energy (5)

There is no local production of primary energy in the country.

Primary energy is imported in relatively large quantities in the form of liquid fuels. Only a small portion of that energy is consumed in the country, whereas the largest part of it goes to "Bunkers", meaning that it is supplied to foreign-bound ships and aircraft; irrespective of the flag of the vessel or plane. "Bunkers" are not considered as "Export".

In the period 1959-1962, trade and consumption of primary energy, expressed in 1,000 toe (rounded) were:

		Bunkers Consumption
1959	1,460 6.01	•- <b>1-,440</b> . 8001 20
1960	. 1,460 AM A.CI	••1•,440 . AD(I 20
1961	1)63-1963 <b>988</b> 1 2004	5-1,840 20 5-1,96 rsey-li eng Al
1962	. 1,910 <u>ec req 7.8</u>	1 1.890 20

### Consumption per capita was: 2019 uditivata bas not salmament (S)

1959 and the 278 kg coal equivalent
-second off office 1960 and the 1278 to 1278 to 18 order admits
classes equivalent of 1961 of 1961 at the 1278 the edition of 1961 of 1961 at the 1961 of 1862 and 1862 and 1862 and 1863 at 1864 and 1865 and 186

### III. Electric Energy (4)

- (1) Existing power plants
- There are only two diesel plants:
  - and the companies of the contraction of the contrac - DE Djibouti with an installed capacity of 8,800 kVA (about 7,000 kW);

I. The sany house y beas ourse (II)

g Joseph Schaller C

- DECArta, Ting a cattle breeding centre, some 40 km from Djibouti. The capacity is 400 kVA.
- (a) The installed capacity of the DE Djibouti has increased Your of one and Consumus gradually since 1953:

Edward Commence	Мем Салас	itv	1 Capacity
Samuano di gerano 1949 Pangahan da aka	in kVA	in kVA	of blog in ckWeres
195310			2,900*
1961	***	6,350	5 <b>,</b> 100*
1963	2,450	8,800	7,000

Production Sold question have a real as the Control will not DE Djibouti

and the following the first boundary 1953 ....- 2.8 GWh

1962 ..... 12.6 GWh

1962 ...... 12.0 GWh (estimation)

1964 ...... 19.6 GWh

In the 11-year period 1953-1963, the rate of increase of production averaged 18.5 per cent.

# (2) Transmission and distribution and di

As the DE Djibouti supplies only the town of Djibouti and its suburbs, there are no transmission lines in the country. The generation voltage of the DE Djibouti is 5,500 V and at that voltage electric energy is fed to about 40 5.5/0.4 kV transformer stations.

<sup>\* -</sup> Estimated.

The installed capacities of these stations range from 13 to 750 kVA. The lengths of the 5.5 kV feeders are:

- 30 km underground cables in the town.
- 10 km overhead lines in the suburbs.

The 220/380V low-voltage distribution system is led mainly as over-481/81 41 ....... head lines.

# end (3) Consumption mumixer will to be end it egrands edil

The consumption of the DE Djibouti itself and the distribution losses amount to about 10 per cent of the total production. Therefore, net consumption is 90 per cent of gross production. About one-third of net consumption falls to the 5.5-kV network and two-thirds to the low-voltage network. Rad ware (or it last but/memon) 17

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In recent years, consumption in the Djibouti area has been as En ..... (some land follows:

> 1963 ..... 14.4 GWh (%) 1964 ..... 17.5 CW harring (4)

### (4) Tariffs

LENGER Ex Si .... (the assume that some desi-(rate of exchange; fr. CFS 1,000  $\pm$  Ffr 23  $\pm$  US\$4.6)

It is very significant that the electricity tariffs have been dropping constantly and quite noticeably. So, for instance, the domestic tariff per kWh (low-voltage, 1st rate) developed as follows:

(.a.1955) ..... about US¢ 12.4 1963 ..... about US¢ 8.3

一类,1000年,1000年,1000年,1000年,1000年,1000年

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that is to say, a reduction of 33 per cent.

In 1963, the tariff structure in fr CFS/kWh was as follows:

THE RESERVE AND AND SERVED SOUTH OF THE PROPERTY OF THE PROPER

### (A) Low voltage

(a) General tariff : fr.22/kWh

The inches a superior (b) Industry: a jij sati i a a sana ndi lst rate (150 h) ..... fr 22/kWh 1990 at 12. 2nd rate (next 175 h) ..... fr 20/kWhatteve me 1 -3rd rate (next 200 h) ..... fr 17/kWh 4th rate (rest) ..... fr 13/kWh The charge is based on the maximum power demand and the corresponding hours per month. more (c) Domestic use: . The tariffs decrease according to the number of rooms. For a three-roomed apartment, the tariffs are: -dst rate (110 kWh/month) ... 18 fr CFS/kWh 2nd rate (next 140 kWh/month) 17 3rd rate (next 160 kWh/month) 15 4th rate (rest) ...... 13 (d) Power: fr CFS 18/kWh ..... (e) Public lighting: 1st rate (till midnight) ..... 18 fr CFS/kWh 2nd rate (from midnight to dawn)14.5 fr CFS/kWh (B) Medium voltage (5.5kV): (a) Peak tariff (from 6 p.m. to midnight): 19.5 fr CFS/kWh. objective (and (b) Off-peak tariffs (from midnight to 6 p.m.) For a two-month consumption: from 0 to 20 MWh ...... 13.0 fr CFS/kWhen by with additional and the state of the contract of the state of th from 20 to 60 MWh ..... 12.0 In 1965. a band revolute from 60 to 140 MWh ...... 11.0 ASSEMBLE LONG (A) from 140 to 300 MWh ..... 9.5 over 300 MWh (c) Fixed charges for power: fr CFS 5,000 per kW and year, the first 10 kW being free.

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(5) Fuel prices

Fuel: FD 6,000 per ton; consumption in 1964: 3,320 tons. Gas oil: FD 11,320 per ton; consumption in 1964: 2,460 tons.

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(6) Future development

In the present five-year plan, the following constructions and investments have been foreseen:

- le contriber es benevous air and a a contriber of the contribution of the con (a) In 1965, a new diesel set was installed in the power plant of Djibouti. Another diesel set with a capacity of 4,200 kW will be installed in 1967-1968. At the same time, the electric installations of the power plant will be modified orded a
- (b) Distribution network: The medium-voltage feeders will be changed from 5.5 kV to 20 kV. The transformer stations will be modified accordingly. - Meganatthous = 120001 answeM --
- (c) Investments: The following sums have been earmarked:
  - FD 150 million for the 4,200 kW dieselset; Hoditswags -
  - FD 30 million for the modification of the power station - Diesel oleofair years yn ar of Djibouti:
  - FD 320 million for the modification and extension of the distribution network.

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- 1. African Electric Power Meeting, Addis Ababa, October 1963, E/CN.14/EP 3, Part I.
- 2. Ibid., Part II.
- 3. Thid.34 Add.11.
- 4. Industries et travaux d'outremer, January 1964, No. 122.
- 5. United Nations, World Energy, 1959-1962, New York 1964, No. 7.

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# Abbreviations and symbols used:

- MW Megawatt = 1,000 kW or can be an our or its and a little in a little
- GW Gigawatta=11,000,000 kW - W Curry Tile. Curry Fecando
- GWh Gigawatthour = 1,000,000 kWho animated with additional security (9)
- TWh Terawatthour = 1,000,000,000 kWheet . 1 1 1 2 2 3 4 4 4 4
- tce Totons (metric) of coal equivalent of the coal equivalent
- DE Diesel electric power plant
- FD TaiDjibouti france no issociate the entre or indire 681 de -

# 4. UGANDA

### I. Primary energy resources (3)

# (1) Hydropower (2, 3, 4) -- the to be shrowed for the

There are several estimates for the total hydro-potential of Uganda. They range from 15 to 45 The prace Most of this potential is concentrated along the Nile below Lake Victoria. At Owen Falls there is already a 120-MW installation, later to be extended to 150 MM. A further 180-MW project has been proposed for future development at Bujagali. Falls, 7 miles down-stream from Owen Falls, and there are seven more sites capable of development on the Nile below Bujagali. In south-west Uganda there is a small hydro-electric installation (1.2 MW) at Kikagati and another small plant is to be erected near Kabale. At present the total hydroelectric energy production is about 450 GM p.a., or 2.1/2 - 3 per cent only of the total lowest estimated potential of the country. About one-half of this production is being exported to Kenya.

### (2) Hydrocarbons

The greater part of Uganda is underlain by rocks totally unsuitable for the formation and accumulation of petroleum. Only in the Rift Valley system of the western part of the country is there any thickness of undisturbed sedimentary rocks, and these appear to be entirely non-marine in character. Oil and gas seepages occur at several localities in the Lake Albert area and some exploration work has been done in the area, including drilling a well. The beds penetrated by the well appear to have originated from very young Plio-Pleistocene lacustrine sediments, and include oil shales. Oil-saturated sands were found at shallow depths and the oil may have resulted from distillation of the oil shales by igneous intrusions associated with the Rift Valley fault system.

### (3) <u>Coal</u>

Small areas of Uganda cre known to be underlain by rocks equivalent to the coal-bearing series of south-eastern Africa, but drilling has not disclosed any workable coals, only coaly streaks having been found.

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(Noward III)

#### (4) Non-conventional sources of energy

### Radio-active minerals

Several deposits of radio-active minerals are known in Uganda and some small low-grade deposits were worked for in the war, although none are at present in production. Prospecting continues and the prospects of finding economically workable deposits are considered to maendg-sour og fimbe good. G figgajak og stogs

<u> 191</u>2 - Jagor Dada<u>ri, Kara</u>li, J.

Uranium minerals, although so far rare in Uganda, have -outre linear been found mainly as euxenite in pegmatites in various ent localities in Buganda, Toro, Ankôle and Karamoga, and as microlite in estern Uganda. Radio-activity is also found in certain spring waters along the boundary of the 

Thorium minerals are common compared to uranium minerals and occur as monazite from the weathering of granites and as thorite. At Kalapata in northern Karamoja monazite is found in quartz-ilmenite-rutile nodules in biotite gneiss, and other monazite occurrences are at Kalere River, Mpuywi, Buhweju and Bugarama. Although some have a ThO, as commercially exploitable. The same is true of thorite which is found at Lunyo (Jastern Province) and Apeykale in northern Karamoja.

No sustained search for uranium has been carried out in Uganda, although, considering its geology, tectonic activity and igneous activity, the country must be regarded as offering many favourable aspects for the occurrence of radio-active minerals; this is confirmed to some extent by the early results of the aerial geophysical survey being carried out under a United Nations Special Fund project. bearing ores are known but the possibility of their commercial exploitation is doubtful at the present stage of knowledge of these occurrences.

### (b) Geothermal

It is highly probable that geothermal fields exist in Uganda, in connexion with the Rift Valley faulting and its associated volcanic activity. At Buranga, in Toro province, there is an extensive area of hot springs and swamps and a definite attempt was made to locate an accumulation of geothermal steam. Ten wells were drilled, most of which gave hot water at 96° - 98° C, and two of which made considerable quantities of steam before dying into geysers. The area is located in the Albert Rift Valley and the springs are immediately adjacent to the main Rift fault.

### II. Production, trade and consumption of primary energy (5,5a,7,9,10)

### (1) Production

Eydropower stations are the only source of primary energy in the country.

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	The state of the s	a sala sa san a garangan da	Hydroe in G			Te į	otal n 1,000	
	or itgainmed	Total	Pub	lica	Private	(	rounded)	e della companya della propriata della propria
•				arter versions,				
5 -	1959ad	345.6	345	<u>"6</u>	_	4	173 H S	ng a
	1960	396.2	396		WAY I THE AVERTAGE ,		198	
	1961	450	<sup>801</sup> 434	.8 abo	ut 1 <b>5</b>	1.49.0	225	To State of the st
	1962	470		.0 1.68 n		i di	235	The state of the s
	1963	570	<sup>₹81</sup> 500	r.885 n	10	• * ;	255	ia ope <b>i</b> Nasion
_			A STATE	f (98)				4.

Conversion ratio : 1 KWh = 0.5 kg coal equivalent.

### (2) Trade

In docs (5 and 5a), there is a want of clearness about the real amounts of imported and consumed quantities of liquid fuels. The figures quoted are as follows (in 1,000 tce rounded):

	Net Imports	Bunkers	Consumption
1 80 10 10 10 10	FIRE LANGUAGE TO THE		
1959	170	below the	1,80 <sub>0 (20)</sub>
1960	170	level of rounding	190
		10/4 10/4	
1962	180	10,000	190
1963	1,80	10 <sub>11011</sub>	
er i de la companya d		gradient (Specification	7.3

Quantities given under "Bunkers" were supplied to foreign-bound ships and aircraft, irrespective of the flag of the vessel or plane. "Bunkers" are not considered as "Export", nor as "consumption" of the country under consideration

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In the figures given above, the equation:

Net Imports - Bunkers = Consumption

is not complied with.

### (3) Consumption

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Part of the hydro-energy produced is exported to Kenya according to a 50-year agreement between Uganda and Kenya.

	Programme Company Comp							
	Produced <sub>.</sub> 1	Export		energy Consumed in count GWh	1 ~ ( ) ( )	tce Liquio	· Profit	tce
1959	345.6	129.4		1216.2	108	180	288	
1960	396.2	160.1		236.1	118	190	308	
1961	450	191.3		258.7		180	309	
1962	470	188.9	41 M30	281.1	140	128 621 <b>90</b>	330	
1963	570	190		320	1 <b>6</b> 0	<b>2</b> 00	360	

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	Copulation in 1000)	Kr of o	[3] III o an	lian iga-sut;,
1959	6513 · 44 · 8	o <i>id i<b>44</b>0,s</i> c	Pa <b>ll</b> uta	Strasty of in
1960	6677	46 <u>a</u>		
1961	6845	45		
1962 mass	7016	47	•	9.5 9.5 ***
1963	7190	50		• • • • • • • • • • • • • • • • • • •
		S	· 10 1	intoT

### III. Electric energy (2,4,5, 5a, 7, 8, 9, 10)

# (1) Existing power plants who so we was accurate found

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is 9.4 per sent.

### (a) Installed capacities

The bulk of electric energy is produced in the <u>Har Owen</u> Falls, north-west of Jinja. This hydropower plant is constructed on the Victoria Nile, with a head of about 20 m.

HE Owen Falls is designed for 10 turbo-generator sets, each 15 MW, with a final installed capacity of 150 MW. At present, only 8 sets are installed with a capacity of 120 MW. The last two sets will not be installed until about 1968. The total producibility of the plant will amount to some 700 GWh.

Besides HE Owen Falls, ULB (Uganda, Electricity Board) has a small hydropower plant at Kikagati (1,200 kW) and another small hydropower plant will be erected near Kabale (installed capacity not known).

The U.B has had an installed diesel capacity of about 15 MW since 1950, but since 1954, when AT Owen Falls was commissioned with the first two sets (30 MW), the diesel power plant has served for stand-by purposes only.

Besides the U.B, there are some industrial enterprises (mines of Kilembe, plantations of tea and coffee, and cotton-spinning mills) with their own hydro and thermal plants. Their installed capacities are not known.

Summary of installed capacities (in MW):

	<u>U.3B</u>	Private	Total
нз	121.2	Not ) known )	Not
Ti	15.0	known )	known
Tota1	136.2		

### (b) Production, export and consumption as a SA National Distriction and Consumption and Consum

Exact figures are available only for UEB's production (in MWh): 

	eri ma erina	obern with ri <mark>tte</mark> me o	: <u>DZ</u> f	Total	
– di drosto Promoto	1959	345,5 <del>7</del> 0 396,166	316	345,886 2)	
e et Services	1960	396,166	292	396,458 }	The 4 year
	1961	434,774	69	434,843 )	average rate of increase
. Philoph	1962	** 452 <b>,328</b> /	. 18 <b>1</b> 8	453,146 {	is 9.4 per cent.
	· 1963 %	Bullianna ? Latin	<b>?</b>	495,000	

· Albanda (1976) to the control of the transfer of the

For the electric energy production of the private enterprises, there are available only very rough figures in GMh (docs. 5, 5a):

(\$)	a do incop ji	(ala sil)	<u>H.</u>	TE	Total
	1959	Alteriation to	oden <del>–</del> den	o go g <b>20</b> go - 1	20
14	1960	this light p	suo <del>g</del> ouby,	ú j <b>20</b>	20
	1961 · ′	Mary and Conta	20,	::	40
sythida i	1962 <sub>so</sub>	160 J. (1	<b>20</b>	20	40
	1962 o 1963	ar ji iyi .	10	20	30
		Mark Own	81. s/S		i de son de la servición. De son de la servición de servic

ිස් විශාල <mark>වර වර</mark>ුවට දැ<mark>ල්</mark> සිටිසු ලබනවා. ගැන්නේ ගැන රාජු රාජ්යකරු

In the same way, therefore only rough figures for the country's total production, export and consumption in Gah:

	<u> </u>	<u> </u>	il tado sobsastas, e	
	Total production	xport	Consumption	
1959 1960 1961 1962	370 420 470 490	130 160 190	240 ) 260 ) The 4-year average rat 280 of growth i	S
1963	530	190	340 {	
			/	

"Consumption" includes power-station internal consumption and transmission and distribution losses. In the UBB-system, (a) the station consumption and losses amounted to:

1959	31.04	GWh	=	8.9 % of	total	UBB-production
1960	33.94		=	8.6 % of	total	U B-production
1961	34.38	11.	=00	7.9 % of	total	UdB-production
1962	35 • 34	n	=	7.8 % of	total	UBB-production
		si ji sid	3.11	. 0	9 *FF 12	er executive per the

# (c) Transmission and distribution

In 1961, the route-lengths of the existing transmission lines were:

- 132 kV and 66 kV ---- 265 km, overhead
  - 33 kV and 11 kV ----3400 km, overhead
- 33 kV and 11 kV ---- 50 km, underground

The system-lengths of the transmission lines are not known. In the same way, there is no information about transmission lines constructed after 1961.

The distribution system of the U\_B is standardized at 240/415V 50 cycles, 3 phase with neutral wire. In 1961, the low voltage distribution system consisted of:

Overhead lines about 730 km route-length Underground lines of the second secon

#### (d) UEB generation costs in cents per KWh sold

					02001
•	15.5s	130	<u>1959</u>	<u>1960</u>	1961
cost of	fuel	160	0.01	0.01	AUCTO IND. T
Operatio		enance	2.83	2.73	2.70
Deprecia	tion and in	terests	7.69	7.66	9.76

Total costs 10.53 10.40 12.46 g the tribunations acceptable of

The Fire Rollings of the Salar Self-

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- tybl

# (e) Tariffs with the said of the

The tariffs of UEB are as follows (US\$ 1 = AS 7 

articular.

Domestic: For domestic purposes in premises used exclusively as a private residence:

propond-Ellister and an First 6 units per month, per room 100 cents per unit Next 18 units per month, per room 30 cents per unit 

Premises with less than three rooms shall be taken as a second TANK ON POS -Salvers of 1 0058- --- Value Smill Smill RATE L having three rooms.

Power: For industrial premises and others where electricity issued mainly for motive power purposes, a limited amount of lighting of the premises being permitted of the second of the 188 188 B 188 188

Low voltage supply

district out First 50 KVA of maximum demand Shs 31.00 per KVA per month Next 250 kVA of maximum demand Shs 29.50 per kVA per month All kVA of maximum demand in " 28.00 per kVA per month excess

1000

First 200 units per month per kVA of maximum demand
13.25 cents per unit con Next 160 " " " " 11.75 " " "
All units in excess 10.25 " " "
- For premises requiring a supply not exceeding 50 kVA for power and/or heating. Lighting is not included.
First 500 units per month 47.5 cents per unit  All units in excess
Floor area block: For hotels, residential clubs, hospitals, cinemas, theatres, boarding schools, missions and other similar premises:
First 25 units per month, per 1,000 sq.ft. of floor area,
Next 75 reside a time of the form of the state of the sta
The floor area shall be taken as the superficial floor area of the premises and part of 1,000 square feet shall be regarded as 1,000 sq.ft. This tariff also applies to restaurants with the proviso that the number of units allocated to the 100 and 45 cents rates shall be not less than 175 and 525 per month respectively.
General: For all purposes in premises requiring a supply of electricity exceeding 50 kVA, except premises to which the domestic or maximum demand power tariffs apply.
For all kVA of maximum demandShs 33.00 per kVA per month and  For all units
<del></del>

For all units
lectrode boiler and approved industrial heating installations
- For supplies of electricity to appliances each with a
capacity of 30 kV and over where the installation is
separately wired and metered. The right is reserved
to restrict the supply during periods of peak demand.
For all units
Meter rentals:
tety es the sale fair eligon estates well the 20 more goods
Single-phase meters over 40 A maximum rating and three -
phase meters
Time switches " 1.75 " " "
Security lighting tariff: The consumer must be taking
a supply of electricity on one of the Board's other
tariffs.
Separate metering has to be provided.
For all units
그는 그는 그를 모습한 사람들은 학생들이 다른 유민은 그를 가는 그 때문에는 그리고 그렇지 회에 함께 되었다. 그런 그는 그는
Institutional cooking tariff. The consumer must be taking
a supply of electricity on one of the Board's other tariffs.
Separate metering has to be provided.
For all units
Consequent II also as a second of the second
Consumer unit tariff: For supplies of electricity for
lighting, radio and small appliances to premises where
the installation is comprised solely of a consumer unit
of the Board's standard pattern and controlled by a current
Advertising terms of the contract of the second of the sec
She 8 50 non month
With 1 A current limiter
With 5 " " " " " " " " " " " " " " " " " "
rest:

L Barrango.

#### 2. Future development

For the time being, there is no need of additional hydropower plant besides Ha Owen Falls, which is far from being fully exploited:

Power plant parameters	Present (8 sets)	Final (10 sets)	Actual utilization in 1962
Installed capacity, MW		*	
Installed capacity, MW Producibility, GWh	-	•	_
-1963, Rev ices, Lyan Po	E Li <b>es</b> 1960	ne vereno o	
t Intelligence dais a con-	teloonou	• • • • • • • • • • • • • • • • • • •	ii juga Vai assot d

In order to utilize the HE Owen Falls, completely, transmission lines have been constructed, under the first Five-year development plan, from Owen Falls Power Station to Kasese, Fort Portal, Lira, Gulu, Masindi and Hoima. These installations were to have been completed in 1964, but there is no confirmation existing in that respect. Also some other information is missing, as e.g. voltage, length etc.

By 1965, a new switching station is to be built at Kabulosoke near Masaka and the lines from Kampala to Masaka and Fort Fortal are to be up-rated from 66 kV to 132 kV.

For expanding transmission and distribution networks, a yearly investment of L 500,000 has been planned.

<sup>1/</sup> Jstimate

#### Documents used

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- inforesting is austrag, as s.g. voltegy, legal etc. Uganda Government Statistical Abstract 1963, Intebbe 1964.
- odesoladed to fline of a ministrate waideline you a life 1961.

  Uganda Electricity Board, Annual Report and Accounts, 1961

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- United Nations, Monthly Bulletin of Statistics, March 1965

#### Abbreviations and symbols used

- MV - Megawatt = 1,000 kW
- MWh- Megawatthour = 1,000 kWh
- GWh = 1 million kWh - Gigawatthour
- TWh - Terawatthour = 1,000 GWh
- tons (Metric) of coal equivalent
- HE - Hydroelectric power plant
- $D_{ab}$ - Diesel
- $T_{ij}$ - Thermal

# His trade and second by the Kenya tose-force become the

· 通知 (17 ) · 14 (17 ) · 12 (17 ) · 12 (18 )

# Primary Energy Resources (1, 3) LE GETTER CONTROL OF THE CONTROL OF T I.

Estimations of the exploitable hydro potential of Kenya range between 1.5 and 50 TWh p.a.. The present hydroelectric production is only about 205 GWh p.a.. There are eight existing hydro stations having a total installed capacity of about 26 MW. All of them are runof-river plants, and most of them are on the Tana River system. A 250 MW project known as the Seven Forks scheme has been planned on the Tana River system. This could produce about 1,246 TWh p.a. and would be a scheme for combined power, irrigation and flood control. Further exploitation would be possible to the extent of about 150 MW on the Tana River downstream from Seven Forks, 10 MW at Lugards Falls on the River Athi and about 20 MW in multipurpose plants east of Lake Victoria.

# 1 (2) Hyerocombons

The coastal area of Kenya, bordering on the Indian Ocean, is underlain by sedimentary recks of marine origin and the sedimentary section appears to be favourable for the generation and retention of petroleum in economically exploitable quantities. Some exploration work has been carried out and is still in progress. No deep exploratory wells have yet been drilled on the mainland but wells drilled on Pemba and Zanzibar Islands, off the cost of Tanganyika, were unsuccessful.

Exploration work has not yet progressed to the point where it is possible to give a definite opinion about the possibility of finding oil or gas in quantity.

- (3) Non-conventional sources of energy
- (a) Geothermal: There are good possibilities of finding geothermal steam in association with the Rift Valley system, where deepseated faulting is associated with extensive Pleistocene volcanic activity. Such volcanic rocks are found in several parts of the highlands to the south-east of Nairobi, in the Northern

B 94 (

Province and north-east of Mount Kenya where they form the Nyambeni Range.

Carbon dioxide gas occurs under pressure at Esegeri on the west flank of the Rift Valley and at lower pressure on the east flank. It is exploited for making "dry ice", some 700 tons per year being produced. The energy content of these adeposits is probably small, but they are an indication that -man suitable réservoir conditions exist for geothermal steam. Some wells were drilled for steam in the Naivasha area, but no details are available. There is no exploitation of geothermal energy in Kenya at the present time. Liver ara con.

(b) Radio-active minerals: No workable deposits of uranium minerals have been found yet in Kenya, but there are indica-State II tions that other radio-active minerals occur. Geological **見**続いたのでは、 conditions over much of the country are favourable for the occurrence of such minerals, and economically workable deposits may eventually be found. Makerid I real to the bear the appear and

# II. Production, Trade and Consumption of Primary Energy (5,6)

# Production Only hydro power in enclosionity oxelitiviti. Fee feiter. Buse explorator o

asitural bus t	the state of the s	in GWh	in 1,000 toe rounded ) see as little as a desp
	<b></b>	140	targer to seen up line , cinnis.
・ 特別の主席の特別がある。	1960	150	e sy, where se <b>75</b> th his more moderate.
A Property Community Commu	1961	130	on the state of th
	1962	160	in 80% in the state was the state
	1963	170	85
I no d <b>t</b> oon, ny Ede	1964	205	

The Manager of the cameege

Conversion ratio: 1 KWh = 0.5 kgs -day an acrateff evisor to the coal equivalent

the first of the second ತ ಪಡಿಕೆ ಕಾರ್ಯ ರಾಷ್ಟ್ರಾರ್ ಕೃತಿಕೆಯ ಅಥವಾಗಿ ಬೆಂಬರು ಸಂಕರ್ಣಗಳು ಕುರುತ್ತ ಕೊಂಡಲ್ಲಿ ಗಟ್ಟಿಗಡೆ ಕಾರ್ಯಗಳು

### (2) Trade (in 1,000 tce, rounded)

A.		IMPO	RTS	i godin servi	e follow	Net
	Solid fuels	Liquid fuels		opower 1,000 tce	Bunkers	imports
1959	40	1,170	150-	-75	190	1,095
1960	40	1,230	182	100 t 91	180	1,181
1961	40	1,180	- 211	106	250	1,076
1962	40	1,290	210	105	240	1,195
1963	40	1,360	205	102	<b>2</b> 30	1,195
1964			183	91	ga (1. 🛥 - 1	A Section Section 1

Quantities given under "Bunkers" were supplied to foreign-bound ships and aircraft, irrespective of the flag of the vessel or plans. "Bunkers" are not considered as "export", neither as "consumption" of the country under consideration.

## (3) Consumption in 1,000 tce:

		., U.L. (12	Carrier Control of the Control	
•	Annang Amerika mengentak mengentak di Administrativa di Amerika di Amerika di Amerika di Amerika di Amerika di	Production	Net import	Total
	1959	70	1095	1165
	1960	75	1181	1256
	1961	65	1076	1141
	1962	80	1195	1275
	1963	85	1272	1357

#### Consumption per capita:

1959		167	Kgs	Coal	equivalent
1960		170	ŧŧ	11	· ·
1961	*******	163	H	11	<b>#1</b>
1962	*******	171	15	*1	tt.
1963	*******	182	ŧŧ	<b>†</b> †	11

# III. Electric Energy (2,4, 5,6)

(1) Existing power plants

(a) Installed capacities in 1964 and production in 1960 and 1964

Changer of the contract water 12

Talian La Alore

A. Hydropower stations (HE)

					luria de la composición dela composición de la composición de la composición de la composición dela composición dela composición dela composición de la composición de la composición de la composición dela composición de la composición dela composición de
	- CV-1	IQ	Installed	Or Production	in. MWh.
Area	Name	River	capacity in 1964	087 1960	1964
det.i	088 088	ÇOL	OIS KW }		: r : : 1,8 g f
Nairobi	Tana	़् Maragua	₹96,400) /	)	119,013
Nairobi	Low Tana	Tana	ं-8,000}	1- <b>3</b> 2-1 /45	77.5 99.51
Nairobi	Wanjii	Mathieya	7,400	52,741	58,064
Nairobi -	Mdula of hee	Thika	2,250	12,210	18,743
Nairobi	Mescoev egg	Maragua	400	was 19404 colf	360 <b>و 1 و 1</b>
Eldoret	Selby Falls		360		2,805
Manykki	Liki	Liki	100	Parance $677_{-3}$ , $_{9.00}$	797
Nyeri	Sagana Falls	Nyeri	. 30.1d on 6	4,422	4,402
	TOTAL	HE,	26,410	146,500	205,184
			M reischber	4.	

des Mais de la companya del companya del companya de la companya d

B. Thermal power stations (T	1)	المناه المالية		
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			(beh z)	en si	
Area	Name	Installed	Produ	ction i	n MWh
-2012aa 2.)	norî incel	capacity in 1964 (KW)	1960		1964
(i) Steam	m power plants (SE)	en de la conferencia del la conferencia del la conferencia del la conferencia de la conferencia del la conferen	in the last fight as the second secon	ergennique y 50 or 18 o refugiales	enna ferfet vans e kan broodige - ee dadoon new
Coast	Kipevu	27,500	53,500	10 1	12,345
	Total SE	27,500	53 , 500	1	12 <b>,</b> 345
	el power plants (DE	)	160	s \$	A.
Nairobi	∂O <b>Ruiru</b> = 1	3,000	IVI		· ·14
ð	Nairobi South I	20,700)	्र <b>6,5</b> 22	i č.	⊶136ାଙ୍
			and the state of t	ude produce of a specified design Miller State of	ar gana sanan kerampan dan keram Sanan dan bandaran dan kerampan
n .inec	nec <mark>Malindf</mark> ic can ac	ifq: <b>240</b> ) îo	5,000 sauemni 10	63 59 60	463
Rift Valley	Mereron	4,400	9,660		10
Eldoret ixea	Kenya ha <b>terobiE</b> rcom	: <b>nb,i600</b> (insta	iti bi <b>2,</b> 808 au	AUST	1,7169
Nyanza i - j	ata Kisumu atubuko e	Ida <b>1</b> ,965	tith Ugander		
11	Kericho	1,200)	. taca2,237 <sub>300</sub>	Laged	119
Kitale	Kitale	1,230	2,337	Route 1	2,434
Nanyuki	Nanyuki	1,445	600	awellot	1,295
Nyeri	Sagana	450	17	44 22	. 2
	Total DE sy i	w 42,230	29,261	3 wire	5,642
(iii) Gas	turbines (GE)		general de la grande de la companya	walka super philipsory i has procupated and	
Nairobi	Nairobi SouthII	4,400	1,000	194	Nil
, ed £oV	the Total GE and	<b>4,400</b> ⊯∋ ta	78 - 1,000 dt	nih mi	Nil
	* 1	Tridual litis	ស្រាស់ ស្រាស់	bayer izo	

The Court we department of the above the number of distribute.

(b) Production, import and consumption in the period 1959-1964 in GWh (rounded)

LESS TO THE CONTRACT OF THE CO	and the second s			
Year	Production Total Hydr	o Uganda	Import from Tanganyika Total	ption
1959	210	ю 129.,	22 151	<b>361</b>
1960	230 15	60 160	21 181	411-
1961 5.516	210 213	io <u>1</u> 91	: 20 at [ 3] of 211	421-
1962	240 16	50 189	(111) 19:51 10:4208 a	448
1963	263 17	71 190	15 <u>kradici</u> 205	:dc <b>468</b> %
1964	323 20	05 (177)	1 1940 <b>6</b> . 18811-183	506

The average rate of increase of consumption was about 7 per cent.

(c) <u>Transmission and distribution</u>: Kenya has interconnexion lines with Uganda: 132 kV double circuit line Nairobi-Tororo, total length about 400 km.

The second of th

Route lengths of transmission and distribution mains are as follows:

Ž's	66 kV	40/33 kV	_ 11 kV		na managana kabba dha ka ka ka ka dha ka ka
258.2	3 wire	3 wire &	6/3/2 wire	O.H. &	
and the same of the same of the same	and a gramman angle post of the control of the cont	U.G.	O.H. & U.G.		to which approximate in the part of the protection of
	7.0.4		0 - 20		mi (AAA)
1.48	194	<b>706</b> 000.1	2,160 004.1 ELature	1,060 km	jekel <b>i</b> .

The distribution system is standardized on 240/415 Volts, 50 cycles, 3 phase with neutral wire.

There are no data available about the number of distribution transformers.

#### SUMMARY

SUMMARI 120 I PARIS LANG MISS		wind halfa
	KW Mark Street	1960: 1964
i) SE	27,500 42,230	29,261 5,642
Total HE		146,500 205,184
Power stations in total	100,540	230,261 323,171

Consumption and the maximum power demand in the various areas of Kenya were as follows in 1960 and 1964:

· ·	Sent out to system	Consumpti CWh (ro	on (sales) unded)	Maximum KW	demand
	)GWh:	1960	1964 \î)	1960	1964
Nairobi	300.1	227.0	270.64	49,360	54,940
Coast	112.5	71.2	107.0	14,646	19,400
Rift Valley.	25.7	°15.1°:0	: -, -, 23 <sub>⋅</sub> 2 <sub>⋅</sub> -, <sub>-, -, -</sub>	4,220	4,400
Eldoret	6.5	100 4141 01	6.Q <sub>0</sub> ,	1,080	1,160
Nyanza	12.6	edi 8.9° an	4 (11.1°) 8	2,259	1,400
Kitale	2.4	2.0	or 79 <b>2.1</b> -29	500	504
Nanyuki	2.0	• 16. 1. 7 · 1. ·	1.8 g.f	480	546
Nyeri	4.3	3 <b>.9</b> .;	3.9	950	934
Total for Kenya	466.1	334.1ª/	425.7ª/	73,486 <sup>b</sup> /	83,284 <sup>b</sup> /

This figure is for about 19 per cent lower than the figure given in the next table. The difference might represent losses in transmission lines and distribution networks plus consumption of power stations' auxiliary drives, but in spite of that, the figures should be checked for correctness.

b/ The actual total maximum demand of Kenya is somewhat lower than the sum of all partial maximum demands, as they did not occur at the same time.

(d) Cost of electric power: In 1962, the price for diesel oil

F.O.R. Mombasa was EAS 250.29 per ton, and furnace oil cost

EAS 112.17 per ton. In both cases the cost of transport

should be added for supplies elsewhere. Therefore, the fuel

cost per kWh generated is about 6 cents at Mombasa, but inland

the cost is up to 9 or 10 cents. Taking into account all

other expenses for generation and distribution, including
interest and depreciation, the total costs per kWh sold may

be approximately 22 cents near the coast and 37 cents or more
in the Highlands.

Hydropower in Kenya is cheaper. It is estimated, that the selling cost per unit is about 19 cents, including interest and depreciation.

(e) <u>Tariffs</u>: The tariffs of EAPb (East African Power and Light Co.) in the Nairobi area for the public supply are calculated as follows: (1/- (one shilling) = 100 cents (East African)).

### Method A. Lighting and Power for Domestic Purposes:

- 1/- per unit for the first 20 units per month, subject to a minimum charge of 18/- per month,
- . 17 1/2 cents per unit for the next 125 units per month,
- . 10 1/2 cents per unit for the next 1,100 units per month,
- cents per unit for all consumption in excess of 1,245 units per month.

All units supplied under this method of charge in excess of 145 units per month are subject to a Fuel Oil Price Surcharge.

- Method B. Lighting for all purposes and for the supply to domestic radio sets:
- 1/- per unit subject to a minimum charge of 6/- per month.
- Method B. Restricted supplies for all lighting purposes and for the supply to domestic radio sets:

either:

(i) . ll/- per month payable in advance, including the hire of a composite supply unit and a load limiting device;

or

(1i) . 10/- per month payable in advance including the hire of a load limiting device only.

A GOVERNMENT OF THE STATE OF TH

The Yoad limiting device will be so adjusted that the supply will be disconnected when the load exceeds 120 watts.

Method C. Lighting and Power for Hotels, Clubs, Hospitals,

Prisons, Restaurants, Cafés, Boarding Houses,

Schools and Flats (not separately metred) for

both dighting and power purposes:

- . 75 cents per unit for the first 125 units per months subject to a minimum charge of 70/- per month,
  - . 30 cents per unit for the next 400 units per month.
  - . 17.5 per unit for all consumption in excess of 525 units per month.

#### Method D. Power for Off-Peak Water Heating:

. 9 cents per unit plus a Fuel Oil Price Surcharge, subject

# Method E. Lighting only for Churches, Chapels, Cinemas, Theatres, Offices, Shops and Commercial Premises:

- . 72.5 cents for the first 200 units per month subject to a minimum charge of 100/- per month,
  - ... 55 cents per unit for the next 240 units per month,
- cents per unit for the next 500 units per month,

Long to be a familiar and designation and the second and the

. 27.5 cents per unit for all consumption in excess of 940 units per month.

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# sait w Method F. Small Power Supplies:

- . 42 cents per unit for the first 375 units per month, subject to a minimum charge of 17/50 per month,
- cents per unit for the next 600 units per month,
- 27.5 cents per unit for all consumption in excess of 975 units per month.

There is also a charge of 2/50 per KVA continuous rating of all electric welding plant.

Method F. Restricted Power Supplies for Water Pumping: cents per unit plus a Fuel Oil Price Surcharge, subject to a minimum charge of 120/- per month,

# Method G. Large Power Supplies - including limited supplies for lighting purposes:

A maximum demand charge according to the following (i) table

22.	The CONTRACT SHOULD NOT	engangar
No. State of the second	Maximum demand as recorded:	
	0 to 50 kVA	305/-
	51 to 200 kVA	101 1260/-
្រ ប្រទៀតបែក ស្រុកប្រៀបប្រ	Over 200 kVA	225/-

(ii) A unit charge of 7.5 cents per unit subject to a minimum annual guarantee of consumption of 40,000 units.

The unit charge will be subject to a Fuel Oil Price Surcharge, but such Surcharge will not be imposed on units which have not been consumed but are deemed to have been supplied in order to make up the guaranteed annual consumption. There is also a charge of 2/50 per kVA of nameplate kVA continuous rating of all electric welding plant.

### Method H. Restricted Power Supplies for the Production of Sisal Fibre only:

. 17 cents per unit, subject to a minimum charge of 60/per month.

Method K. Lighting and Power for Military Camps, Hospitals, Institutions, Hotels, Clubs, Prisons, Restaurants, 771 .onE Cafés, Boarding Houses, Schools, Flats (not separately 1963/1967 : 12.1 metred) and large buildings with a mixed load for 1967/1971 : 13 d combined purposes of lighting and power (including 12 (1975 : 11.4 W water heating)

A fixed charge of 32/50 per kVA per metre reading period, (i) based upon the actual recorded maximum demand, otrados and police of the control of same relief control control control

(ii) ll cents per unit plus a Fuel Oil Surcharge. os viicāgas istro ā driv ezichīsēv The above charges are subject to a minimum charge of 812/50 grand the control of the control

#### MethodoM. Lighting and Power combined for Cinemas and Theatres vriniminels will only: room equipota notico modific fina

- . 85 cents per unit for the first 200 units per month subject to a minimum charge of 150/- per month,
- adscences owt. 32 dents per unit for the next 1,000 units per month,
  - . 18 cents per unit for the next 2,000 units per month,
  - 16 cents per unit for all consumption in excess of 3,200 For the counity per month, and a form that the contract

# Method N. Lighting and Power combined for Commercial Premises: . 72.5 cents per unit subject to a minimum charge of 6/- per

month.

# Method N. Bulk Supplies for Lighting and Power Purposes to

This ages . 30 cents per unit subject to a minimum charge of 400/- per eddin .t. monthio dore a diest let let let is in 1971 i god o kro. A. ಕಟ್ಟಿಕ ಅಂತ 1

# (2) Future development (2,6,7,8)

There are available three estimates of the future consumption growth of electric energy:

Doc. (2)	post Docal(6)		Doc. (9)
1964/1965 : 10 %	1962/1970 : 9.5%	1964/1970 : 13 %	1963/1967 : 12.1 %
1966/1968: 15%		in de la life. Californio de M	1967/1971 : 13 % 1971/1975 : 11.4 %

However, there is no official estimate existing

Future power plant development is based mainly on the hydroelectric potential of the Tana River. Long-range plans have been made for a three-stage development at Seven Forks with a total capacity of about 250/270 Mw. The producibility of the individual stages has not been given. The total investments will amount to £ 37 million. The Seven Forks scheme will be completed in 10 to 12 years, but construction works will be phased to anticipate expansion in the demands for electricity and other water storage requirements.

(a) Kindaruma power station, installed capacity 40 MW:

Construction started in March 1965. There will be two generating units, each with a Kaplan turbine of 28,000 HP (gross)

or 20 MW nett and a generator of 23.5 MVA. The main transformers of 25 MVA will each step up the voltage from 11 KV to 132 KV for transport to Nairobi. Later, a third unit should be added and in this way the total installed capacity would be increased to 60 MW.

The total investments of the 40 MW phase, including transmission line 132 KV to Nairobi amount to £ 6 million.

(b) The Gtaru scheme power station with a total installed capacity of 170 MV will have four power units, each of 42.5 MW. This power station, with a head of about 203 m, will be situated underground and will be supplied by water from the large water reservoir upstream.

(c) A reservoir scheme power station (40 MW) will be located immediately downstream of the dam of the large reservoir. The useful storage of this reservoir will be about one million acre-feet of 1,200 million m3. (d) At Kipevu on the coast, an additional oil-fired steam plant is to be installed in 1965; it is a 12.5 MW unit, the boiler of which is already in service. Property of the property of the second of the of the programme in the second of the control of th APPER A COMMON LINES WE BOURD TO BE COME. andija intopropri applinimo ali uni programi in programurini, a i a - nda - India - Miles it between its The Arra as at the exp March 1 . Co. 2 . London Company in the fact of a substitute of the second the few commission will be a commission of figure with the electric grant of the first of the second of the second of the to be a second to the time of the contract of

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#### Abbreviations and symbols used:

MW : Megawatt = 1,000 KW

GWh : Gigawatthour = 1,000,000 kWh

TWh : Terawatthour = 1,000 GWh

tce : tons (metric) of coal equivalent

HE: Hydroelectric power plant

DE : Diesel electric power plant

SE: Steam power plant

GE: Gas turbines power plant

TE: Thermal power plant

L.T. - Length of transmission and distribution mains

O.H. - Overhead lines

U.G. - Underground lines

#### 6. TANZANIA

The action of the second secon

#### A. TANGANYIKA

### I. Primary Energy Resources (3)

#### (1) Hydropower (from page 7)

Exploitable sites for hydropower are situated on the rivers flowing into the Indian Ocean. Other rivers, feeding the great lakes, are dry during part of each year and are not regarded as suitable for developing hydropower owing to the over-riding demands of irrigation. In general, hydropower and irrigation projects are inter-related in a grant and irrigation and irrigat Tanganyika, and must be planned as a co-ordinated whole. No complete survey has been taken yet, but it would seem that not less than 2,500 million kWh p.a.  $\frac{1}{2}$  could probably be generated ultimately, even though some of this production would be very costly owing to the need for large storage dams to even out the wide seasonal variations of flow. At present about 40 MW of plant is installed or under construction at five sites, and the total production of hydraulic energy is about 100 million kWh, p.a. though this should be about doubled when the Hale 21 MW plant is in full operation. The largest of the possible hydro schemes is in the Rufiji Basin, where a total of about 500 MW of plant ould be installed.

#### (2) Hydrocarbons

The coastal zone of Tanganyika, bordering on the Indian Ocean, is to a large extent underlain by sedimentary rocks of marine origin. A considerable amount of exploration for petroleum has been carried out in this area during the last 10 years, including the drilling of a deep well at Mandawa in the Southern Province. So far no economically exploitable accumulations of oil or gas have been found, but exploration continues.

医乳状炎 网络哈拉尔 海关 紫色体 化二二苯甲羟基对抗性 人名

<sup>1/</sup> According to doc. (1), hydro potential is estimated at 75,000 million kWH (=75 TWh). The figure in the text above seems to be very much underestimated.

#### (3) <u>Coal</u>

Tanganyika has large reserves of bituminous coal, which have not so far been developed on a large scale, reportedly owing to the remoteness and inaccessibility of their location. The largest part of this reserve is in the Ruhuhu river area, on the east side of Lake Nyasa near its northern end. Numerous coal seams are known to occur in this area, varying in thickness from a few centimetres up to 5 metres. Reserves of good quality non-coking bituminous steam coal in this area are stated to be of the order of 300 million metric tons; if lower grades are included, the reserves exceed 400 million metric tons. The seams are generally undisturbed except for some block faulting, but only a small proportion of the coal could be mined by open-cast methods.

4.5 % 1987

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Analyses	OT.	SOME	OT 1	the	coals a	re	given, helow:		
11101000	-	~ 0.00	~ ~	~	0000	7.	given below:		
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Ngaka 2.7 26.0 _ 6 63.8 7.5 0.9 6,800		er Arme	Volatiles	Fixed Car	. %		Calorific Value Calories/ gramme
South Manda - 1.5" (19.7) (19.7) (19.6) (15.6) (0.57) (19.6)	Ngaka					0.9	. 6,800
	Ketewaka , 🔹		^> ≈ 23 <b>∗</b> 4	50.2	.25.2	0.53	5,800
Njembe 3.5 19.9 40.6 36.0 0.24 4,100	South Manda	1.5%	· 19.7	63.2	15.6	0.57	6,500
	Njembe	3•5	19.9	40.6	36.0	0.24	4,100

All. the above analyses were made on coal samples taken from out-

Smaller coal-bearing areas are known to occur in the general area of L. Rukwa, between L. Nyasa and L. Tanganyika. These areas are of limited extent, bounded by faults, the coal is in general of poorer quality than that in the Ruhuhu valley, and the reserves are much smaller.

### (4) Radio-active minerals

No economically exploitable deposits of such minerals have been found yet although significant indications are known to exist. Exploration continues and may be successful.

where  $i \in \mathbb{N}$  and  $\operatorname{diagram}_{\mathcal{C}}(i)$ 

#### (5) Geothermal

It is undoubtedly possible that genthermal anomalies may exist in connexion with the Rift Valley system and the extensive recent volcanic activity associated with it, but no specific details are available.

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### II. Production, trade and consumption of primary energy (1, 5, 5a)

- (1) Production
- (a) In natural units (rounded):

	•	Hydroene	Coal	
		GWh		tons
1959		90	ur by i	2,000
1960	**	90	1 2 2	2,000
1961		90		2,000
1962		100	* t	2,000
1963		100	111211	2,0001/

(b) In equivalent units, 1,000 toe (rounded):

	Hydr	oenergy	Coal Coal	Total
1959	• • • • • • • • • • • • • • • • • • • •	45	2 1 1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1 1 1	47
1960	**	45	2	47
1961		45	eatherlager of	47
1962	* # # # # # # # # # # # # # # # # # # #	50	2	52
1963		50	2	52

Ratio of 1 kWh = 0.5 kgs coal equivalent has been taken as the basis for calculation

(2) Net import of liquid fuels, in 1,000 tce (rounded):

programmer many against grant or or considerable in	to a marine to	
<sub>a.</sub> 1959	370	
1960	430	
1961	400	24. 1
1962	11.961-rs 1.4 <b>30</b>	waan, b.it r
1963		venim vije de

(3) Consumption in	1,000 tce:		in a serie ais	
Potential de la companya de la comp	ydroenergy	Coal L	iquid fuels	Total
#dases a nov <b>1959</b> -	45 A5 Control	· 2 1.1 45	3.70	27-417-
		K <b>2</b> im betw.	Love 430 Synthy 1 -	477
1961	45	2	400	447
1962	. 50	2	430	482
1962 1963	50	2	450	
C	onsumption pe	r capita:		(t)
			quivalent	(8)
<u>[180]</u>			quivalent	
err of	1960 51 1961 47		11	
000,3	1961 47 1962 <sup>(2</sup> 51			
	1962 51			
000.	-	**	i o di	
III. Electric energy (2,		7, 8)	n Neg	
(1) Existing power	plants 191		£861	
(a) Installed capa	<u>city</u> (in 1961	) <b>( )</b> ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )	zalevijio af	
Hydropower	plantsone 2	0.2 MM		
Diesel pow	er plants 2	6 <b>.</b> 3 "	1 white 5 to 2 to	
	(4. 4	6.5 "		
Hydropower pla	nts:			
		anaci tv	Producibility	
		in kW	_	
HE Pangani	Falls 1	7,500	80.0	
HE Kikulet	wa.	1,160	6.0	
HE Little	Ruaha River	1,220	2,6	
HE Mbalizi	(near Mbeya)	340	1.6	(8)
		0,220	90.2	
	Co. :	_ <u> </u>		
Diesel power p	lants		* * **	
	i (near Dar-e		1966 1966	17,200 kW
Small DE ( about	Arusha, Moshi	, Mwanza a	nd others)	9,100 "
			:	26,300 "

方面計劃大

#### (b) Production, trade and consumption, in GWh (rounded)

ide politica de

***	Hydro	roduction Diesel	Total	Export to Kenya	Consumption
1959	***************************************			202707	
-	-	∂∂ 60 / i	-		130
1961	90	ୁ <b>7</b> 0 <sub>୬୪୦</sub>	160		140
1962 	100	80	180		<b>160</b> 000 3
1963	100	90	190	. <u> <b>20</b>a san</u> a	agr.   170 mail

In the period 1959-1963, the average rate of growth of consumption was 6.8 per cent.

In 1962 the distribution of unit sales was as follows:

	Per cent
Household power and lighting	270-100
Sisal supplies	2 <b>8</b>
Power supplies	22.6
Commercial power and lighting	15 Tall 1
Street and lighting supplies	ac 19 <b>13</b> 11 11
All other	4.4
1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	100.0
The state of the second of the	

# (c) Transmission and distribution

In 1961 there were no internal transmission lines between the existing power-centres. There is only one 33-kV cross-frontier inter-connexion line with a total length of 70 km (estimated to the border of Kenya).

No information is available about the existing distribution systems.

# (d) <u>Tariffs</u> (US\$ 1 = EAS 7 = E.A. cents 700)

In Dar-es-Salaam, Arusha and Moshi, the tariffs are:

easity of Ordinary lighting E.A. cents 120/kWh

B.A. cents 60

Lighting and power for hotels, hospitals, clubs, cinemas:
standing charge per month and the first rate 25 E.A. cents/kWh
exceeding

Domestic, private consumption: standing charge per month and 25 E.A. cents/kWh

Off-peak domestic water-heating and air-conditioning: 8 E.A. cents/kWh

The tariffs in the Tanga area are lower on average than the above cited ones, except the price for lighting, which is also 120 E.A. cents/kWh. In other distribution areas the tariffs are similar to those of Dar-es-Salaam.

#### (e) Fuel costs

The price of diesel oil at various places in Tanganyika depends very much on transport costs:

Dar-es-Salaam	247.60	EAS/ton
Arusha	316.95	11
Moshi	317.24	. 艺术(2)
Mwanza	387.92	ng se di di

# (f) Production costs

Hydropower costs: About 18 E.A. cents/kWh. This covers all expenditure including interests and depreciation, and a high voltage line from the hydropower plant to the consumption centre.

### Diesel power plants

Fuel costs
6.7 - 10.2 E.A. cents/kWh
Operating costs
11.0 - 16.0
"
Interest and depreciation not known

# (2) H.E. Hale and 132-kV transmission line Hale - Dar-es-Salaam

In 1964, the HE Hale on the Pangani River was to have come into operation, according to provious construction plans. At the same time the Dar-es-Salaam distribution system was to have been linked to the Tanga system by a 132-kV line with a length of approximately 280 km.

H.E. Hale is to have an installed power of 21,000 kW with a yearly producibility of 95 GWh.

There is no information available which would confirm that the above-mentioned objects went into operation according to schedule.

# (3) Future development (8) . Terminological administration of the contract of

For the five year period 1964-1969, it is supposed that the average rate of increase of consumption will be 12 per cent. The provisional breakdown of 1970 sales of electricity is as follows:

Dar-es-Salaam	201.0 GWh 10 84 A D English 201
Tanga	पर्वे <b>80:5</b> ण भाषी २० आगम के एक्स्प्रेस के किस्स्येक क्रमार्थ 🗕
Arusha/Moshi	ં કે <b>24.8</b> જ માનવા જાય-મહેલા વડાંગા છે. વડાંગાં સ્થાન
	23.21 CHRS.
Central line Up country	25.9 militare-dia alego on elegations
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The new investment that is required up to 1970 to achieve this increase in electricity supplies is estimated at £10.6 million, of which £8.1 million will pay for the installation of new generating capacity and transmission lines.

The preliminary phasing of investment is estimated to be (in £1,000):

A					and the second contract of the second contrac		AP 9 - 111 Seriego - mos
000,011 3 000,011	1965	1966	1967	1968	1969	e <b>1970</b>	Six-year total
General extension to	<del></del>		<b>V</b> V		titi go.	žralma;n	(1)
existing plant	350	. 400 . 800,014, 5-3	400			olit <b>500</b> °	2,550
New power station	_			2 1 2 M	2,300	3,000	6,600
New transmission lines	1,500		ante que se se percente.		energy or the selector	Company of the Company of the Company	1,500
Total	1,850	400	400	1,700	2,800	3,500	10,650
	A Company of the Comp		gar Land - Andrews		el leos!	$M = \langle \gamma \rangle$	

The total investment programmes of the Tanganyika Electricity Supply Company (TANESCO) for the five-year period 1964-1965 to 1968-1969 amount to £ 6.71 million.

### (a) Additional power station of about 30 MW to supply Dar-es-Salaam

It. was not yet decided if this power station will be erected on the Pangani River or on the Wami River.

Breakdown of the total project inv	estments and s
- Power station for Dar-es-Salaam supply	\$ 3,500,000
- Duplicate Hale/Dar-es-Salaam 132-kV	in the ES Salah papa Men y
Transmission line	520,000 <sub>free</sub>
- Additional interconnectors Pangani/Hale	30,000
- Additions to Hale Sub-station switchgear and	
transformers	100,000
- Additions to Ilala Sub-station	80,000
- New feeders out of Ilala	100,000 Tainuoc ju
Total	£ 4,330,000
equipment of the law to the course of the second of the se	taeathered war ang

# double to resilling a. Some the formulae and the supplies with the supplies

Items		Amount
- HE Nyumba ya Mungu (5 c	or 6 MW)	€ 710,000
Transmission line HE N	yumba ya Mungu to Moshi	140,000
- Sub-station Moshi	general and general and the second of the se	140,000
- Moshi/Arushi duplicate	transmission line	of mar. 120,000 mar.
- New 32 kV-feeders		160,000
A Company of the Comp	Total	£ 1,230,000
		The Archenicans of the way

### (c) Miscellaneous small scale projects

Total amount of £1,150,000

The total investages programmes of the Targesting Slacetisty Supply despaint of the Polyment of the 1965 to 1966. Supply despaint distributions of the first of the Polyment of the first of the Polyment of the first of the Polyment of the first of the f

B. ZANZIBAR AND PEMBAsois . and a case (a) social of spinoscock

Very little is known about the energy situation in the island part of Tanzania, on Zanzibar and Pemba.

#### I. Primary energy resources

No data

#### II. Production, trade and consumption of primary energy

There is no domestic production of primary energy. Only the imported liquid fuels are consumed in the country:

	Import and consumption of liquid fuels
1959	20,000 tce (rounded)
1960	20,000 " ( " )
1961	20,000 " ( " )
1962	20,000 " ( " )
1963	20,000 " ( " )
	Consumption per capita
1959	55 kg coal equivalent
1960	53 " " "
1961	51 " " "
1701	· · · · · · · · · · · · · · · · ·
1962	60 " " "

#### III. Electric energy

The total installed power of thermal plants was 3,600 kW, with a yearly production of 11.9 GWh in 1961. The number and the kind of power plants is not known, but according to some indications they are diesel power plants. There are no hydropower plants.

According to docs	s. (5) and (5a), production and	sonsumntion of
	autla goggale Ado fou como de e	
1959	10 GWh.(rounded)	
1960	30 " "	
1961	10 " "	
1962	10 " "	
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5a.	11	<b>†</b> †	P#	***	***	1960-	1963,	17 11 	1965,	No.8
atae∦ 6•ci	rReport	of an TA	EA Missio	ricocyal n to Ta	nganyik	a & Vi	enna,	1962		
7. 0	<u>Develo</u>	pment Pla	n for Tan	ganyika	1961/6	2 <b>–</b> 19	63/64.		iqelsk	
8. 3	Tangan	yika Five	Year Pla	n for E	conomic	and S	ocial I	Develop	ment,	
) () ) () ) () () () () () () () () () () () () ()	ી. Ĵuly	1964–30	June 1969	, OGI	. 83	·		••• ೧೮೮	and of the co	
	(a) V	olume I:	General	analysi:	<b>s</b> .[]			aal". B	orlineR	
Ĺ	∂(ъ) v	olume II:	The prog	rammes	And		ខ្ទុំ ១៦៩ មា	rozgai	Various	
9.	္လ Dê <b>ve</b> lo	pment of	the Steel	् Indust	ry in E	ast an	d Cent	ral Afr	ica,	
And the second s	្រ ១៩មេប៉	tkins and	5.0 Tr \$T	hantel j			A CONTRACTOR OF THE CONTRACTOR	D-30,20	ing Coupe (Coope ) resigned in management of the Coope (Coope ) and	(Complete Pilon 25)
Abbi	eviatio	ns and sy	mbols use	<b>d</b> 93 <sup>17</sup> b	1.	in the half-reference of the	. 4 1284	196	* * ;	13 P
<b>A</b> (3.1)	MW — Me	egawatt =	1,000 kW	ఎమ్కి కైగా! ఎక్కార్స్	1 lo 19	. 6 . <u></u> .vi	. कर्ग <b>्य</b> ः 	icesva Leonia	and the state of t	
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		Terawatth			: T +				•	
		tons:(met:				•				
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									The Land	



# 7. MALAWI

#### I. Primary Energy Resources (3)

#### (1) Hydro-power

Malawi has a considerable hydro-power potential, located principally on the Shire River between Matope and Chikwawa. Details of the various schemes and quantitative estimates of their potential output are given in a report prepared for the Government in 1954 by Sir William Halcrow and Partners. In this report, the following figures are given on the Shire River potential sites and the necessary investments:

Africas Paga a saga sotia .

Site		Capa <b>c</b> it	Investments	
	Pirm	Peak	Installed	L million
Matopi	S <b>16</b> ( )	af 3 <mark>39</mark> 78	40 10 mag	2.740
Nkula	67	135	180	9.496
Mpatamanga	96	120	150	10.985
Hamilton Falls	61	75	100	7.229
Various improvements		NAME OF THE PARTY		2.441
Total	240	360	470	32.891
. pojnika isto kranti	in 4. 3	Yatsubah.	nwell of the Steel	odenski 🙀

Expressed in US \$, specific investments of the whole scheme would amount to \$ 196 per kW installed and the energy costs to 3.2 mills/kWh. It should however, be pointed out that these estimates were made in 1954 and that since then, the level of prices has risen considerably.

# (2) Hydrocarbons

Malawi has no known hydrocarbon resources but small amounts of dissolved methane are present in the deep waters (300 m plus) of Lake Malawi and it is possible that further prospecting might show produceable quantities.

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#### (3) Coal

Coal is known to occur at five different localities: two of these are in the Shire Valley and three in the Northern Region not far from Lake Malawi. In general, the coal seams are thin, with a high ash content and, locally, badly broken up by faulting. In the Sumbu area of the Shire Valley they have been intruded and partly decarbonised by igneous rocks. The most promising occurrences appear to be in the Livingstonia and Nkana areas. located on the west side of Lake Malawi near its northern end. At Livingstonia, coal is found in an area of 90 km<sup>2</sup>: it varies laterally in thickness from 30 cm to 3 m and is often split into more than one seam. The area is block-faulted and the coal seams are overlain by sand-stones locally containing artesian water. The coal has an average ash content (including outcrop samples) of 31.9 per cent but there are some thick workable seams with an average ash content of 14 per cent. The calorific value ranges from 5,400 to 7,050 cal/g. (mean 6,230). However, the coal would be difficult and expensive to mine. It Nkana, just south of the Tanzania border, there is a smaller amount of coal that would probably be easier to mine and that is of similar quality: individual seams are up to 2 m in thickness. The average ash content is 21.2 per cent and average calorific value 4813 cal/g.

# (4) Non-conventional sources of energy

- a) Radio-active minerals: A number of occurrences of refractory
  U-minerals are known in Malawi, the largest of which are at Tambani, Blantyre
  District, and to the north-west of Chitipa (Fort Hill). If extraction
  problems can be solved, the deposits may be economically exploitable.
- b) Geothermal: Geothermal energy derived from hot springs is a possibility as such springs are fairly commonly associated with the Rift Valley faults bordering Lake Malawi.

# II. Production, Trade and Consumption of Primary Energy

(1) Production

Only small amounts of hydroelectric energy are produced in the country. In 1961/1962, this production amounted to 4,6 GWh.

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(3) Consumption

No data available.

# III. Electric Energy (1,2,4,5,6)

- (1) Existing power plants
  - (a) Installed capacity at 30 June 1963

		in kW c	Total Peak apacity Load in kW kW	<u> </u>
	DE 1	x 2500 + 2 x 1000 x 1340 x 1100	) 10,540 )	
Zomba	. DE I	en e	2,800)	<b>55•5</b>
, and the second	+ 1	x 700 + 2 x 240 x 235 + 1 x 140 x 85	) } -1,810 700	43•9
Fort Johnston	DE 3		60	ing sa
	·	x 105 + 1 x 80 x 50 + 2 x 20	) 275 () ()	inded La secióne

Breakdown of the total capacity according to the type of power station:

 SE
 7,000 kW

 DE
 7,825 kW

 HE
 600 kW

 Total
 15,425 kW

(b) Production in 1961/1962 and 1962/1963, according to the type of the stations and the province of the country (in MWh):

The second section of the second section is a second section of the second section is a second section of the second section of the second section is a second section of the section of th	D	E 🗽 :	. 5	SE	HE		Total ger	neration
9.7	1961/62	1962/63	1961/62	1962/63	1961/62	1962/63	1961/62	1962/63
Southern	me to be be the second of the	* C 34, 95	2,001					
	2,890.8	4,276.0	28,383.9	30,488.3	4,553-4	4,276.1	35,828.1	39,040.0
Lilongwe	2,538.9	2,691.7	And the same process of the same of				2,538.9	2,691.7
Fort Johnston	46.2	48 <b>.</b> 2	·	*** * * * * * * * * * * * * * * * * *		lavilator (1)	46.2	48.2
Mzuzu	143.0	200.2		en e	Maria <u>a</u> gga e	odinia-ce	143.0	200.2
Total	5,618.9	7,216.1	28,383.9	30,488.3	4,553.4	4,276.1	38,556.2	41,980.5

(c) Breakdown of consumption in 1961/1962 and 1962/1963, by various groups of consumers (in MWh):

Groups of consumers	Sout Prov	hern vince	Lile	ongwe	District Fort Job	s Mzuzu and inston
Consumers	1961/62	1962/63	1961/62	1962/63	1961/62	1962/63
Street lighting	-241	312	36	51		
Industrial	17,346	18,651	<b>56</b> 6	855	14	52
Domestic	8,565	9,088	683	669	88	107
Commercial	4,339	5,272	<b>86</b> 8	769	62	57
General purposes	167	147	27	26	er way year.	
High-density areas	<u>.0 104</u>	108	21	18	1	2
Sales total	30,761	33,577	2,201	2,388	165	218

TOT L:

Groups		1961 / 1962	196	2/ 1963
of consumers	M!vh	%	MWh	%
Street lighting	277	0.8	363	1.0
Industrial	17,926	54.2	19,558	54.1
Domestic	9,336	28.2	9,864	27.2
Commercial	5,269	15.8	6,098	16.8
General purposes	194	0.6	173 etc.	ht- 2930.5
High-density areas	126	0.4	128	0.4
Total	33,127	100.0	36,183 <sup>S</sup>	100.0
· · · · · · · · · · · · · · · · · · ·	-	1961/19	962	1962/1963
Total generation	1	38	B <b>,5</b> 56	41,980.5
% P	The state was the same and the same of	Contract to mention of the contract of the same of the	or 14 %	5,797 or 13.8
(d) Transmissio	n and dis	tribution network	cs as at 30	The state of the s
(d) Transmissio	n and dis- nes and un	tribution network	cs as at 30	5,797 or 13.8 9 June 1963 Total
Overhead li  OVERHE D LINES  66 kV  33 kV  11 kV and 3.3 kV  Low voltage 400/23  Overhead lines Total  WNDERGROUND CABLES  11 kV and 3.3 kV	n and distance and un Prov	tribution network derground cables thern Lilongwe vince  44 - 43 55 39 38 36 93	Es as at 30 s, in km: Districts  12 .9 .21	June 1963  Total  44 210 410 236 900
Overhead li  OVERHED LINES  66 kV  33 kV  11 kV and 3.3 kV  Low voltage 400/23  Overhead lines Total	n and distance and un Prov	tribution network derground cables thern Lilongwe fince  14 - 10 - 13 55 39 38 36 93	Es as at 30 s, in km: Districts  12 .9 .21	June 1963  Total  44 210 410 236 900

The total length of power lines was at that time:

Transmission lines: ......

Distribution - Medium voltage Meders .......

- Low voltage network .....

254 km (rounded)

11

424 km

240 km

#### Transformer capacity, in kVA:

46 4.1.2 <b>0</b>			Facility 100 cm.		-
		Southern	T Tolkin strik	Districts	Motol
11/33	Lisas viis see ac kV	6,000	file 🚅 bna	on service 🛨 Agreed	6 <b>,000</b>
N. C. M. C.	hub-total		1,100	210	7,610
33/0.4 11 and	v cV kV 3.3/0.4 kV	4,500 2,315 20,075	2,665	170	4,500 2,315 2 <b>2</b> ,910
2 Tud (199 T <u>od (189</u>	Sub-total	26 <b>,890</b>	-2 <b>,6</b> 65	170 <sub>00 188</sub>	
	-\@;		3,765	380	37,335

(e) Prices of electric energy in pence/kWh by consumer groups and provinces, including fixed charges for power, for the periods 1961/1962 and 1962/1963:

Consumer groups	South P <b>r</b> ovi		Lilongw	e i do	Distri	icts
and the second of the second o	61/62	62/63	61/_62	62/63	61/62	62/63
Street lighting	3.47 ca	3.37	4.58	4.50	and the second second second second	CIPA THAT I PROOF F AND INC.
Industrial		3.15	4.78	4.78	7 • 35	8.74
Domestic	3.57	3.51	5.66	5.68	12.16	11.80
Commercial	-5.24	4.99	5.52	5.65	12.20	12.51
General purposes	16.02	16.07	16.32	16.62	15.61	17.23
High-density areas	8.50	8.56	13.55	13.97	17.14	14.61
Provincial averages	3.60	-\01.61	5 • 57	. 5.51	11.81	11.29

The average for the country amounted to  $\frac{3.77 \text{ pence/kWh}}{3.78 \text{ pence/kWh}}$  in 1961/1962 and  $\frac{3.78 \text{ pence/kWh}}{3.78 \text{ pence/kWh}}$  in 1962/1963

(f)	Tariffs:	Salar Sa Salar Salar Sa
of information of the state of the At-Sandaubur make in	Since 1961, the	tariff-system in power has had five scales:
		stic tariff and the same
The body of the state of the st	For the supply of	electricity to premises used solely for resi-
.00.3		and to all apparatus normally used for such
		ng motors up to 2 H.P
9X (; 244.2		Southern Pro- Fort Johnston vince Intercon- Lilongwe Mzuzu nected System
First 20	units per month	1/3d. per unit 1/3d. per unit 1/6d per unit
Next 120	units " "	4d. per unit 6d. per unit 9d. per unit
Balance	• • • • • • • • • • • • • •	2d. per unit 3d. per unit 9d. per unit
	charge per month	10/- 10/-
	***************************************	ral Purpose Tariff  Celectricity to premises or installations for
	which, in the opi	nion of the Commission, no other tariff is
	appropriate.	
		Southern Pro- Fort Johnston vince Intercon- Lilangue Mzuzu nected System
All unit	s per month	1/3d. per unit. 1/3d. per unit 1/6d. per unit
Ninimum	charge per month	
in 1982/1983	3.77 pence/fc/b	F. D. F. THE PER STEEDINGS OF MANY STEEDINGS OF THE SECOND STEEDINGS OF THE SE

Balance as ......

## Anivolio to that, the indifficult of solitities al

For the supply of electricity to premises used for the following purposes: hotels, theatres, restaurants, clubs, public houses, cinemas, institutions, hospitals, offices, nursing homes, garages, shops, small workshops, public halls, schools, hostels, airfields, communications centres, railway stations and similar establishments, providing the demand does not exceed 50 kW of which not more than 15 h.p. of

reiddervil jarposee	vince Intercon- Lilongwe	Fort Johnston Mzuzu
First 100 units pertmont	nected System  h 1/- per unit 1/- per unit 4.5d. per unit 4.5d. per un 2d. per unit 3d. per un	1/6d per unit
finimum charge per month		

## Tariff - Industrial Tariff

For the supply of electricity for manufacturing and processing purposes, commercial water heating, cooking and refrigeration, water pumping,

farming and workshops:

en case ö/6á. per month	Southern Pro- vince Intercon- nected System	Lilongwe	Fort Johnston Mzuzu
First 200 kW of maximum	L 1 12 04	L 1 12 0d	√L1.c12.0d.
demand per month	per kW	per kW	per kW
Next 200 kW per month	<b>L1 6 Od.</b>	L1 6 Od.	L1 6 Od. per kW
Balance	L1 0 Odgaska ta per kW	L1 0 Od. per kW	L1 0 Od. per kW
First 10,000 units per month	2d. per unit	3d. per unit	6d. per unit
Next 40,000 units per month	1.6d. per unit	3d. per unit	6d. per unit
Balance	1.4d. per unit	3d. per unit	6d. per unit

In addition to that, the industrial tariff	has also the following
clauses: a last lag plant paraticle of months and it	
(a) Minimum Charge at all Undertakings,	
(b) Power Factor clause at all Undertaking	100 - 100 -
(c) Coal Price Variation clause at South	
nected System,	,
(d) Fuel Oil Price Variation clause at Li	and the state of t
(e) Fuel Oil Price Variation clause at Fo	
- Scale V - High Density Residential Area Te	III I I service annual conference on transcript of the control of
For the supply of electricity used solely for a	
in premises of a type approved by the Commission	on and situated in areas
declared by the Commission as High Density Res	idential Areas for the
purposes of electricity supply.	
	近日は10   10   10   10   10   10   10   10
Southern Pro-	Fort Johnston
vince InterconL	
nected System	Mzuzu
nected System	C. C. S. C. C. S.
nected System	7/6d. First 8 units
nected System  First 12 units 7/6d.	7/6d. First 8 units for 7/6
nected System  First 12 units 7/6d.	7/6d. First 8 units
nected System  First 12 units 7/6d.	7/6d. First 8 units for 7/6 per unit 9d. per unit
nected System  First 12 units 7/6d.  Balance at 4d. per unit 6d. p	7/6d. First 8 units for 7/6 per unit 9d. per unit
nected System  First 12 units 7/6d.  Balance at 4d. per unit 6d. per u	7/6d. First 8 units for 7/6 per unit 9d. per unit ch case 8/6d. per month
mected System  First 12 units 7/6d.  Balance at 4d. per unit 6d. per u	7/6d. First 8 units for 7/6 per unit 9d. per unit ch case 8/6d. per month
nected System  First 12 units 7/6d.  Balance at 4d. per unit 6d. per u	7/6d. First 8 units for 7/6 per unit 9d. per unit oh case 8/6d. per month in pence/kWh in 1963/1962 ovinces; these costs
nected System  First 12 units 7/6d.  Balance at 4d. per unit 6d. per u	7/6d. First 8 units for 7/6 per unit 9d. per unit 9h case 8/6d. per month in pence/kWh in 1963/1962 princes; these costs on costs for steam,
rected System  First 12 units 7/6d.  Balance at 4d. per unit 6d.	7/6d. First 8 units for 7/6 per unit 9d. per unit 9h case 8/6d. per month in pence/kWh in 1963/1962 princes; these costs on costs for steam,
mected System  First 12 units 7/6d.  Balance at 4d. per unit 6d. per u	7/6d. First 8 units for 7/6 er unit 9d. per unit 9d. per unit ch case 8/6d. per month in pence/kWh in 1963/1962 evinces; these costs on costs for steam,
rected System  First 12 units 7/6d.  Balance at	7/6d. First 8 units for 7/6 per unit 9d. per unit oh case 8/6d. per month in pence/kwh in 1963/1962 princes; these costs on costs for steam,
rected System  First 12 units 7/6d.  Balance at 4d. per unit 6d.	7/6d. First 8 units for 7/6 er unit 9d. per unit 9h case 8/6d. per month in pence/kWh in 1963/1962 evinces; these costs on costs for steam,

	Tarek annetse skorovogen a mare s	C 07411100. 20111111 19111 19111 191111111111111111			ài enar	
Generation costs	Soutl Provi		Lilo	ngwe	Distr	ricts
	61/62	62/63	61/62	62/63	61/62	62/63
Fuel	0.87		2,28	2.15	7.24	6.32
Oil, water, etc	0.05	0.06	0.11	0.11	0.61	0.36
Operation	0.20	0.27	0.37	0.39	3.15	2,62
Maintenance	0.19	0.23	0.39	0.33	2,82	1.91
Interest	0.36	0.34	0.34	0.44	1.94	1.23
Depreciation	0.37.,	0.35	0.34	0,45	1.59	1.33
Overhead charges	28 0 <b>:13</b>	0.12a	ma0.30	0.29	0.74	0,60
Total generation.	2°.17 <sup>(</sup>	2.23	4.13	4.16°	18.09	14.37

Distribution costs	Southern Richard Province		Lilongwe		Dist	Districts	
	61/62	62/63	61/62	62/63	61/62	62/63	
Operation and maintenance	0.22	0.24	0.22	0.22	0.34	0.85	
Interest	0.22	0.24	0.31	0.28	0.62	0.59	
Depreciation	0,24	0.24	0.29	0,28	0.49	0.64	
Overhead charges	0.13	0.12	0.30	0.29	0.74	0.60	
Total distribution	0.81	0.84	1.12	1.07	2.19	2,68	
Total costs per kWh sent out	2.98	3.07	5.25	5.23	20.28	17.05	
Total costs per kWh sold	3.28	3.36	5 <b>.</b> 84	5,72	21.29	18.66	
Average revenue per							
sold	3.60	3.61	5.57	5.51	11.81	11.29	
Difference	+-0,32	+ 0.25	- 0.27	- 0.21	9.48	- 8.37	

## (2) Future development (5)

Very little information is available about the future development plans of the country. The investments of the Electricity Corporation for the five-year period 1965-1969 have been revised as follows:

•	and Alberta Control of the State of the Control of	€ 1000
(a)	completion of the Nkula Falls Hydroelectric Scheme (2nd stage)	350
(b)	Maintenance of general development	100 de foi
(c)	Construction of a second transmission line from the Nkula site to Blantyre	
(d)	Installation of a transmission line to Lilongwe	n 1 <b>600</b> - Francis
(e)	Erection of special transmission lines for large private power producers (Sugar Project	The Hyrixa of
	line)	130
mon manage	TOTAL	1,328

The Electric Supply Commission is already looking ahead to its second hydropower station on the Shire River.

Congression of the State of the

#### DOCUMENTS USED

1. African Electric Power Meeting, Addis Ababa, October 1963, E/CN.14/EP/3 Part I.

67, 43

- 2. Ditto, Part II.
- 3. Ditto, Add.1.
- 4. Nyasaland Electricity Supply Commission: the sixth annual report and statement of accounts for the year 1961/1962.
- 5. Malawi Government: Development plan 1965-1969. Zemba, 1964.
- 6. Nyasaland Electricity Supply Commission: The Seventh annual report and statement of accounts for the year 1962/1963.

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#### Abbreviations and symbols used

MWh - Megawatthour = 1,000 kWh

GWh - Gigawatthour = 1,000,000 kWh

HE - Hydroelectric power plant

DE - Diesel electric power plant

SE - Steam electric power plant

and the second

#### 8. ZAMBIA

#### (1) HYdropower:

The hydro potential of Lambia is mainly concentrated on the Zambezi River, which is shared with Rhodesia. The Kariba scheme, already partly developed, is planned to have an ultimate plant installation of 1200 M and an annual production of 7.5 Th. A further 40-50 MV could later be generated at Victoria falls, raising the total Lambezi production to about 7.8 Th p.a. For the Kafue scheme a further 450 M installation has been planned. The total hydro resources of the country (less whatever contribution must go to (Rhodesia) are at least 12 TWh p.a. which is divided into

.1000 MW firm capacity, load factor 100, = 8.8 Twh, and
.1000 MW seasonal " " 40% = 3.4 Twh

12.2 TVh

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#### (2) Hydrocarbons

Zambia has no resources of hydrocarbons, nor are any likely to be found.

#### (3) Coal:

Coal is reported to occur in Gwembe district of the middle Zambezi, in the valleys of the Launo and Shangani Rivers, and in the lower Kafue valley (Kafue Plats), but the seams are stated to be thin, with a high ash content and to be badly broken up by faulting, so that they are not considered to be capable of economic exploitation. The most promising occurrence is in the Kandabwe area of Gwembe district, where a seam of 2 to 3 metres in thickness occurs, having an ash content of 22 $\mu$ . Reserves of this down to a depth of 300 metres are reported to be 20 million metric tons of coal with a calorific value of 5500 kcal/kg. In doc. (7), the reserves are reported to be 50 million metric tons.

## (4) Non-conventional sources of energy:

- a) Radio-active minerals: The "Copper Belt" of Northern
  Rhodesia is considered a most favourable area for the occurrence of
  uranium, but little has been found so far due to thick over-burden
  present over much of the country. Uranium occurs in low concentrations in most of the large copper mines.
- b) Geothermal: Hot springs are reported to occur in the Lambezi River trough, near the junction of the Gwai and Sanyati rivers. It is possible that these might indicate the presence of geothermal steam.

#### II. Production, Trade and Consumption of Primary Energy (4)

Doc. (5) gives data only about the former Federation of Rhodesia and Myasaland and not about its constituent parts. All information is taken therefore from docs. (2) and (4).

#### (1) Production:

The only primary energy produced in the country is hydroelectric energy:

the second of th

	Hydro-	-energy	**
	Gwh		Remark: Kariba I Hydro-
1961	272	136	power station is treated for
1962 1963	290 305	145 152.5	statistical purposes as a
1964	295		Rhodesian producer.

Conversion ratio : 1 kWh = 0.5 kgs. coal equivalent,

( 35 ) 138 ...

## (2) Trade (Import)

The bulk of primary energy is imported in form of coal, refined petroleum products and hydroelectric energy from neighbour countries. Information about imports is available for 1962 and 1964 (in natural units)

	**=====================================			( 1.
	19	62	1964	
Coal	1,600,00	0 tons	977,842 tons	
Coke and semi-coke	**************************************	ting damaga kang panggalangan dalah sa	65,749 tons	
Refined petroleum pr	roducts 130,00	00 tons	147,576 tons	Section
Electric energy	1,76	6 GWh	1,959 GWh	41.
<b>,</b> ====================================		******	*******	
Conversion factors :	l ton coal = 1 tce l ton refined prod		i de la compania de La compania de la co	
Details of imports (	(in 1000 tce):		4 177 (0)	
The Mark The	throughout a maker of the second	1962	1964	
en de seerwei. Coal (from Hankie in	LANCE OF EIGHT ROLLING	1,600	978	100
Coke (from Rhodesia)	)	?	910	
Refined petroleum pr Marques and Rhodesi Electric energy	ia)	195	<b>220</b> - 2011. 224 - 285 980 - 285 - 285	
	TOTAL	2,678	2,244	- 1. · ·
Of these totals, the from or via Rhodesia		ges came	95~	
(3) Consumption:	Section 1 and the second	e de la companya de La companya de la co		
	**************************************			
	1962		964	
• "	1000 tce	1000 tce	//	
Production	145 5.1	147.5	6.1	
Import	2,678 94.9	2,244.0	93.8	
Consumption	2,823 100.0			Property
lfygdar gji www.www.com	Principal (A)() (A)			
Assuction per capi	1962 1962	830 kgs coal equ		• [

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## III. Electric Energy (2,4)

### (I) Existing power plants:

(a) Installed capacities (in MW) at end December 1964:

Territory and		Hydr∙	Lo	Load factor %		
undertakings	Thermal	Hydr●	1962	. 4 1964		
Copperbelt mines		And the second s	82	84		
Broken Hill mine.	8,0 <u>1</u> 6 3,577	42.7	76	. 89		
Lusaka	15.0	-	54	55°6°		
Victoria Falls		8.0	55	65°° neni		
Others	<u> </u>	4.8	30	34 · school		
TOTAL	208.4	55 <b>-5</b>		**************************************		
Total TE + H	E 263.	9	.05			
A STATE OF THE STA				S. S		

Doc. (6) indicates some more diesel power plants (state at end of December 1960):

,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,			
	Mongu	300 kW	A STATE OF THE STA
	Choma	600 "	grand and the second
No. of the contract of the con	Monze	7 - <b>2</b> 28 " / 3	and the second of the second o
and the second s	Mazabuka	558 "	
	Kafne	480 "	and the second
and the second seco	Fort Jameson	3 J 495 ** 3 A	
The second secon	Fort Rosebery Abercorn	2,000 "	Contraction (Contraction)
	Abercorn	500_"	$(p_{N}, p_{N}, p_{N})$ , where $p_{N} \in \mathbb{N}$ , we see that $P_{N} \in \mathbb{N}$ , $P_{N} \in \mathbb{N}$
	Kasama	495 "	
	TOTAL:	_5 <u>.656_k</u> W	

It is not known which of these power plants are still operating.

(b) Production	in GWh		(* )				
	1959	1960	1961	1962	1963	1964	
Broken Hill	and a group of contract to the	and the second section of the section of the second section of the section of the second section of the section of th	La La Caragna Braha i i di i di i di i	to all a programme and a second secon	ه معنی سینسید	out the state of the second	
Mine	228.0	233.6	242.6	255.2	275.5	263.5	
Victoria Falls	17.9	21.8	22.9	27.3	30.4	32.3	
Others	4.4	5.5	7.3	<u> </u>	8.4	9.7	
HE Total:	250.3	260.9	272.8	290.3	314.3	305.5	
Copperbelt	þv <sup>†</sup>		r	1		la <b>c</b> olució	
Mines	827.0	455.1	344.3	310.2	400°,5 <sup>[6]</sup>	372.4	
Lusaka 🎎	്37.8	46.8	21.5	· <u>15.3</u>	4.9	15.3	
Ndola	52.3	44.5	1 <b>5.</b> 3	- 3 <i>a</i>	?	12	
Chilanga	20.3	15.5	14.9	4.7	j a gy <b>?</b> ·//	γη·	
TE Total:	937.4	561.9	396.0	330.2	and a figure to the second	387.7	
HE + TE Total	1,187.7	60 16 <b>822 48</b>	∴668.48	620.5	0 2730:020	693.2	
(c) Import in C				igy seed f			
		( 'sg}		81.319.3		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	
		398 <b>196</b> 0	1961			1964	
From:	ৰ	T. A.		\$ 1.795 1.79 11.	;		
Congo	744.7	<sup>005</sup> , 521.3	463.2	470.3	275.0	201.4	
Rhodesia (Kariba).	0.5	800.1	1,124.4	1,296.0	1,570.0	1,757.7	
TOTAL	745.2	1,321.4	1,587.6	1,766.3	1,845.0	1,959.1	

The state of the state of the second of the

(d) <u>Consumpti</u>		ding power	-station	consumptio		erin GWh:
edr or dels.	195 <b>9</b> 0) al	1966 <sup>0.8%</sup>	1961	noise 1982 1962	1963 1963	1964-13
Import Import	745.2	1.321.4	1.587.6		730.0 1,845.0	1.959.1
TOTAL	1,932.9	2,144.2	2,256.4	2 <sub>0</sub> 386.8 <sub>0</sub>	2,575.0	2,652.3
In the period	I doloaida 1959/64,	the averag	e rate of	increase	of consump	tion
was 6.5 per ce	nt.	an Seinssi	కా రిమ్ దూరాలు	electric	tro goldindi	∵it <b>a≛</b> ″
(e) Breakdown	of consu	nption, in	. GWh:	in ina <b>n</b> a €8%	Parameter and the property	
Farms of a	1959	<u> 1960:</u>	1961	1962	1963	1964
Farms and of the	s waq <b>0. 1</b> 1. 30	าไวส์ช.4กไ	8 3. 0:7°	0.8	1.2	1.5 m
Mines od	<b>1,625.</b> 3	1,773.7	1,828.7	1,907.8	2,031.5	2,176.4
Industry madd	-5 -46 <b>.</b> 2 €	15 45.4	- 1.13 in	71.8	80.5	98.8
Domestic ( ROLFRE	[135 <i></i> 7 em	128.6	137.5	147.7	154.7	157.1
Others [sqipi:	ywai <b>36:65</b> m. 1	stri65.45	15.1°	91.1	97.5	105.3
Sales Total	1,843.8	2,013.5	2,103.7	2,219.2	2,365.4	2,539.1
Consumption	1,932.9	2,144.26	2,256.4	2,386.8	2,575.0	2,652.3
Power-station consumption and losses	canglibus ceung sol	labadi jask art v 130.7	d	ied ed geo Gr	- 1301 <b>∀</b> 2100 - 4211 120 - 209∮6	sin and the second
In % of consumption	5 <b>4.6</b> %	7. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	6.7%	7.0%	ydw . moidw 8.1%	a/
	( संदेश । क्षेत्राचा स्थल जन	4-20-1-20-1-20-1-20-1-20-1-20-1-20-1-20-			,	je kija i 1597 bij

a/ Internal consumption of power stations and losses seem to be abnormally low. Most likely some of the figures given are faulty.

#### (f) Transmission and distribution

Interconnexion between Zambia and the Congo (DR) exists in the form of a 220 kV transmission line from Jadetville (Congo) to the Kitwe sub-station where two step-up transformers effect liaison with Zambia's 330 kV system, namely with the transmission lines Kitwe-Lusaka and Lusaka-Kariba (Rhodesia). The capacity of the line-Kariba-Lusaka-Kitwe, with a total length of 600 km, is about 250 MW.

The state of the s

At Lusaka, there are 330/88 kV step-down transformers, but no data are available about the medium-woltage transmission lines in Zambia.

Distribution of electric power is carried out by fifteen different undertakings, most of which have considerable unused capacity. The largest undertaking is the Rhodesia Congo Border Power Corporation (RCBRC) which distributes about 86 per cent of the total energy, mainly to the mines. It also wholesales power to the municipalities of the region (Ndola, Kitwe, etc.) and to the Northern Electricity Supply Corporation. There are three other major undertakings: the Central Electricity Corporation (Lusaka), the Victoria Falls Electricity Board and the Livingstone municipal undertaking.

There is no information available about the technical and economic details of Zambia's distribution systems.

The dissolution of the Federation of Rhodesia and Nyasaland resulted in the transfer of responsibility for Kariba power development from the former Federal Power Board to the Central African Power Corporation, which has now the responsibility of operating and developing the system on behalf of the Governments of Zambia and Rhodesia.

## (g) Tariffs; we have a property of the safety of the safet

In doc. (7), the following information is given: "The normal tariffs are approximately 0.70 pence per kWh but a large consumer taking power with a 80-90 per cent load factor would purchase at 0.40 pence per kWh."

#### (2) Future development (4)

There are no fixed development plans existing but in doc.(4) some projections and recommendations are made.

#### (a) Electric energy consumption in 1970 (in GWh)

	1962	1970
Mines: supplied by RCPBPC  Broken Hill	1,900 2 <b>20</b>	2,800
	10 10 10 10 10 10 10 10 10 10 10 10 10 1	
Domestic	<i>,</i> -	
Agriculture Railways	where $x = \frac{1}{0}x$ , then	ं <u>्र</u> 150
Total	2,431 <sup>a</sup> /	4,265

The average rate of growth in the eight-year period is 7.3 and a per cent.

There is no information about maximum demand in MV.

### (b) New generating capacity:

ed in two stages. The first of these, Kariba I, consists of the dam and the erection of a generating plant on the south bank of the Zambezi River (in

a/ - This figure is not consistent with the figure for consumption in the foregoing table, but the difference is not large.

Rhodesia). Stage two, Kariba II, will consist of a corresponding installation on the north bank in Zambia.

	Installed capacity <u>MW</u>	specif. investment £/kW	Investment
Kariba I	5-1-85 <b>700</b> 2836	rmampillo coult	78 - 24 - 25
Kariba II	900	collaborate con con	42 1 44.4 400

As Kariba I is not fully operational (in 1962, the maximum demand was only about 345 MW or less than 50 per cent), there is no need for the time being to construct new capacities.

Kariba II should go on stream not earlier than 1973.

- . After 1970, construction of the hydro power station in the fifth gorge of the Victoria Falls (184 MW) and its connexion with the Kariba system should be considered.
- . The Kafue River development should start early enough to meet the needs after 1980.

# (c) New transmission lines:

and the second of the second o

By 1970, the RCBPC's maximum power demand will be about 384 MW and a second 330-kW line (Kariba-Kitwe) will be necessary. The cost of this secondline is estimated at £5.5 million.

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#### Archifella . . 9

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- Ditto, Part II.
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  - Development of the steel industry in East and Central Africa, 7. W.S. Atkins & Partners, Preprint 1965. La Hand

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1. 1977年 - 阿拉尔伊南南 安徽安徽 (西西里西山北部市) (1975年 - 西西州市至南西 (1976年) (1976年) (1976年)

# Abbreviations and symbols used: .sixtrak the sixtra again of the hebitoleters

- MW -Megawatt = 1,000 kW mes sound on Thomas Mead abwinds but on
- GWh Gigawatthour = 1,000,000 kWh so shirty shift shelle will be would adv
  - TVh Terawatthour = 1,000 Gib d . setimenty veided direct to accomp
  - tce tons (metric) of coal equivalent ad of haden get as highwarder based
  - HE Hydroelectric power plant
  - Diesel electric power plant
- Thermal power plant g half to got a man which is the formal and the new to a stole . A dide again a little

#### 9. RHODESIA

I Richard

## I. Primary Energy Resources (3)

#### (1) Hydropower

The hydro-potential of Rhodesia is considerable, particularly on that section of the Zambezi river which forms the border Wetween Zambia and Rhodesia. There are no data available about estimates of Rhodesia's hydro-potential. For the total of the former Federation of Rhodesia and Nyasaland the hydro-potential was estimated at 36 TWh.

#### (2) Hydrocarbons

Rhodesia has no known hydrocarbon resources nor are any likely to be discovered.

#### (3) Ceal

Rhodesia is relatively rich in coal of good quality, which is exploited on a large scale at Wankie.

In the Wankie field there are three seams of coal, of which only the lowest is mined. This yields a bituminous coal of excellent quality, much of it with coking properties. In thickness it ranges from 4 to 12m, and reserves are reported to be of the order of 5,000 million metric tons.

graphic control of the second

Coal occurs elsewhere in Rhodesia, principally along the Zambezi river, but its quality is inferior to that of Wankie and it is not mined on a large scale. Total reserves of coal in Rhodesia are reported to be in excess of 10,000 million metric tons.

The following information on coal deposits is taken from  $d \bullet c \cdot (9)$ . It is somewhat different from the data given above.

			, Çaya S	rijani p	I (A)	
Coalfield		Ash content	Calcrific	Reserves in million tons		
		in %	cal/g	Proved	Probable	
Wankie	Coking Claice	11.0	7,400	824	300	
Wankie	Non-coking	°°; <sub>"U</sub> ° 25 •0	44.27°	266	112	
En tuba	Coking	12.8		68	Angeligi an andre i red i rediged a region de de la caracter de la	
En tuba	Non-coking	30.0	on to the state of the state o	72	S. W. S.	
Lulimbi	Coking (A)	12.8	They et	20		
Lulimbi	Non-coking	18.6	198,4	54	· · · · · · · · · · · · · · · · · · ·	
Bubye	Coking	12.0	3,11	20		
Gengwe	Non-coking	32.0	ISO.	45	i	
Lubu-Sebwngu	Non-caking	23.2		90	. I am an i att i att and the control of	
Makushwe	Non-coking	34.8		4,733	<u>na</u> (S)	
Malilongwe	Non-coking	34•3	and the second of the second	264		
, valktid				6,456	412	
		 	tur i santa Alima i ili ili ili ili ili ili ili ili ili	6	,868	

## (4) Non-conventional sources of energy

Radio-active minerals: These are known to occur in several areas but no economically exploitable deposits have yet been found. Geological conditions are favourable for their occurrence.

# II. Production, Trade and Consumption of Primary Energy (4, 6, 6a)

(1) Production: Coal and hydropower

## (a) In natural units:

	Coal (1,000 tons)	Hydroelectric power (GWh)
1959	4,143	0.5
1960	3,923	1,046.5
1961	3,387	2,205.7
1962	3,115	2,736.3
1963	3,021	3,142.0

#### (b) In 1,000 toe:

and the Conversion factors: 1 ton of coal = 1 toe - 1 to 500

Lordor bevood Also 1 GWh = 500 to

a time in the Carlo Commercial Sections of the Carlo Commercial Co	Control of State (Control of State Control of State Contr					
70 L	\$ 15 \$20,	Coal	Hydroelectric power (rounded)	eisto <b>Total</b> ei im		
1959		4,143	Q. (4 <u> </u>	4,143 5 6 5 7 1		
1960	•	3,923	523 See 18	4,446		
1961	ΑÜ	3,387	a.31 1,103 architector.	4,490		
1962	119	3,115	0.91 1,368 2 2 dive	4,483		
1963	<b>7</b> &	3,021	0.98 1,571 gaiden-coll 3.89 galden-coll	4,592 6 7 - 0		

#### (2) Trade:

(a) Coal: A large part of production is exported to Zambia and very small quantities outside of the former Federation (6):

1959	170,000 tce )	The first of the control of the cont
1960	190,000 tce	
1961	280,000 tce	Export outside Federation
1962	180,000 tce	
1963n.cm = 1900	230,000 toe \$	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1

Data about exports to Zambia are lacking. In 1962, they are reported to have been 1,600,000 tons.

In 1962, the total exports were estimated at 1,780,000 tce.

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party 1500

# (b) Hydroenergy:

- Transland - Colonia - Co	Exports to	Imports fro	om Net	exports
English State of the Control of the	17 . 1 .	Mozambique in GWh		1,000 toe (rounded)
1959	0.5 <sup>is a litt</sup>	·61.5	61.0	30
1960	801.6	71.2	730 • 4	365
1961	1,124.4	71.1	1,053.3	527
1962	1,296.0	80.7	1,215.3	608
1963	1,565.9	87.6	1,478.3	739

(c) Liquid fuels: No data available.

## (3) Consumption: ) A Larry Consumption:

Because of data for trade are lacking, a summary for consumption cannot be set up.

# III. Electric Energy (4, 8)

- (1) Existing power plants:
- (a) Installed capacity of all producers (in MW)

							1995
. 19 		Kariba HE	Other	producer:	S	Total	58 (I
9,42	Syll Barrer		<del>nd de</del>		FCE,	***************************************	
December 19	959	100.0	y etti agracija i in Stik i Militori	509•4		609 • 4	i un se residente de la colonida de la composition de
" 19	960	300.0		501.4		801.4	
0 19	961 45 944	562.5	ra Tro	501.4		1,063.9	
" 19	962	675.0		473.9	A CONTRACTOR	1,148.9	
" 19	963	705.0		483.4		1,188.4	

Thermal power plants consist mainly of steam power plants and of only two small diesel power plants (position in 1960):

<u>.</u>	team power	nlants		ara dan ba		Diesel po	wer	plants
	† )()() . )	prair ob		en graven sak takon vilonike. Pendan kanan saka		DICEOUT PO	V+ O.T.	prunvs
1.	Salisbury	153.0	MW	1.	Koma	tivi		2.01 W
2.	Bulawayo	148.5	MW	<b>2.</b>	Chip	inga		0.37 M.
3.	Umniati	120.0	MW	\$2.77 f		otal a 💖		2.38 INW
4.	Shabani	30.0	MW			Same Sugar	<u>.</u>	
5•	Wankie	18.5		; o <b>I</b> n	1960 ·	was:		E a C.C.
6.	Umtali	16.5	MW	a. #8	•	• *		
7.	Gwanda	12.5	MW	books to the control of the control	questido e	the same of the same of the same of the same of		Conjugate the Charge of Calabase Conference of Charge Conference
	SE Total:	499.0	MW	SE	+ DE '	Total	501	38_MW_

## (b) Production, net export and consumption (in GWh)

: Di	regissia to the l	Produc	tion	the grades such as	2.50%	ja ja ka	
	Centr. Power	African Corp.	Other	***************************************	Net	Consump-	
	Inter- connected TE	HE	producers TE	Total	Export	tion its	in teh in Filmony
1959		0.5	1,530.2	1,530.7	-61.0	[1,591.7(s)	
1960	448.1	1,046.5	893.1	2,387.7	730.4	1,657.3	
1961-	297.4	2,205.7	278.4				a management
1962	131,8	2,736.3	121.6	2,989.7	1,215.3	1,774.4	
1963	105.4	- <del>3,1</del> 42.0	121.8	3,369.2	1,478.3	1,890.9	na 2

The average rate of growth of consumption in the period 1959-1963 was 4.4 per cent.

#### (c) Breakdown of consumption (in GWh)

<u> </u>	1959	1960	1961	1962	1963
Agriculture, forestry	61.5	69.1	69.4	76.8	81.5
Mining, Quarrying	377.0	390.6	398-7	383.9	389.2
Manufacturing industries	432.0	435.6	442.7	455.8	528.2
Domestic consumers	388.8	406.9	427.9	430.1	436.7
Others	193.4	211.5	223.3	254.3	273.4
Sales total	1,452.7	1,513.7	1,562.0	1,600.9	1,709.0
Consumption	1,591.7	1,657.3	1,728.2	1,774.4	1,890.9
Power-station (GWh) consumption (GWh) % of con-	ary 9 <b>139.0</b> %	143.6	166.2	173.5	181.9
consumption ) % of con- and losses ) sumption	8.85	8.65	9.6	9.75	9.6

# (d) Transmission and distribution

The circuit lengths of the high-voltage overhead transmission lines are, according to information of different years:

With Shi

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			f i	and the	*								
<b></b>	330	ΚV			(informa								
-	110	kV	5	km	II.	ζ gi	11	n <sub>j</sub>	ra sitt	1961	-	n	8
_	88	kV	"925	km	11	r)	, <b>I</b> II'	'n	n n	1961		tt	8
-	66	kV	190	km	<b>.</b> . f		. 11	, tt	. ***	1961		11	8
-	33	kV	1,580 3,730	km	16		<b>51</b>	11	n	1961		II L	8
		. 48	3,730	km		enti e	J. 1257 da	11.		. •			

Medium-voltage distribution feeders, in 1960 (8):

ll kV	1,194	km	The second secon	
3.3 kV	23	km	) Total: <u>1</u>	.433 km
others	216	km	- • • • • • • • • • • • • • • • • • • •	

In 1960, the length of the low-voltage distribution networks was about 4,800 km (8).

(a) president of consumption (in 0.0h)

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Section of the second section of the section of the second section of the s	(e) Tari	ffs <sub>(5</sub> ):	In 1962,	the Federa	l Power	Board's	tariffs_to
and the second second second second	the	Southern	Rhodesia	Electricity	Supply	Commissi	on were as
g.15	g.Syfoll	ows st	A CO	<b>₹</b>			Sining, Gu
- <u>- 234</u>	0.19£	398.7	3.060 	0.TTE	eneo di 1	Grow	A large of the control of the control of
s. Ng	, 9.23× <del>-</del>	Demand	Basic Consump		Ef		neany growth
Reg	ion 14,968	€ MW	tion	rence	, 01	either d	emand or con-
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anW and		$\frac{1}{3}$ or, $\epsilon$	1, 8, 87, 3	7.120.77	, 	and $0.1^{i\frac{1}{4}}$ d	
*************	g national residence of the second of the se	5,801		139.0			consumption
181.3	In 1962,	the avera	ge prices	in pence p	er kWh	441	rent olasses
₹ <b>4</b> , 65	of consum	ers were:	- C. ( )	for an	in desire entite tellesiste sentitute et l'élégi		And the second s
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	the new	-Domestic	ey ada to	)farmarion	2,168	W.C.L.	47 080 m
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	e) (1		ic lighti		1,779	081. <b>"</b>	Valoria m
	11	Ψotali –	All class	11	1.29त	1,580	The state of
	<u></u>				1	7.34	
	The price	quoted al	bove incl	ude the fix	ed char	ges for p	ower allegation
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#### Abbreviations and symbols used:

\* Mark to Megawatt = 1,000 kW (or Posterio grands of the contraction)

GWh - Gigawatthour = 1,000,000 kWh

TWh - Terawatthour = 1,000 GWh

tce - tons (metric) of coal equivalent

HE 1 - Hydroelectric power plant DE - Diesel electric power plant

SEARCH Steam power plant, become the contract of the

- Thermal power plant.

#### 10. MALAGASY REPUBLIC (MADAGASCAR)

aibbA (Maritage 1985) Addie

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#### 1. Primary Energy Resources

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#### (1) Hydropower

According to Parker (World Power Conference Survey of Energy Resources, 1962), the hydroelectric potential of Madagascar is very large: a theoretical potential of over 100 TWh p.a. could be inferred. At present a total installation of some 28 MW is producing about 74 GWh p.a. from nine stations. Further projects have been investigated at twenty-four sites involving a possible ultimate installation of more than 2,500 MW with an annual production of about 17 TWh.

The total exploitable potential is estimated at 114 TWh. Gross theoretical capacity is calculated as follows:

,	For arithmetical	mean flow was sany by	- p	80,000 MW

- For 50 % probability flow (Q 50) 49,000 MW

- For 95 % probability flow (Q 95) 14,300 MW

### (2) Hydrocarbons

(a) Petroleum and gas: The western part of Madagascar is underlain by two sedimentary basins separated by a basement ridge in the neighbourhood of Bemolanga. The northern basin, which is smaller, is known as the Majunga, and the southern one as the Morondava basin.

Petroleum exploration in Madagascar commenced in the early years of this century with an investigation of the extensive tar sands which outcrop in the neighbourhood of Bemolanga and Morafenobe.

In 1945, exploration for petroleum, using modern geological and geophysical techniques, commenced in the Morondava basin, followed by the drilling of a number of deep exploration wells. It was found that geological conditions in the subsurface were complex, and although a thick sedimentary section

was present ranging in age from Permian to recent, much of it of marine origin, it was decided that the possibility of finding economically exploitable deposits of oil or gas was slight.

Following this decision, exploration was commenced in the Majunga basin, which had heretofore been considered less promising because of the presence in the sedimentary section of intercalations of volcanic rocks.

# d as the SPN carried out: and shows edit . seemiolds

Tavo francisco de la cita

CONTRACTORS FOR

- detailed geological surveys directed at a study of variation in the properties of rocks and the thickness of strata;
  - several large-scale terrestrial and fluvio-marine seismic reflection operations;
    - finally two test drillings to study two marginal problems, the results of which were important for the continuation of exploration.

Finally, rafter three years of exploration, the SPM defined a zone of interest in the central part of the Majunga basin. During subsequent operations, work will be concentrated on this area to find the areas of subsidence and sedimentation fringing the continent.

Despite the lack of success attending the considerable effort and money so far expended on petroleum exploration in Madagascar, the presence of enormous quantities of hydrocarbons in the tar-sands of Bemolanga-Morafenobe indicates that petroleum has been formed and accumulated on a very large scale at some period during the geological history of the island. This being so, there always remains a possibility that further exploration may discover petroleum in economically exploitable quantities.

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(b) Tar-sands: These outcrop irregularly at the surface over an area of some 3,500 km2 between latitude 19050' and 21030' in the general region of Bemolanga-Monafenobe in the west-central part of Madagascar. The degree of impregnation of the sands with tar varies locally but averages about 3-4 per cent over the area as a whole. The sands themselves form the basal unit of the Isalo series and are some 200m; thick, resting directly on crystalline basement. The tar itself is black, very viscous, and apparently homogeneous throughout its thickness. The richest impregnation is only of the order of 8 per cent by weight, as compared with 14.7 per cent in the case of the Athabasca tar sands in western Canada; this latter is the only occurrence of this type which it is proposed to exploit for its petroleum content, on an economic tasis, at the present time. The tar yields the following constituents scolasuace acl cafien upon distillation:

Naphta	Par 7.2 per cent
Kerosene	25.1 per cent
	24.3 per cent
Heavy fuel oil	21.1 per cent
Coke	7.8 per cent
Gas and losses	7.8 per cent 4.5 per cent
· · · · · · · · · · · · · · · · · · ·	over the second

The sulphur content of the crude tar is 0.65 per cent, which is relatively low for this type of material. The distillation analysis of the tar indicates that it would be an economically desirable product if it could be extracted from the sands at a low enough costs so far no method of doing this has been discovered.

Total reserves of tar in place in the sands appear to be of the order of 1,000 million metric tons or more, of which 25 million metric tons have been proved by localized drilling. It is estimated that about 100 million metric tons could be exploited from the surface by open-cut mining.

(c) Oil shales: Oil shales occur in two or three localities in the central part of Madagascar, where they were deposited in ancient lakes resulting from volcanic action. The beds are more of less horizontal but are generally rather thin and reserves are comparatively limited:

Near Sambaina, located about 100 km south-west of Antananarivo on the Antananarivo-Antsirabe railway, are two deposits of oil shales: one at Mandroschasina contains about 500,000 tons of shale; the other, at Antanifotsy contains about 26 million tons. The yield of oil from the first deposit was relatively low, most of the hydrocarbons being semi-solid; the Antanifotsy deposit gave a better oil yield with about 35 per cent of volatile matter, of which 40 per cent was liquid hydrocarbons.

Distillation of the bistuminous schists gave the following composition (in percentages) of the run-of-the-mine product:

<u>St</u>	ratum No.	Water	<u>0il</u>	Gas	Semi oke
· 為如此 學問其語。 (1976年1月8日	<u> </u>		n dagegery	្រំ ព្រះស្ថិត្តិសុខភទ	
form entitle of the solution o		60.96	4.3	4.6	30.1
	TA	42.1	5.2	7.2	45.0
er roma atulis	* ; * * . *.	in the garden	SEAS TO	main mention	

## And by (3) Solid fuels were about a second to the Antique of the

District Applied Street Conference

(a) Coal: Only one occurrence of coal is known in Madagascar, at Sakoa near Tulear in the extreme south of the island. The coal is of Gonswana age and type, similar to that of southern Africa but of a lower grade. Total reserves are reported to be of the order of 1,000 million metric tons. Measured reserves are 100 million tons.

CONTRACTOR CONTRACTOR CONTRACTOR DE LA C

In the area that has been investigated in detail, there are five beds of coal, three of them of workable thickness:

And the State State and Andrew Commencer

	Thickness	ريد ا		Volatile matter
		*		
III .	1.2 - 1.8 m		32 %	24 %
IV (the second)	3.5 - 7.0 m		17.%	26 %
V	5.0 - 9.0 m	17	22 %	31 %

The coal is composed of an intimate mixture of vegetable and mineral matter, with calcareous granules and calcite veins; washing does little improve its calorific value.

The calorific value of run-of-mine coal from the No. IV seam is 6,500 calories/gramme, and after screening and washing 6,900 calories/grammes.

Proven exploitable reserves of coal in this area, down to a depth of 400 m., are of the order of 50-60 million tons of bituminous hard coal, having 25 per cent volatile matter, 17 per cent ash, 0.5-1 per cent sulphur, and a calorific value of 6,500-6,900 calories per gramme. It is stated to

be good for industrial furnaces and boilers, and for thermal electricity generating plants, but unsuitable for ships and locomotives. It is not reported to have coking properties.

The location of this coal is remote from the main centres of population, and although a number of plans have been drawn up for its exploitation, no large-scale development has yet taken place. It appears that the minimum level of economic production would be of the order of 1 million metric tons per year, which would require the export of a considerable portion of the output to markets outside Madagascar; the quality of the coal, however, precludes its ready sale in foreign markets.

(b) Lignite: A small deposit of lignite occurs at Antanifotsy in association with the oil shales. Reserves are stated to be of the order of 32 million tons.

Run-of+the-mine crude lignites of stratum III have the

je en espore esta Humidity Gadinail ni Laeppous bis	47.9	Fixed carbon	23.6
Combined wat	er 5.1	Tar	0.6
Ash	15.8		5.06
nsonagaisi ito aminimao	o arajaya-d	tuos erastri susa e	

The mean calorific value of the dry lignite is 3,500 cal./
gramme. The lignite consists of combustible matter closely
mixed with mineral particles and cannot be enriched.

y gidegyet i ad bluuße

### (4) Non-conventional sources of energy

(a) Radio-active minerals: Madagascar has numerous deposits of radio-active minerals of various kinds and appears to have abundant resources of most of the minerals necessary for the production of metals needed for obtaining atomic energy. At present, uranothorianite is mined at a rate of 440-550 tons p.a. for export to France. Estimates of the known reserves are:

ind oil	Uranium oxide	ns voges ab	out 1,000 tons	
	(hebrura <b>Thorium oxide</b>	abo	out 2,000 tons	ny constrantific - e - y 2 y 5 y 60 emperir
In	the period 1959-1964,	production	was as follows:	• . •
	1959		536,679 tons	
Ç, ı	1960	55	510,203 tons	$\mathbb{Q}(\mathbb{Z}^{n}) \stackrel{\mathcal{C}}{\longrightarrow} \frac{1}{n_{k}}$
X Ţ	1961	1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	416,588 tons	
•	1962	712	534,579 tons	¥
	1963	moderne from the Unit Pet 11	480,651 tons	magazini ana kati ta
	1964		560,125 tons	

At that yearly production, the known reserves of the uranthorianite will be exhausted by 1968. . 17

- (b) Geothermal: Numerous hot springs are known in Madagascar; volcanic rocks of the Neogene and Quaternary ages are common, and there is considerable deep-seated faulting. Given these conditions, it is probable that a definite programme of exploration for geothermal deposits would succeed in finding them.
- Wind: The mountainous south-eastern coastline of Madagascar lies in the zone of the south-east trade-winds, and runs approximately at right angles to them. These winds are of moderate strength and blow from the same direction throughout the year. The combination of topography and wind conditions should be favourable for the development of wind-power on a large-scale, if this should ever be necessary or desirable.

# 0 B

#### Production, Trade and Consumption of Primary Energy (1, 2, 5, 8) II.

#### (1) Production: 1 All wileselformed Clarks C. The exist 5 dis 1 - 2 and Only hydroenergy and small amounts of coal are produced इन्स्टाल का अस्ता अर्थ में मुख्य मुख्य

	, . <u>'.'.'\</u> .	Hydro	power		Total
	GWH			1,000 toe (rounded)	
1959		53	26	Langer Baltie	26
1960		61	31	<u> </u>	31
1961		, 60	33	20	35
1962		70	35	2 *	37 *
1963	i i i	. 74	37	<b>≥</b> €!	39

Estimation.

The conversion coefficient taken is 1 kWh = 0.5 kg coal equivalent.

## (2) Trade of solid and liquid fuel in 1,000 toe (rounded)

					$\gamma r(\cdot)$		
	13		1.1	Import	Bunkers	Net import	
1959	::		21 21	190	10	180	
1960	.4		! 3	200	10	190	
1961				180	10	170	
1962				200	10	190	
1963				210	10	200	
					94 TENE L. 48 N	ra katawa 1. an	

# (3) Consumption in 1,000 toe (rounded)

	190 M		Production	Net import	Total	
1959			26 Wol	180	206	. AF - TPI IT AF 1
1960	% PTT \$11	75.5	31 7.76	190	221	May 1
1961	54		35 <sub>ი</sub> ე, მა	170   3	:205:	
1962	è	7	378c* . 452	190 ્ર	227 *	
1963	3I	e con con control de conserva algorithm de la control de conserva algorithm de la control de la cont	39 *789.07	200 ∂ 🔆 , ें	23 <b>9</b>	()

<sup>\*</sup> Estimation.

Breakdown of energy consumption according to the various kinds of energy (in 1,000 tce, rounded):

**************************************	Solid fuel	s Liquid fuels	Hydropower	Total
1959	000 <b>, 10</b>	ovice and 170 mis	ad <b>sy26</b> d	206 <sub>88500</sub> 54480
1960-	20	ovinsen 170 ha	#3 <b>1</b>	221 moles al
1961	300, i 2	ovicamentaries ovi70	ુલું ૈકિક ૦૩૦ <b>33</b> 71	205 6 12.5 %
1962-	12 *	6d5180772	skob 13 <b>5</b> 01	227 *
1963	12	soutantentil Sabban <mark>120</mark> 1sa	37	239 valoritati
Estimation.		gabusana edous dan aso luf	ารณ์ที่ได้ 263 ภาษายุสสตร์ 224 การยนะเคยอาณ์	Title State (1911) Views und 1910 Views and 1910

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# Consumption per capital as the transfer and the second second second

and responsible of the control of the state of the control of the	1959	38	kg	coal e	quivalen	t
gradyjak ak i	4.5e 1960	2774 <b>-40</b>			11	
was drawn sampae i monthles and all province in 1995 in 1995, in 1995, in 1996, we	1961		11	11	11	\$ 1.00 m
Oct	<sup>1</sup> 962	ි 39	Ħ	11	11	NK PROT
lekt.	1963	40	ŧŧ	**	<b>†1</b>	,
	1/4	·54				

# III. <u>Electric Energy</u> (2, 4, 5, 6, 7)

- (1) Existing power plants:
  - (a) Installed capacities: aligner) and 300.1 dt coltanuamed (1)

D. J. J. P. S.	Installed p	ower in 1963	Producti	on in GWh
Power stations	kVA	kW AC	1962	1963
Hydro ESS	34,712	27 <b>,</b> 7698	75 <b>•5</b>	74
Diesel, public	23,182	18 <b>,</b> 560	13.5	18 - AQ.
Diesel, private	30,760	24,608*	32.0	33
Total	88,654	70,937*	121.0	125

an absolute Comme

# 

		. 5 /5/47	Table 1 Annual Park 1 Annual P	,
Location	River	Near the town	power	Yearly pre- ducibility in-GWh
Mandraka	Mandraka	Antananas <b>iv</b> o	11,000	68.0 C.
Antelomita I	Ikopa	Antananasivo	5,000	33.0
Antelomita II	Ikopa	Antananasivo	5,000	27.0
Volobe	Ivondro	Tamatave	4,500	35.0
Ambohimanga	Manandona	Antsirabe	1,620	11.0
Manandray	Manandray	Fianarantsoa	460	1.5
Ifahidaky	?	Ambohimahasoa	160	? hall
Ambodiriana	Iefitra	Vatamandry	80	
Fitososona	Andranobe	Ankazobe	50	. orba <b>?</b> the wh
Beantsy	Fiheranana	Tulear	500	3

There are also some small private HE with a total installed power of about 300  $k\ensuremath{\text{W}}_{\bullet}$ 

<sup>\*</sup> Estimated.

Diesel power plants (public), in 1963

4	kVA  5,000  3,020  3,435  2,840  1,630  1,490  575  395  420	- 19070 Ja
6. 3 4 5. 3 5 4 5. 4 4 4	3,020 3,435 2,840 1,630 1,490 575 395 420	2,400 2,750 2,280 1,300 1,200 460
5. (1) 3. (1) 4. (1) 5. (1) 4. (4)	3,020 3,435 2,840 1,630 1,490 575 395 420	2,750 2,280 1,300 1,200 460
3.4 4 % £ 5	3,435 2,840 1,630 1,490 575 395 420	2,750 2,280 1,300 1,200 460
4 ° E	1,630 1,490 395 420	1,300 1,200 460 320
3 5 (100 (1) 4	1,630 1,490 395 420	1,200 460 320
4	395 420	- 320 - 19010 Ja
4	395 420	- 320 - 19010 Ja
4	395 420	- 320 - 19010 Ja
4. dr. ko.	420 1 ne / 1 ces 1 no ne 300	340 240
3	300	240
i. ariin		
3	POTENCIA MAKEN THE A	
Numai	215 × 0**	170
👣 oak - azo-	1,500 vy sy	1,200
4 33 x	5 530	420
3	205	160
3	415	330
3	310	220
?	500 PC 40000 HE	440
er der si Karanter	23,182	18,560
	4 3 x x 3 2 x x 3 2 x x x x 3 2 x x x x x	4 3 2 5 530 415 3 415 3 310 7 500

\* Estimated.

Show the product of the strappy and the said supply and additional additio Details of the private (industrial, municipal) diesel power plants are not known.

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● 1986年 1986年 1986年 1986年 1986年 1987年 1986年 19

## (b) Production and consumption in CWh:

Year	WK.	Hydro	Diesel public	Diesel private	Total rounded
1959	30c,	53 <b>,</b> 2 00	17.6	not known	100.0
1960	004,5	61.2 <sup>OSO</sup> .	15.9	30.2	107.3
1961	MT.S	66.3 🖖 🦠	<b>15.</b> 5 (	31.3	113.1
1962	785,S	75.5	13∙5€	32.0	121.0
1963	105,1 -75,4	74:0 000.1	18.04	33.0	125.0 125.0 Burboromoils

Production figures in documents (7) and (8) differ slightly from each other.

#### (c) Transmission and distribution:

- (40 km) and to Tananarive (50 km);
- Tananarive, 2 x 25 = to circuit km;

ar shaddall

- INO THE TOL NOW ALL DOLLY

• 35 kV as medium voltage for the feeders to the substations in the suburbs of Tananariva. The total 35 kV-feeder length is about 34 km.

The total length of the 35 kV and 63 kV lines is 174 km.

In the city of Antananarivo and in other localities, the distribution feeders have a voltage of 5 kV.

The low-voltage distribution systems are changing over from 127/220 V to 220/380 V.

(d) Tariffs in CFA or FMG per kWh

At Antananarivo, the tariffs are as follows:

<sup>1/</sup> Since July 1963 the Fr. CFA has been replaced by the FMC
(Franc Malagache) with the rate 1 Fr. CFA = 1 FMG.

and the second of the second	<u>1962</u> <u>1963</u>
- Domestic lighting, up to 10 kWh/month :	24,527 25,423
- Domestic lighting, over 10 kWh/month:	27,294 29,167
- Other domestic use	13,647 14,583
- Other domestic use, off-peak	10,918 11,667
	n garan kazantekki

# - Power low-voltage:

	Yearly fix	ced charge	Per kWh			
	1962	1963	1962	1963		
Up to 1 kW	1290.80	1379.56	17,031	18,200		
1 to 5 kW	1267.75	1354.92	16.840	17,996		
5 to 10 kW	1244.70	1330.29	16,677	17,821		
10 to 15 kW (5)	1221.65	1,305.65	16,513	17 <b>,</b> 646		

ji ka cir Si soldlerg

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# Fixed charges for metres (in Fr. CFA/month):

0.60% 0.60% 0.60%

product (will be 1.4 ft.)				νς . ξ'ελ	•••	196231	1963
- 0	ne-ph			amp.		72.47	73.41
1	n j	tī.	10	$\mathtt{amp}_{\bullet}^{CC}$	ija sak	87.00	88.13
- T	hree-	phase			and the second s	101.43	102.76
	11	11	15	amp. Mag	ann 18 截。2018度。	112.43	113.84
	. #	.11	20	amp.	and the second s	123.35	124.84
	11	in it	30	amp.	en de la companya de	130.48	132-18

# (e) Fuel costs:

The prices of diesel oil depend very much on transport costs.

They were in 1963:

20.750 Fr FMG/litre
14,246 Fr: 67 " 1 17 Fully 1 was a stable -
14.470 Fr of 1980 of the first had a well a
18.850 Fr " : :: :: :: :: :: :: :: :: :: :: ::
20.150 Fr "
23.100 Fr "
16.113 Fr "
922.2 21:430 Fr
20.950 Fr
<b>a</b> .

# (2) Future development (7)

(a) The total production of electricity should be increased, according to the five-year plan 1964/1968, as follows:

	Total production in GWh	<u> </u>	Production of the GWh	f hydroenergy % of total
1962	121001		75.5	
1968	195	7.2	138	
1973	385	14.5	295	76

# (b) Breakdown of consumption in percentages: (b)

2000		1960	1968	1973
		1,000	+/9 <u>%</u>	T)(1)
Industry	grammage, againean s <u>an sakhani kanada kan</u> ge, sakan ora asari san sake sake sake sake sake sake sake sake	35.0	41.0	57.0
Water pumping		6.9	6.1	24.7(8)
High voltage o	consumers	7,•7 gas	8.2	6.5
Low voltage co	consumers onsumers	37.0	30.8	22.2
Losses		13.4	13.9	9.6
		100.0	100.0	100.0

# (c) <u>Investments in two five-year periods</u> (in million FMG):

	to the contract of the contract of			• 3,
		1964	- 1968 1969 -	1973
			1.12	*
Α.	Studies		<b>, 200</b> , 10 , 10 , 10 , 10 , 10	250
В.	Production . No add you are recommended.		1200	3700
•.	1. Large power stations High Plateau	560	2850	• 1
	2. Equipment for regional centres	190	200	k
	3. Small DE and HE	_450	650	** · ·
C.	Transmission and distribution	<u>រ</u> ុំ	2100 - Jana W	3500
	1. 90 kV-line Antsirabe-Antananarivo	500	· <del>-</del>	
	2. 150 kV line Fianarantsoa "	***	1500	· .
	3. Distribution	1600		
			3500	7450
		0.54	<u>(</u> a 1900/ 1898/61 (. <del></del> .	41/1

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## Abbreviations and symbols used

MW - Megawatt = 1,000 kW

GWh - Gigawatthour = 1,000,000 kWh

TWh - Terawatthour = 1,000 GWh

tre - tons (metric) of coal equivalent

HE - Hydroelectric power plant

DE - Diesel electric power plant

SPM - Société Pétrolière Malagache

#### 11. MAURITIUS

## I. Primary Energy Resources

No data available

## Production, Trade and Consumption of Primary Energy (1,2)

# (1) - Production:

There are only small amounts of hydro-energy produced on the island:

				in GWh (rounded)	in 100 tce (rounded)
	and the second	e de la companya de l			
1959	• •	<u> </u>		30.	15
1960	• •			30 .	15
1961	* *			20 ,	10
1962	0		*****	50	25
1963	• •	) er		60	30

Conversion ratio: 1 kWh = 0.5 kg coal equivalent

#### (2) - Trade:

country under consideration.

·我真心: 人名阿克 医乳红 医乳色 医乳色膜壁

in 1000 tce (rounded):

	, redri€		Import	<u>Bunkers</u>	Net import
1959	ŏ o	ь о	110	10	166
1960	e <b>®</b> , <b>®</b> , <u>a.</u> 3 ° 2 ° 1 ° 1		, 4 90	20	70
1961	* * * * * * * * * * * * * * * * * * *	1.1 0 0	90	20	70
1962	<b>.</b> .	• 0	130	20	110
1963	<b>₩</b> •	• •	110	20	90

Carridos

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Quantities given under "Bunkers" were supplied to foreign-bound ships and aircraft, irrespective of the flag of the vessel or plane. "Bunkers" are not considered as "Export", nor as "Consumption" of the 44 2 23 0 800 Com Grange

# (3) - Consumption: in 1000 tce (rounded)

			Production	Net Import	Total:
1959	• •	<b>▶</b> 0	15	100	115
1960	• •	0 0	*		_
1961	* * * * * * * * * * * * * * * * * * *	,	.coisqmuen <b>40</b> ò.s c	70 - J	80 <sup>22</sup>
1962			25	110	135
1963	• •	• •	30	905	120

MAGE LAX . . .

og open a nagá to observad filozo olim od smedi Breakdown of consumption according to various forms of energy, in 1000 tce (rounded): TOUR COLORS

ieński i	A BOOK SOURCE COMMENTS	Solid fuels	Liquid fuels	Hyd	lroenergy	Total
1959	• • (i)	15 ×	· 85 <b>≭</b> /	2 %	15	115
1960	• • • • • •		70	4 · · · ·	15	85
1961	• • 5	- ,	70	. *	10	80
1962	• •	10 <u>x</u> /	100	*	25	135
1963	• • •	-	90		30	120

x/-Estimated as the rounded figures in the doc. (1) and (2) are not always consistent. The second secon

liquid fuels: 1.3 Conversion ratio for: solid fuels : 1.0

that is to say: 1 ton liquid fuel = 1.3 tce. toogaa (B)

#### - Consumption per capita:

1959	• •.	185	kg	coal	equivalent
1960	3 3	127	Ħ	11	11
1961	<b>.</b> Q\$	129	11	Ħ	H ° °
1962	•. <b>*</b> ;	192	11	11	11
1963	. • •	171	77	11	11
					4 7

# Electric Energy (1, 2, 3, 4)

# (1) - Installed capacity and a second of the second of the

The only available information is taken from doc. (4), issued in 1963 when the International Bank made a loan of \$ 7 million to expand electric power facilities in Mauritius.

The beneficiary of the loan was the Central Electricity Board (C.E.B.), a semi-autonomous government corporation established in 1952 to consolidate the various electricity undertakings on the island. Since 1956, CEB has been the sole public supplier of electricity on the island and now serves about half the population.

CEB obtains most of its energy requirements from its own plants, which have a combined capacity of about 30,000 kH, of which about half is in hydro plants. It supplements this capacity, in the dry season, by purchases of power from private plants on sugar estates.

The loan helped to finance the construction of a 12,000 kW diesel power station at Port Louis, the capital city, and an expansion and improvements of the transmission and distribution systems.

The project increased the island's public supply by nearly a third, improving the efficiency of service in towns connected to the power network, and extending service to some additional communities. It is expected that the project will meet the CEB power requirements until mid-1968.

The new station is equipped with two diesel generating sets of 6,000 kW each. The plant site is large enough to permit eventual expansion of the station to 40,000 kW.

The total cost of the project was estimated at the equivalent of \$ 8.6 million, which gives a specific investment of \$ 715 per installed kilowatt.

The loan was given for a term of 20 years at an annual interest rate of 5.5 per cent, including the one per cent commission allocated to the Bank's special reserve.

# (2) - Production and the second confidence of the production and the second confidence of the se

There are only a few data available:

the latitude part of the season production of the GWh (rounded)

and prosent factorial at press of a or

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and the second of the second o	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
Production  Public & industrial  Total Hydro		Consump- tion
	- Commercial and the second	<i>-</i>
i sa i na na na sa	in faceta Company	
1959 150 30 1960 150 1961 160 20	54.6 30	150
1961 160 20	<b>6</b> 3•2 ,20 ,	160m
1961	77.2 50	popular de 170 garago
1963 180° 180° 60° (80° 60° 60° 60° 60° 60° 60° 60° 60° 60° 6	37.4 60	jejska 1974 (1 <mark>1,80</mark> ) registi. Sura sa

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# Abreviations and symbols used: now the tip meeting of the colors and symbols used:

GWh - Gigawatt hour = 1,000,000 kWh.

tce - tons (metric) coal equivalent.

#### 12. RWANDA

## I. Primary Energy Resources (3)

## (1) Hydro-power

ves soile

Rwanda has considerable hydro-power resources in relation to its needs for electricity. Hydroelectric stations have already been constructed at several locations, but it is reported that there still remains a considerable unexploited potential, especially on the River Ruzizi between Lake Kivu and Lake Tanganyika.

The largest part of the total difference in elevation between the two lakes (689m) over a distance of some 30 km downstream from Lake Kivu, lies on Rwandese territory. The hydro-power potential of this part of the Ruzizi is estimated to be some 2.6 tWh, but one half of this potential belongs to Rwanda as the Ruzizi forms the frontier with the Congo.

# (2) Other primary energy resources

- (a) Hydrocarbons (3,8,9): Rwanda has no known petroleum resources, and in general the geology of the country is not favourable for their occurrence. The waters at the bottom of Lake Kivu lying between Rwanda and the Congo, which covers an area of approximately 2,300 square kilometres and is very deep, contain a considerable quantity of dissolved gases, including methane. Tests have been made to investigate the possibility of using this gas as a source of energy. Reserves of methane are reported to be 57,000 million m3 which is equivalent to 76 million tons of coal. A pilot extraction station of methane from water has been set up at Gisenyi and the gas is employed as free for one of the boilers in the Bralirwa brewery.
  - (b) Coal: No coal is known to occur in Rwanda.
  - (c) Peat: Thick layers of peat occur in many of the river valleys and exploitation has commenced near Shangugu to provide fuel for a cement plant.

- Radio-active minerals: These are known to occur in Rwanda and may ultimately be found in economically exploitable i statistica in the second second quantities.
- (e) Geothermal: It is possible that geothermal anomalies may o occur in connexion with the Rift Valley in which Lake Kivu lies.
- Production, Trade and Consumption of Primary Energy (5, 5a) II. timbes of the last of the property

## (1) Production:

www.databatwa.nafake kiva ee hake Tearmayatu Only small amounts of hydro-energy are produced in the country, but it is not clear what are the real amounts. The available documents give the following information: ( ) as a first order of the following information: Miva, Line of themselves to be a compared

Doc. (4): Hydro energy produced in 1961 in Rwanda-Urundi was 5.6 GWh. Doc. (5a): For the period 1961-1963, production of hydro-energy was 10 GWh Doc. (6a): Table I.p.7: Present hydro-energy production amount to 37.5 GWh (This should read "producibility" and not "production").

Net import of liquid fuels (in 1,000 tce, rounded) (2)

```
, as a constant 1959 of the continuous and some with
                                                                                                                                                                                                                                                                                                       grader 30° and a
                                                                                                                                        1960 ......
                                 1961 ...
                                                                                                                                                                                                                                                                                                                                                                            1 - 14-15 - 14-15-16 40 -
           aboa : 1962 wiv. .. 1
                                                                                                                                                                                                                                                                                                                             The end of the section of the section of the community of the section of the sect
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(3) Consumption (inst,000 toe, rounded): tog gagi eysi name. . . n green jibuinni sasana

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10 1960
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Consumptions per capita (in kg coal equivalent); (4)

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1959 ..
                                                                                                                                                                                                  . Proposition and the state of 
                                                                                              1960 ..
                                                                                               1961 ...
                                                                                                                                                                                                                                                                                                reson vals to special reduct a train
                                                                                               1962 ..
1963 ..
                   terf stir ... if ugugasid ween bennesser and which sell to best
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# III. Electric Energy (5, 5a, 6, 7):

# Mx na griongso neiletanl Prower plants: [18] (1)

The available information is in some respect not clear:

ne.

(a) Doc. (6)

Kilsenyi

·· Abbutua

Hydropower plants

Nisysa

Locality	Installed in Présent	l capaicty 1 kW Possible		Production (= production Present	cibility)
Ntaruka Kisenyi	7,500 inc. 7,500 1,100	11,250 bas 6 1500 1,100	1,510 oxii (s: 550	9.0  }    ons (2)    2.5(be)	20 000 (c) magaz 5
Total	8,600	12,350	2,060	11.5	25

908

The maximum load is only 36 per cent of the present installed capacity.

total light.

Thermal	power	plants	(=DE)	į
---------	-------	--------	-------	---

Locality		I <b>nst</b> all capacit kW		Prese Max. lo kW	ad :	Yearly Production kWh	(16) (16)
Butare	31	555	ten	120	+ ,k	476,000	
Nyanza	- : <u>I</u>	70	-bunda	20	,	72,000	
Gisenyi		690	gai	Stand-by		2.35	
Kigali	s server en marine	250	The speed report were former spring upon the	: <u></u>		- mrs stak men men trans state state state state of	t ia i kaliwa ansima
Total		1,565		c 140		548,000	es i de la

## gell transmiller i lines exist between the larger (b) Doc. (7):

r faith we emissed of a residence In 1958, the Power and Water Company REGIDESO had the following power plants in Rwanda:

Minetsin.

And the second of George (about 115 and 1070).

And the second of the secon

Locality		Thermal	lled capaci Hydro	Total
was the same and the same of t	·www.g ver cesqas		MODERNA	s I – s Bak. De jewn
Astrida	• •	265		.265
Kisenyi		690	- 550	1,240
Niawza	-	40		40
	Programati ens (= produ	250	oodienteri	320
mak eldizae¶ <b>Tot</b>	al Marketta (1997)	1,245	620	1,865

O Caraca (C) caraca car

(c) Doc. (5) and (5a): Production and consumption, in GWh (rounded)

	Total	iones was 'F or		
	_ · · · · · ·	Hydro		
				the first time and time and the second
1959 Vilent V	100000000	below	10	a de de la compania del compania de la compania del compania de la compania del la compania de l
1960	lood .xad	the the season	10	
1961	10	level	10	the second of th
1962	10	of	10	1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -
1963	10	round-	10	##.cess ()
		ing		And the second second

- (2) Transmission and distribution (6)
  - (a) 70-kV transmission lines exist between the HE Ntaruka and and the following substations:
  - Substation Kagera for the region of Kigali and for the mines of Somuki at Rutongo;
  - Substation Musha for the mines of Minetain.
     Substation Rwinkwaon for the mines of Georwanda (about 115 km long).
  - (b) The medium distribution voltages are given as 15 kV and 6.6kV. The length of the respective lines is not given, nor the number of distribution substations.

- (c) The low-voltage distribution systems use 220/380 V, mainly with underground cables. The length of the lines is not known.

  The number of the substations is not known.
- (3) Power plants, transmission lines and distribution networks under construction or in project:

Only recommendations given in (6) are known:

- (a) Hydropower plants:
- It is possible to raise the installed capacities in the HE Ntaruka and Mururu by 19,350 kW.
- The hydropotential of the River Ruzizi south of Lake Kivu amounts to some 2,600 GWh/year. Half of this potential belongs to Rwanda.
- (b) Transmission lines: The Albert Manager Man
- 130-kV transmission lines are to inter-connect the HE Mururu with Gikongoro-Butare, ending in the power station "Forces" to the north of Kigali. Naither technical nor economic explanations have been given for this recommendation. The possible installed capacity of the HE Mururu is quoted at 28.2 MW but no justification for such a high voltage as 130 kV is given.
- 30-kV lines are in the same way recommended for the gross distribution network without any technical or economic justification.
- (4) Tariffs:

No data available.

(5) Fuel prices in retail:

No data available.

# DOCUMENTS USED CORVOSO OFF THE THE TRANSPORTED FOR THE SECOND

- African Electric Power Meeting, Addis Ababa, October 1963, E/CN.14/EP/3 Part I. . gwont tog at anything Ibid, Part III and and any and and any or all the later of the later o
- 2.
- 3. Ibid, Add.1.
- Industries et travaux d'outremer, January 1964 No. 122
- United Nations, World Energy Supplies, 1959-1962, New York 1964, No. 7 5.

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- " " 1965, No.8 5a.
- Les problèmes énergetiques au Rwanda, Paul Meystre, UN Expert, with the Government of Rwanda.
  - a) Rapport périodique No.I, February 1964
  - No.II, April 1964 Agging the Anthony ( ) b)
  - c) Rapport final, June 1964
- Rapport 1958, by the public enterprise REGIDESO (Régie de distribution d'eau et d'électricité du Congo Belge et du Rwanda-Urundi).
- Mise en valeur du gaz methane du lac Kivu, J. de Lavallée, UN Technical Assistance, Butare, Rwanda (1965)
- Development of the Steel Industry in East and Central Africa, W.S. Atkins & Partners, Preprint, 1965

# Terre i Africa de la Servicia de la Composição de la Comp Abbreviations and symbols used:

MW - Megawatt = 1,000 kW

GWh- Gigawatt hour = 1 million de kWh

tce- tons (metric) of coal equivalent

DE - Diesel power plant

HE - Hydro power plant

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# 13. BURUNDI

I. Primary Energy Resources (3)

No data are available.

- II. Production, Trade and Consumption of Primary Energy (5, 5a)
  - (1) Production:

Only small amounts of hydro-energy are produced, but they are "below the level of rounding", which means under 10 GWh/year.

(2) Net import of liquid fuels (rounded):

i d	1959		20,000	tc
	1960	an of a	20,000	## 7 (1)
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	1961		30,000	11
	1962	, appol	30,000	tt
and the second	1963	, ar ch	40,000,	. 11
rynike?		A personal	11	

(3) Consumption (rounded):

```
1959 .. 20,000 tce )

1960 .. 20,000 " ) + small amounts of hydroenergy which are "below the level of rounding"

1963 .. 40,000 " )
```

# Consumption per capita:

```
1959 .. 10 kg coal equivalent
1960 ... 11 " " "
1961 .. 12 " " "
1962 .. 13 " " "
1963 .. 14 " " "
```

III. Electric Energy (5, 5a, 6)

The only data available are:

(1)	Existing	power	plants	$\circ f$	REGIDESO	in 1958	_	(6)	)
-----	----------	-------	--------	-----------	----------	---------	---	-----	---

	Installed capacity Production in				
	TO STORY IN A STATE OF THE STAT		(in kW)	1958 (kNh)	
DE	Usumbura	• •	3,040	9,276,774	
DE	Kitega	a s		141,948 .	
ing the second at 18.1 The second at 18.1			3,135	9,418,722	

(2)	Production and	consumption	in the perio	od 1959/6	<u>63 (5,5a)</u>
	1959	* * * * * * * * * * * * * * * * * * * *	under		) + small amounts
	1960		more than	10 GWh	of hydroenergy,
	1961		$(\theta_{ij})^{\mathrm{T}} \nabla_{ij}^{\mathrm{T}} \theta_{ij} (E_{ij} - \theta_{ij})$	10 GWh	which are
	1962	• •	20 14 3 <b>0</b> 10 10	10 GWh ;	) "below the level of rounding".
	1963		m garatti H	10 GWh '	}

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- African Electric Power Meeting, Addis Ababa, October 1963 E/CN.14.EP/3 Part I
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- 5. United Nations, World Energy Supplies, 1959-1962, New York 1964, No. 7
- " 1960-1963, New York, 1965, No. 8 5a.
- Rapport 1958, RECIDESO (Régie de Distribution d'eau et d'électricité du Congo Belge et du Rwanda-Urundi).

#### Abbreviations and symbols used:

tce tons (metric) of coal equivalent

 $\mathtt{DE}$ Diesel electric power plant

# III. SUMMARY

The following six tables give a survey on the energy situation in thirteen countries of the East African sub-region:

Table 1:	Summary of the conventional fuel deposits (proved and							
The second secon	estimated).	17 (12 (184))	Visit de Service	Matter (mil)				
Table 2:	Summary of the		oelectric potentia					
Table 3:	Primary energy	in the period	1959-1963, in 1,000	O tce Oracio,es litaredo,e				
Table 4:	Projections of	primary energy	consumption for t					
•1.	1963-1975			Andlilogott Topaci. (				
,	4.			sôma U 🔑				
Table 5:	Electric energ	y in the period	1959-1963	ayooA 📢				
Table 6:	70.0	electric energ	y consumption for	the period for the same of				
	1963-1975.	_		•				
7 s - • •	in the second se	•	·n ·	In the .th				
San			nas,	( ) ( ) ( ) ( ) ( ) ( )				
	ing a^k £oustropoe, tr	••	****					
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Section 1	na en	Arrivation (**)	the time too					
edia.	****	••	•••					
** ** ** ** ** ** ** ** ** ** ** ** **	4 ▼ + 128]	The work through	ow establish	海田(大きない)では、まま -				
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the Title	in the state of the same	ind . (no free:	Confidence of the second of th	[1 88 H. X.				
	the state of the s		net e komin <b>to n</b> et ekonomi.					

TABLE I <u>Summar</u>y

Auto District

# of the conventional fuel deposits

(proved and estimated)

No. Country	Hydro	carbons	Solid	fuels
No. Country	Quality	Quantity	Quality	Quantity
1. Ethiopia	inises (Borises)	Indiang. But were	Non-coking Lignite	10 m.tons 3 m.tons
2. Somali Republic	r 2000 to <del>via</del> ja karas			not known
3. French Somaliland		1980 - Santa Barrell, 1980 - 1980 - 1980 - 1980 - 1980 - 1980 - 1980 - 1980 - 1980 - 1980 - 1980 - 1980 - 1980	or ten <u>-</u> al all resigns	. <del>∏</del> e <u>i</u> g√ T
4. Uganda	-	•••	<u>- 6500-361</u>	
5. Kenya	7.001-08			<del>-</del>
6. Tanzania			Rituminua cost	300 m.tons
a tati.	i 🤏 ur Igunia.	North Additional	4,000-7,000 kcal/kg	10.7
			low grade	100 m.tons
7. Malawi	-		low grade coal	50 m.tons
8. Zambia		-	coal	20 m.tons
9. Rhodesia		-	coal	10,000 m.tons
10. Malagasy Republic	tar (in sands).	25 m.tons proved 1,000 m.tons estimated	6,500 kcal/kg	100 m. tons measured 1,000 m.tons estimated
	oil shales	17.5 m.tons	lignite 3,500 kcal/kg	32 m.tons
11. Mauritius	***	***		-
2. Rwanda	methane	equivalent of	peat	large
13. Burundi	Lake Kivu	76 m.tons coal	-	~

Expressed in tons of coal equivalent, the total deposits in all countries of the East African sub-region amount to:

Hydrocarbons	1,435
Solid fuels	11,615
	43.050
In total	13,050

# TABLE 5

## Summary

# of the estimated

# hydroelectric potential

		In GWH	and made
1.	Ethiopia	45,000	
2.	Somali Republic	1,000	
3.	French Somaliland	Acceptable of the Control of the Con	not known
4.	Uganda	5,000	
5•	Kenya	50,000	
6.	Tanzania	75,000	
7.	Malawi		
8.	Zambia 2	36,000	
9.	Rhodesia {		
10.	Madagascar -	114,000	
11.	Mauritius		not known
12.	Rwanda	1,300	
13.	Burundi		not <b>k</b> nown
East	African sub-region	367,300	****

The continental part of the sub-region (without Madajascar and Mauritius) has an estimated hydropower potential of 253,300 Gwh per annum.

TABLE 3

Primary Energy in the period 1959/1963 in 1000 tce

			Pr	oduction							Trade	9			* *	Consumpt	ion	
Country	ele	ydro ctric nergy		Coal lignite	То	tal	Elect		Co li	al gnite	lic fue	quid els	т	otal		Total	Per o kg of equiv	capita coal
	1959	1963	1959	1963	1959	1963	1959	1963	1959	1963	1959	1963	1959	1963	1959	1963	1959	1963
1. Ethiopia	14	54	_	_	14	54	-	_	10	10	170	190	180	<b>20</b> 0	194	254	9.7	11.5
2. Somali Republic	5	6 <b>X</b>	/ _	-	5	6	-	_	-	-	50	50	50	50	55	56	23	23
3. French Somaliland	-	_		-	-	-	~	_	_	-	20	30	20	30	20	30	278	367
4. Uganda	173	255	-	_	173	255	-65	-95	-		180	200	115	105	288	360	44	50
5. Kenya	70	85		-	70	85	75	102	40	40	980	1130	1095	1,272	1,165	1,357	167	182
6. Tanzania	50	55	2	2	52	57	-10	-7	_	_	370	450	3 <b>70</b>	450	422	507	45	51
7. Malawi	_	2	-	-	-	2)	403)	182)	-127	-259)	710)	810)	986)	733)	5,129)	5,480)	512)	476
8. Zambia	_	153	_	_	<b>-</b> :	153	}	. }		}	}	}	}	}	}	}	}	,
9. Rhodesia	-	1,571	4,143	3,021	4,143	4,592)	Ś	5		}	5	5	5	5	5	·	Ś	, .
10. Madagasoar	26	37	_	2	26	39	-	_	10	10	170	190	180	200	206	239	38	40
11. Mauritius	15	30	-	_	15	30	-		15	<u>r</u> /_	85 <b>*</b> /	90	100	90	115	120	185	171
12. Rwanda	5	5	_		5	5	-	_	-		30	40	30	40	35	45	. 11	15
13. Burundi	-	-	-	-	-		-	-	-	-	20	40	20	40	20	40	8.2	14
East African sub-region	358	2,253	4,145	3,025	4,503	5,278	403	182	-52	-19 <b>9</b>	2,785	3,220	3,136	4,203	7,639	8,484	113	128
Total for Africa	3,180	4,820	42,080	46,590	48,800ª/	90,780ª		_	200	-1033	11,370	21,400	11,570	22,430	<b>60,37</b> 0	68,350	225	233

#### Remarks:

- (a) The Conversion ratio selected for electric energy is: 1 GWh. = 500 tce.
- (b) Under "Trade", the figures with a negative sign indicate exports. The figures without any sign indicate "Net Imports" that is "Imports" minus "Bunkers".
- (c) In the East African sub-region, there has been no production of hydrocarbons yet.
- (d) The whole of Africa including all countries of the continent had the following production of crude petroleum and natural gas, which is included in the "Total" of production:

	1959	1963
crude petroleum	3510	38810
natural gas	. 30	560
hydrocarbons	3,540	39,370

TABLE 4

Projections of primary energy

consumption for the period 1963-1975

		Rate of	growth, %	Con	sumpti	on in 1,	000 tce
		44			Estimate	ed.	
		1959-1963	1963-1975	1963	1965	197C	1975
1.	Ethiopia	5.6	5.0	254	280	460	750
2.	Somali Republic	0.4	5.0	56	62	100	163
3.	French Somaliland	8.5	5.0	30	33	54	88
4.	Uganda	4.5	4.2	360	392	480	590
5•	Kenya	3.0	3.0	1,357	1,440	1,670	1,950
6.	Tanzania	3.7	5.0	507	560	920	1,500
7.	Malawi	) )	)	)	)	)	+ 200
8.	Zambia	1.5	2.5	5,480	5,780	6,520	7,380
9•	Rhodesia	ý ý	\frac{1}{2}	Ś	5	)	
10.	Madag <b>as</b> car	3.0	5.0	239	263	430	700
11.	Mauritius	0.8	3.0	120	127	148	172
12.	Rwanda	5.0	5.0	45	50	82	134
13.	Burundi	15.0	5,0	40	44	72	118
Eas reg	t African sub- ion	3.0	4.0	8,484	9,031	16,936	13,745

		Ex	isting in	stallatio	ns				Produc	tion in	GWh		Tr	ade		Consump	ion	
Country	Power sta	tions, in	MM	Trans- mission	Distrib. feeders	Low- voltage		HE	TE		T	otal	in	GWb.	1	Cotal	Per c	apita
·	HE	TE	Total	lines km	km	km	1959	1963	1959	1963	1959	1963	1959	1963	1959	1963		1963
1. Ethiopia	60.0	29.3	89.3	577	662	?	28	109	61	66 <del>z</del>		175	<b>'</b> -	_	89	175	4.	4 8.
2. Somali Republic	-	7.9	7.9	-	?	?	-	-	10	13≖		, 13	-	-	10	13	5.0	5.
3. French Somaliland	_	7.0	7.0	-	40	?		· <b>-</b>	10≚	15	10≚	4 15	_	_	10	15	13.8	20.
4. Uganda	121.2	15.0	136.2	265	3,450	798	350	510	20	20	370	530	-130	-190	240	340	36.5	47.
5. Kenya	26.4	74.1	100.5	900	2,160	1,060	140	170	70	92	210	263	150	205	360	468	46.2	52.
6. Tanzania	20.2	29.9	50.1	70	?	?	90	100	70	, 100	160	200	-20	-20	140	180	14.8	18.
7. Malawi	9.6	14.8	15.4	254	424	240	4₹⁄	4	28 🛎	38	32 <sup><u>≭</u></sup>	42	-	-	32	42	9.3	11.
8. Zambia	55.5	208.4	263.9	600	?	?	250	314	937	416	1,187	730	745	1,845	1,933	2,575	620	736
9. Rhodesia	705.0	483.4	1,188.4	3,730	1,433	4,800	1	3,142	1,530	227	1,531	3,369	ó1 -	4,478	1,592	1,891	452	475
10. Madagascar	27.8	33.2	61.0	174	?	?	53	74	47	51	100	125	-	-	100	125	19.0	21.
11. Mauritius	15.0 <del>*/</del>	27.0×	42.0 <sup>¥</sup>	/ ?	?	?	30	60	120	120	150	180	_	-	150	180	240	256
12. Rwanda	8.6	1.6	10.2	?	?	?	2	- 11	?	?	10	11	-	-	10	11	3.8	4.
t3. Burundi	***	3.1	3.1	?	?	?	?	?	10	10	10	10		-	10	10	4.1	3.8
East African sub-region	1,040.3	1,144.7		6,550	8,169	-6,898	948	4,494	2,913	1,168	3,869	5,662	806	362	4,675	6,024	69.0	81.
Total for Africa	2,747 <sup>B</sup>	7,604	10,351		33 <b>,</b> 585.	?	6,350	9,640	28,290	34,280	34,640	43,920	_	-	34,640	43,920	130	150

#### Remarks:

- (a) At the end of 1961
- (b) Under "Trade", the figures with a negative sign indicate exports. The figures without any sign indicate "Imports".
- (c) Dashes (-) in the table mean "zero".
- (d) Question marks in the table mean that the relative data are not available.
- (e) The "Total for Africa" includes all countries of the continent

x/ Estimated

	I	Rate of grow	th, i	n %	Tot	al Consum	ption, i	n GWh			onsumption the total		Estimated rate of growth for the
Country	Past 1959-1963	Future offici		Estimate for 1963/1975 in average	Past	E	Future stimated		Past		Future estimate for 1975		remaining consumption (= without industry) for the
		Period	%	%		1965	1970	1975	Year	%	GWL	%	- period 1963-1975 <b>%</b>
1. Ethiopia	20.0	1963/1967	17.0	13.1	175	257 0/	477	890	1961	46.0	578	65.0 b	/ 12.0
2. Somali Republic	6,8	-		17.6	13	15	34	77	1961	27.0	46	60.0	12.0
3. French Somaliland	10.7	-	_	12.0	15	18	32	57	1963	30.02	€/ <sub>17</sub> ¥/	30.0	12.0
4. Uganda	9.2	_	-	10.0	340	410	660	1,060	1961	67.0	708	67.0	10.0
5. Kenya	6.7		-	12.0	468	530	935	1,650	1961	31.0	856	51.5	12.0
6. Tanzania	6.5	1964/1970	12.0	15.1	180	204	355 °	978	1962	65.6 <sup>5</sup>	<u>4</u> ∕ 785	80.0	10.0
7. Malawi	7.0	_	-	40.0	42	48	85	2,250	1963	54.0	2,100	93.1	12.0
8. Zambia	7.2	1962/1970	7.3	7.3	2,575	2,950	4, 265 9/	5,900	1962	90.0	4,660	79.0	7.3
9. Rhodesia	4.4	406074067		4.4	1,891		2,570	3,200	1963	54.0	1,710	54.0	4.4
10. Madagasoar	5.7	1962/1967 1968/1973	7.2 14.5	13.5	125	152 <b>2</b> /	240 2/	680	1960	35.0	441	65.0°	10.0
11. Mauritius	6.2	_	-	6.2	180	204	276	374	1963	25.0 ×	s/ 95	25.4	6,2
12. Rwanda	2.5	-	-	25.0	11	12	38	121	1963	30 ₹/	94	78.0	12.0
13. Burundi	-	-	-	19.5	10	12	29	73	1963	30 ₹/	46	63.0	12.0
East African sub-region	5.2			9.1	6,024	ం,882	9,996	17,310	1 <b>9</b> 63	67.0-X	12,136	70.0	8.2

#### Remarks:

- (o) Official estimate or based on its extra- or inter polation.
- (a) Including supplies for the sisal industry plus commercial power and lighting.
- (x) Estimated, as nearer data are lacking.
- (b) For 1967, the official estimate is 58.5 %
- (c) For 1973, the official estimate is 57.0 %

As a result of all these surveys the following conclusions may be pointed out:

1. Hydrocarbons: Crude petroleum and natural gas have not yet been found in the sub-region in economically exploitable quantities.

The methane gas in Lake Kivu seems to be the best known source of hydrocarbons in the sub-region.

Crude petroleum for the refineries and large quantities of liquid fuels have to be imported for the time being.

#### 2. Chal, lignite:

There are relatively large deposits of high grade coal and other kinds of solid fuels in the sub-region.

Taking into account the estimate that by 1975 about one-third of the total requirements for primary energy will be covered by solid fuels, the known and the probable deposits of coal and lignite in the sub-region would be sufficient for some 2,400 years.

Five countries in the sub-region are without any known solid fuel deposits.

#### 3. Hydropower:

The East African sub-region has a very large hydropcwer potential with Madagascar being relatively the strongest in this respect.

The per capita hydropower potential amounts to:

Madagascar about

19,000KWh p.a.

Continental part

of the sub-region about 3,700 KWh p.a.

These figures have to be compared with about 5,500 KWh per capita and per annum for the whole of Africa.

#### 4. Electric energy

In 1963, the ratio of hydropower production to thermal power production was 80:20. This ratio will steadily increase in favour of hydropower and by 1975 it might be 90:10 or thereabouts. To cover the future

requirements for electric energy by 1975, about 6 per cent of the total hydropower potential of the continental part of the sub-region will have to be developed.

Limit of the group in a By that time, new power projects with a total power of about 2000 MW will have to be constructed and the total investments, including transmission and distribution installations are likely to amount to seme US. 700 or 800 millión. Hassa a hayáideons sais is seid se ాయ్రాయ్ కుర్మం - అయ్రా ఇండుకుంటులో ప్రామాన్నికావా—కుండు కుర్యాలు కార్యకారుకుండాని అయ్య కేంద్రాని - కుర్మాన్నిక మార్క్ కుర్మం - అయ్రా ఇండుకుంటులో ప్రామాన్నికి పాటాంత్రుకుండి కారణకులు మండుకుండాని అయ్య కేంద్రాని - కుర్మాన్ని

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> The Appendix of the State of th · and it is the state of the st

# strate and the three or a . IV. RECOMMENDATIONS

- 1. Taking into consideration the fact that all kinds of primary energy and especially the secondary form-electric energy are among the basic prime movers of economic development, appropriate attention should be given to a proportionate development of various forms of energy in the sub-region.
- 2. In the light of the necessity to so-ordinate the general economic development of the countries on a sub-regional basis, the same basic principle of co-ordination should be applied in the energy field as well.
- 3. As the aim of co-ordination in the energy field is to provide various forms of energy for the countries in the sub-region on the most economic conditions, all possible efforts should be made to get a really complete and up-to-date picture of the economic side of the production and distribution costs of various forms of energy in all countries of the sub-region.

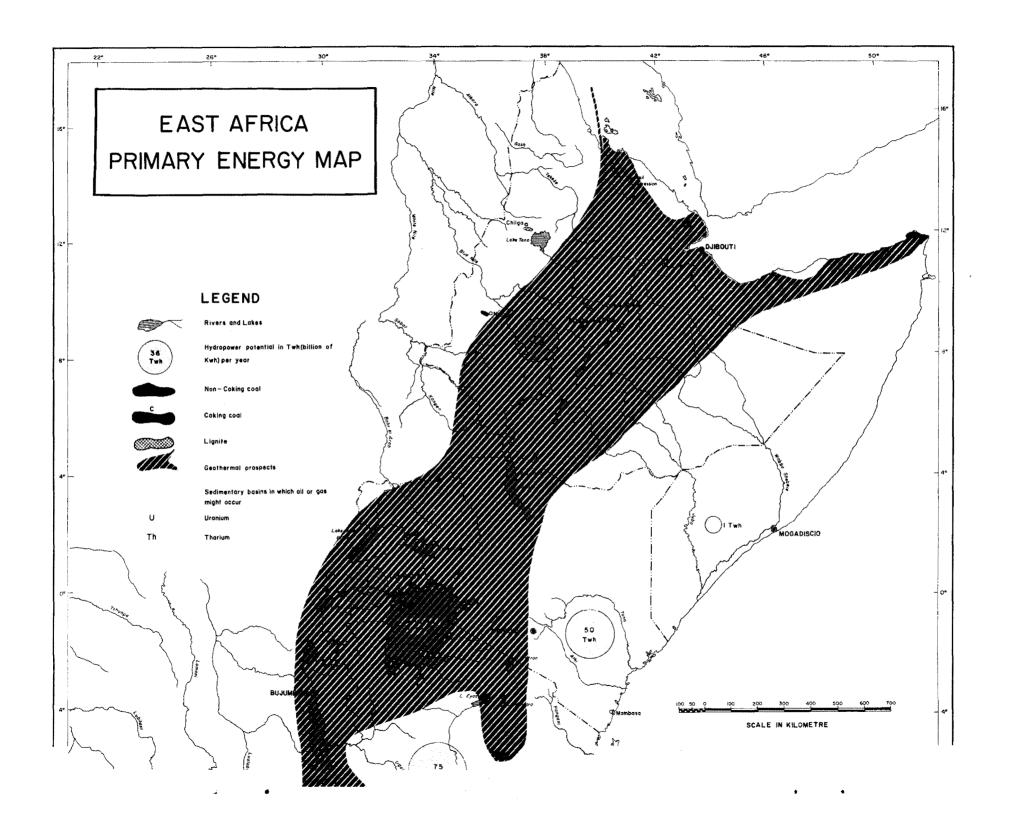
These energy price analyses on a country-by-country basis should be later co-ordinated in such a way that similar or equal financial conditions be taken as starting points in order to get a realistic comparison between various countries of the sub-region.

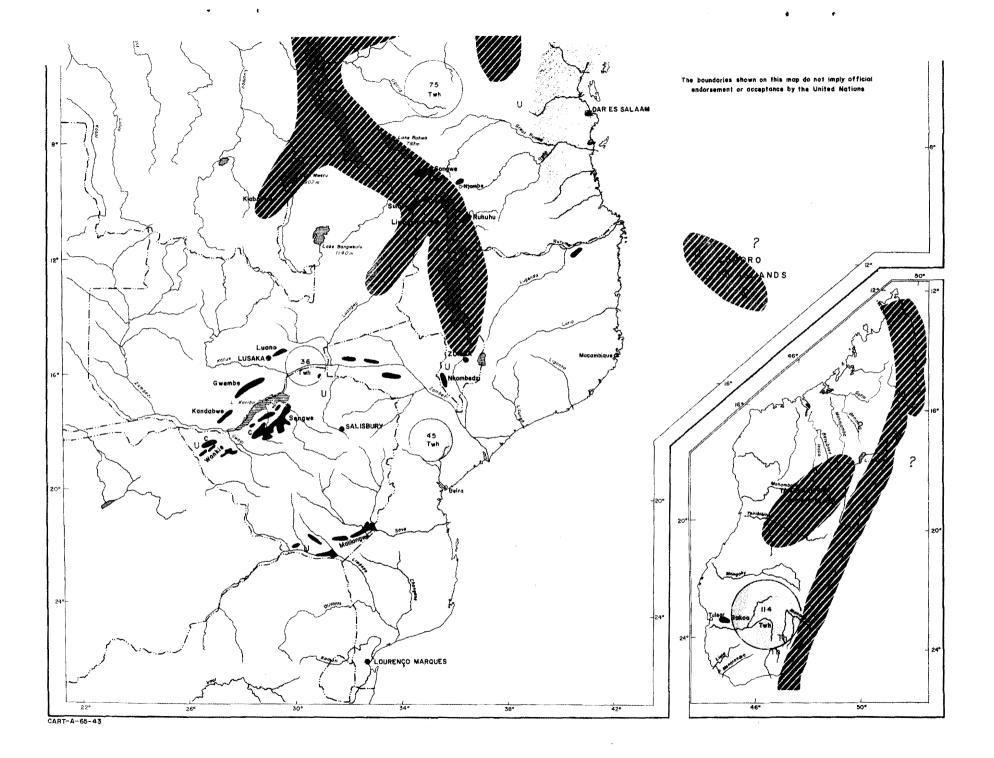
- 4. The dynamics of the economy and energy development require that the necessary, reasonable amount of statistical data from the energy field be collected on a routine basis.
- 5. Being one of the most promising primary energy resources in the sub-region, hydropower potential should be intensively studied in all countries in order to find out the most economic hydropower sites.
- 6. It seems that the methane gas in Lake Kivu has been sufficiently explored from the theoretical as well as the practical points of view with pilot plant in operation and that a feasibility study of its large scale exploitation should take place.

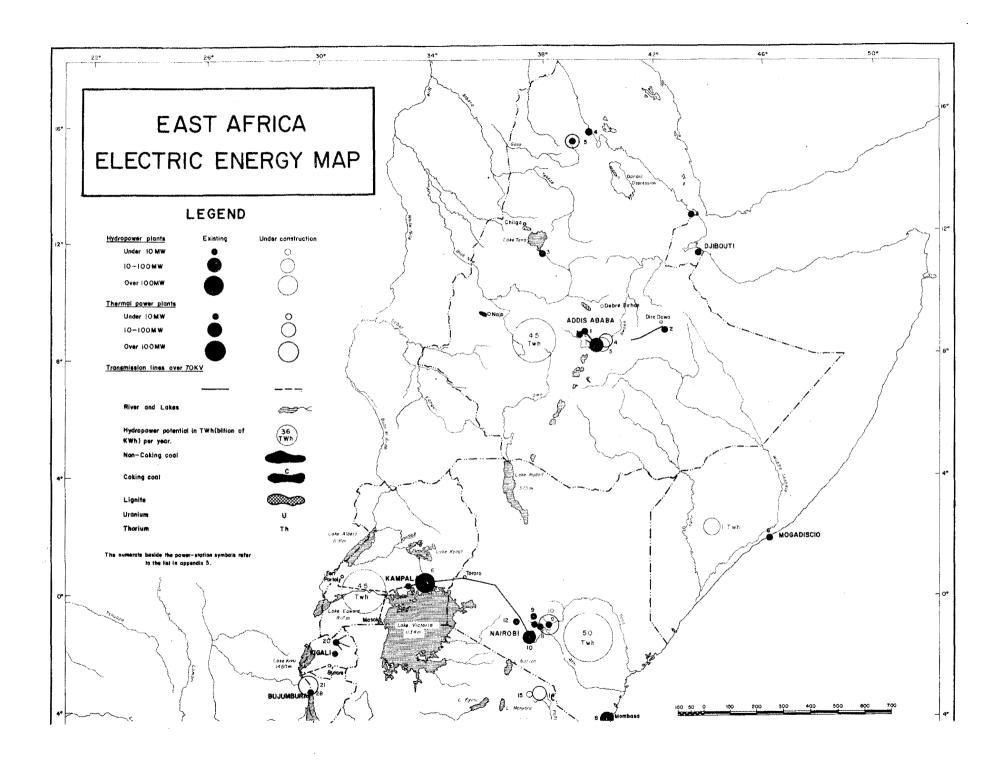
- 7. The prospects of exploiting geothermal energy in the East African sub-region in an economic way are supposed to be large and it would be advisable to propose a few sites for which feasibility studies should be prepared.
- 8. In parallel with the technical and economic side of energy development, the manpower problem in this field of activity should be given the necessary attention by the governments in the sub-region.

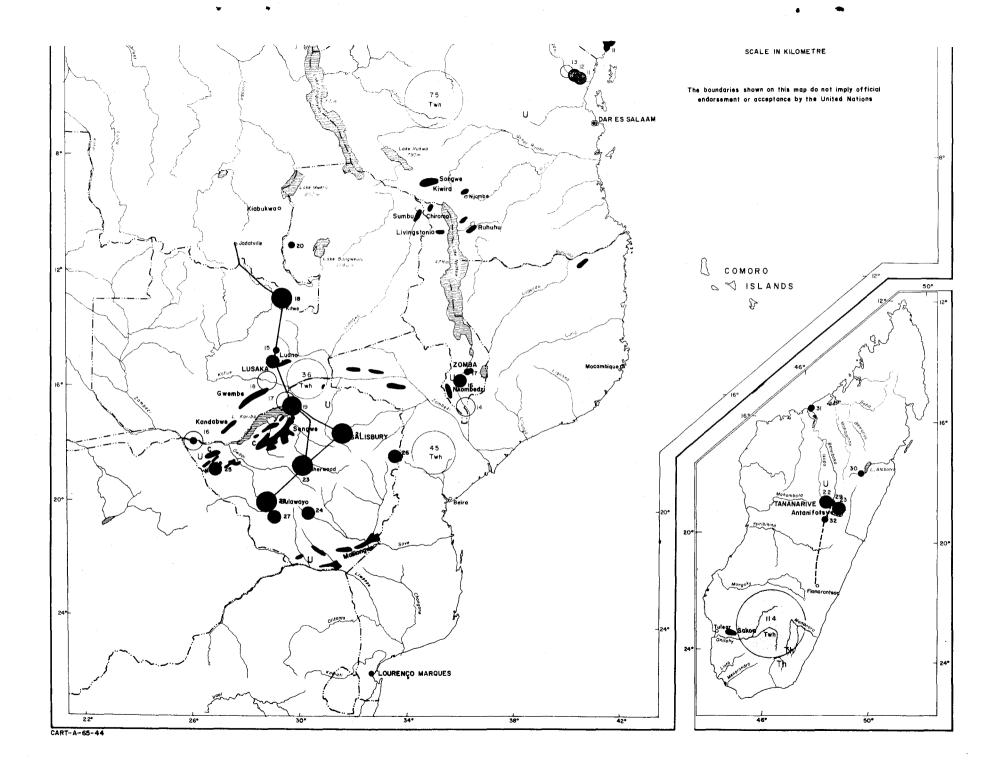
UNESCO and ILO should be requested to render assistance to the governments in organizing various training programmes to provide the necessary professional and skilled personnel at all levels.

9. Efforts in the energy field should be co-ordinated to such extent that more important power projects may be financed and administered on a sub-regional basis.









#### APPRAIDTX III

L	arger	electric	power	stations	in	the	East	African	gub-region

A. Hyd	ropower S	tations (over 5 MV		
	a stri			led Capacity
Country	No.	Name	Existing	under con- struction or proposed
Ethiopia	1	Koma	45.0	
. 50	2	Aba Samuel	6.6	
	14 cars - reservence (4) Herbert - repres - serve - se	Tis Abbay	9.6	
The state of the s		Awash II	Fa	32.0
	5	Awash III		32.0
Uganda	6	Owen Falls	120.0	+30.0
Kenya	7	Tana	6.443 . • t	
	8	Low Tana	8.0	
	9	Wonjii	7.4.	
ay a sa s	10	Seven Forks	ininatri .fi	250 .
Tanzania	11	Pangani Falls	≋108-≈ <b>17.5</b>	
₹. • · · ·	12	Hale	21.0	
•	13	Pangani River	<u> </u>	30.0
and the second s	n de anno e composito de anno esta e	or Wami River	ge casis .e.	300 G-A 0
Malawi	14	Shire River	Tag 100	470.0 Tana
Zambia	15	Broken Hill	42.7	
	16	Victoria Falls	8.0	184.0
ng pagang ang mang mendalah persebuah paganggan paganggan pada	17	Kariba II	- 100 mg	900.0
	18	Kafue River		257.0
Rhodesia	<b>1</b> 9	Kariba I	705.0	
Rwanda	20	Ntaruka	1 7 5 1 1 - 1	+ 4.2
	21	River Ruzizi	A STATE OF THE STA	2600GWh/year
Madagascar	22	Manoviaka	11.0	
gradien in der der Geberate der	23	Anklomita-I + II		en e
in the second of		e a positività della compania della compania della compania della compania della compania della compania della		the state of the s

$\mathbf{B}_{\bullet}$	Thermal	reweg	stations	(Over	2 MW	installed	capacity)	

	/ 100	and lifts ourse or	Install	led Capac	city in MW
Country	No.	CEO C Name Co.			construct- or sed
Ethiopia	1.	Addis Ababa	્5∙0	- 10 3gT	37.00
I man from	<u>.</u> : 2.	Alemaya	2.0		•
greeners and a single group and a contract of the sign and a	3.	Assab	2.0.,	A to the second of the second	erania.
	4.	Massawa	6.0		The filtren of the filtren
	5.	Asmara	5.0		30.C
Somali Republic	6,	Mogadiscio	2.7	-	- 1.9
Fr.Somaliland	7.	Djibouti	7.0. m	C.	and an experimental section of the s
Kenya	8.	Kipe <b>vu</b>	27.5		
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	10.	Nairobi South I	+ II 25.1		
	11.	Mbiraki	6.0		
	12.	Mereron	4 • 4		
Tanzania	13.	Kurasini (		<del>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</del>	
		(Dar-es-Salaam)	17.2	÷ ;	11
	14.	Moshi	?		13.5
	15.	Arusha	remitt after i	s	8. €
Malawi	16.	Blantyre	10.5	The second secon	
	17.	Zomba	<sub>9790</sub> ; <b>2.∙8</b> ⊹ ,	41	
Zambia	18.	Copper belt mine	s 193.1	11. 14	eramin der udlere sign
	19.	Lusaka	<b>15.</b> ●		
	20.	6.8 Fort Rosebery	2.0	.4. ! 	
	21.	Salisbury	153.0		
8-312	22.	Bulawayo	148.5	e ang a garan makang man	oners removed that the second of the second
No. of Art of the Methods and Art of the Meth		T+,	120.0		
la	24.	Shabani	30.0	17 is	A Company
$acs k / q_{kQ} ac \beta C$	25.	Wankie	in 18.5	\$ 1.	
also not consider a facility of the control of the		Umtali	6.16.75 mile	emerican support to the support to t	e, o programa de la composição de la compo La composição de la compo
		Gwomda	12 <b>-5</b> - 3-01		
Burundi		Bu jumbura	3.0		
Madagascar		Antananarivo	5.0		
		Tmatave Majunga	3.0 3.4		
		Ant <b>s</b> izab•	2.8		

The main elec	tric Tra	ensmission Lines in the E	ast African	Sub-region
A. Exi ting (	over 70	kt) 100.6173.00 p.		
Country	No.	End points	d par	Circuit length Km
Ethiopia 30	1.	Koka-Addis Ababa  Le condessions (owdix-solder)  Koka-Dire Dawa	132 )	418
Uganda s sag		Kampala-Owen Falls -Tororo - Kenya	32 · O	200 <sup>x</sup>
Kenya •	4.	Nairobi-Tomornoga di -u	1.132 . ·	400
Tanzania	5.	Hale-Dar-es-Salaam	132	280
Zam <b>bi</b> a	6.	Kitwe-Jadotville(Congo)	220	290
	7. 8.	Kitwe-Lusaka Lusaka-Kariba(Rhodesia)	330 }	600
	9.	88kv - System	330 ) 88	115ª/
Rhodesia	10.	Kariba-Salisbury	330 )	
	11.	Salisbury-Sherwood	330 )	
-	12.	Sherwood-Bulawayo	330 )	1,030
	13.	Kariba-Sherwood	330 )	
	14.	88 kv - system	88	925
Rwand <b>a</b>	15.	Ntvmka - Kagera	70	?
	16.	Ntvmka - Musha	70	?
	17.	Ntvmka - Rwinkwaon	70	115
B. Under con		on or proposed		
Country	No.	End points	KV	Circuit length km
Ethiopia	1.	Koka-Awash II	132	50°
	2.	Koka-Akaki	132	75
T 3	3.	Akaki-Sabata, Gafarsa	132	25 100 <sup>x</sup> /
Jgand <b>a</b>	4•	Kampala - Kabulasoke	132 132	100 <sup>∞</sup> / 130 <sup>∞</sup>
	5• 6•	Kampala - Masaka Kabulasoke - Fort Portal		260 <sup>x</sup>
Tanzania	7.	Hale-Dar-es-Salaam duplication	132	2·5 <b>0</b>

B.	Under	construction or proposed (continued)							

Country	No.	End points KV Circuit length km					
Zambia	9. Antanan		Kitwe, duplication arivo-Antsirabe arivo-Finnarantsoa		90	600 150 <sup>x</sup> 300 <sup>x</sup>	
Rwanda	11.		Gikongoro-Bu	tare	130	12 <b>●</b> <sup>X</sup>	
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