PAPER 13

POWER

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This paper briefly traces the development of the power sector in Uganda, analyses its present state, takes a look at the future and makes recommendations about the areas needing action.[1]

2. It may come as a surprise that in a country endowed with rich hydel resources, the first electric power came through thermal sets which were installed by the East African Power and Lighting Company Limited. It was not until 1935 that serious assessment surveys were made of the hydro-electric potential of the river Nile. And it was in the light of these surveys that Uganda Electricity Board (UEB) was established in 1948 for the generation, transmission and distribution of electric power. Work was started on a 10 x 15 MW hydro power station at Owen Falls, near Jinja, and in the interim, till the construction was completed in 1954, diesel sets were installed as a source of power. As the estimated power demand of Uganda at the time was hardly 10 MW, a 50-year agreement was made with Kenya to supply that country with 30 MW per annum starting 1958.

3. Annex 13.1 shows the total power generating capacity installed in the country. It will be seen that the predominant source of electric power is the Owen Falls station.

4. Today the transmission and distribution network extends over 9,000 kms. serving nearly 93,000 consumers. There has been a ten-fold increase in power generating capacity - from a mere 15 MW in the early 1950s to nearly 155 MW now. Yet the present per capita consumption of 45 kwh is one of the lowest in the world. This is also reflected in the state of economic development.

An Analysis of Power Consumption

5. Much more disturbing has been the stagnation and, in fact, the decline in power consumption in the 1970s. Annex 13.2 gives the capacity installed, the maximum demand and the units generated. From a peak of 816 m kwh generated in 1971, the power generated in 1978 was only 639 m kwh.

6. A break-down of electricity sold according to market segments is provided in Annex 13.3. While there has been some growth in consumption by domestic and commercial sectors, that of industry has dropped by 50% over the decade 1968-78.[2] It will also be observed that with the decline in power consumption by industry - the major user in Uganda - the share of Kenya in total units sold has increased from about 34% to nearly 40%.

7. A further analysis of power consumption by major market segments and of the revenue obtained from them reveals certain interesting facts. This analysis is presented at Annex 13.4. It will be seen that in 1970, electric power sold in Uganda (amounting to about 63% of total generated) accounted for 90% of the revenues whereas the remaining 37% supplied to Kenya accounted for hardly 10% of the total income. In 1977, Kenya's share in UEB's revenues was still below 10% despite its consumption of nearly 45% of total power generated.

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1. During the period when most economic activity was showing signs of deterioration, the power sector stood out as an island of strength. True, the generation and consumption of electricity has gone down in the 1970s but this is due more to a decrease in load than to any inadequacy of response to demand.

2. To some extent, the industrial sales were affected in 1969-70 by the switch from electricity to fuel oil for raising steam, for example, in textile mills. While the use of fuel oil for generating process steam may be considered technically superior, the recurring and continually soaring costs should limit its use especially when the other alternative is a cheap and abundant souce of power. It is believed that fuel costs is about-to-be commissioned Lake Katwe Salt Project alone would be over Shs. 10 m per annum. The opportunity cost of not using hydel power seems to be too high. Substantial foreign exchange can be saved by switching over to electricity from use of the fuel oil in industry.

8. This, then, is the present state of the power sector in Uganda:

- A single source of electricity for all practical purposes - the 150 MW capacity Owen Falls hydro station.
- A per capita consumption of 45 kwh - one of the lowest in the world.
- A 50 year agreement (till 2008) to supply 30 MW p a to Kenya.
- A consumption ratio of about 60:40 between Uganda and Kenya with the corresponding revenue ratio being 90:10.
- Within the Ugandan market, a steep fall in consumption by industry - from 72% in 1969 to 48% in 1978.

9. The picture since 1978 is not reassuring either. On 4th June 1979, for example, only five machines (our of 10 installed) were found to be working at the station, each giving an output of 9-10 MW. The load fluctuation in previous weeks has been between 25 and 70 KW.

Recent Damages

10. Fortunately, there has been no material damage to the power project and its associated sub-station at Jinja during the recent fighting. The only damage has been the destruction of a door outside generator No. 10, marks on the outer covering of the machine and the shattering of about a dozen glass panes.. UEB has made an estimate of the requirements in view of damages to the distribution system and other equipment. This estimate amounting to a total of Shs. 20 m. is shown in Annex 13.5.

Planning for the Future

11. In planning for future power development in Uganda, one is immediately struck by the present underutilisation of capacity in view of the insufficient load. No wonder then that when we broached the idea of doubling the power capacity in five years the response was one of surprise. The UEB expects that industrial recovery will at best raise the demand by 10-12 MW. From Annex 13.3 it will be seen that there has been a decline of about 25 MW in power consumption by industry. Thus, a complete recovery to the 1969 production level should entail a rise in power generation by at least 25 MW, if not more.

12. If the expected increase in industrial production is to be sustained beyond the immediate recovery period and if Uganda is to embark upon an industrialisation programme in the process of economic development, there can be no escape from planning now for what the power scene should be, say five years hence. During the early stages of development, quantum jumps take place, especially in infrastructural sectors and basic industries. In fact their growth rates lead those of other sectors. Empirical evidence suggests that an increase in electricity generation has to average 13-15% per annum if the industry growth rate is to be 7-8%. For any effective economic development to take place in Uganda, 13 to 15% growth in power capacity (that is, doubling within five to six years) is desirable, necessary and not highly ambitious.

13. The simultaneous maximum demand in 1978 was 119 MW. Even assuming a further decline, (taking 110 MW as the maximum 1979 load, and assuming only 10% growth p a inclusive of needs for industrial recovery, the projections of generating capacity and the estimated demand are as follows:

Year	Generating Capacity (MW)	Estimated demand equivalent
1979	150	110
1980	150	121
1981	150	133
1982	150	146
1983	150	161

The generating capacity of 150 MW presumes that there is no standby unit as at present - otherwise it will stand reduced to 135 MW. Thus it appears that demand will outstrip supply in or around 1983. Now is it being geared up to meet the situation?

14. An estimate made in 1948 puts the total hydro-electric potential of the country at 2,500 MW. Annex 13.6 lists the projects which were considered in the past but abandoned for one reason or another. Annex 13.7 identifies the possible sites for future hydro-electric stations. In a country like Uganda, well-blessed with lakes and rivers, there would be many sites for local tapping by setting up mini and micro hydel power stations. In UEB's view the capital cost of the latter would be very high. There is a need to work out the economies of cost in each case separately, taking into account the savings in transmission and distribution costs to remote sites.

15. In the present reckoning of UEB, Ayago Power Station is the best bet. While the selection of appropriate sites is the subject matter of concerned experts, the need for setting up additional power generating capacity cannot be over-emphasised. Keeping in view the industrial development requirements of the Western and Northern regions as well as the transmission and distribution aspects, it may be better to have a second major source away from the present location. However, it is a matter of expert opinion. The first stage of 60 MW at Ayago is likely to cost around £16-18 m. Considering the long time taken in constructing a hydel station (five to seven years), there is urgency in initiating the work now.

The time/cost phasing of the project as estimated by UEB is as follows:

Year	Estimated Expenses	Remarks
1979	3	Payments to consultants for preparing project report. Part payments already made
1980	30	Finalisation of negotiations. Start of civil construction work
1981	60	
1982	60	
1983	75	Installation of equipment
1984	30	Commissioning

UEB expects that phase I of the Ayago project would start generating power only by 1984/85. From para 13 we notice that demand will exceed supply by 1983. Thus there is likely to be a shortage of power in 1983/84. It only points to the urgency of planning for additions to generating capacity. While a period of five to six years is normal for a hydro-pwer station, it is suggested that steps like close management monitoring be undertaken to reduce the total time cycle. A token sum of Shs. 2-3 m. could be provided for undertaking surveys and site preparatory work.

16. Besides additions to generating capacity there are the associated needs of transmission and distribution. The highest transmission voltate at present is 132 KV. The considerations of bulk transmission over long distances, possible further exports to neighbouring countries and the needs of industry five years hence raise the issue of whether the country's highest transmission voltage should be the next stage of 220 KV. Preliminary studies in this regard would be desirable. It would also be necessary for the UEB, in view of the relative insulation of the power sector from technological trends in the field abroad, to upgrade its technical expertise, especially in the areas of instrumentation and control systems and high voltage transmission. The UEB has in mind a number of transmission and distribution schemes (see Annex 13.8). These, estimated to cost Shs. 100m., would necessitate outside funding. In the past, the only external financial assistance obtained was a loan of £ 3 m. from the World Bank for installations at Owen Falls during the period 1961-63.

Power Tariff and Supplies to Kenya

17. According to UEB, the power tariff has remained unchanged since 1961. I was told that present rates in Uganda were almost a quarter of those in Tanzania and about half of those prevailing in Kenya. It is true that, unlike thermal power stations, there is not much recurring maintenance expenditure on hydro stations. It is also true that per capita consumption needs to increase substantially if any significant economic development is to take place. But a rise in tariff, it is felt, will affect the power consumption temporarily only and the long-term trend of increasing consumption will not be affected. More to strengthen the internal resources position for future expansion than to meet any increase in operational costs, the Government may seriously consider raising the electricity tariff. Alternatively, a cess could be imposed on the present rates which should go to a fund earmarked specifically for the rural electrification programme which presently seems to be hampered by financial difficulties.

18. This will also provide a vital opportunity of raising the question of a tariff increase with the Kenyan authorities. Even though, it is believed, the contract provides for changes in tariff based on mutual consent, and this issue has been taken up by the Ugandan authorities in the past, there has been no outcome so far. Against approximately 4 cents per unit being charged by Uganda, Kenya, it seems, had indicated 60 cents per unit if it were to make power supplies to Uganda. Even though accepting the fact that long-term bulk power supplies are usually at a low price, the price of power supplies to Kenya seems to be too low. It is suggested that negotiations be held with Kenya on enhancing the power tariff.

19. The UEB has been running two manufacturing works also - one for producing lamps and the other for producing cables. The technology involved in making lamps is quite different from that of generating electricity. The advantage, if any, of UEB running these factories is not clear. On the other hand, lamp manufacture seems to have been neglected (see the paper on Industry). In fact, UEB itself is not keen to retain the manufacturing activity. Under the circumstances, it will be appropriate to detach these operations from the UEB.

Conclusion and Recommendations

20. - The present level of power generation in Uganda is in the region of 90 to 100 MW, with about 40% of it being supplied to Kenya under an agreement due to expire in the year 2008. The revenues from this market account for only 10% of the total income from sales of power.

- The share of industry in the total consumption of power in Uganda has dropped from over 70% in 1968 to below 50% a decade later.

- The full recovery of the industrial production level to that of 1969 within the next two years would entail an increase of 160 kwh in power generation (equivalent to about 25 MW). The present installed capacity will suffice for meeting this requirement.

- The extent of damage to the equipment and systems has been assessed by UEB at about Shs. 20 m. in foreign exchange. Out of this, hardware equipment needs account for Shs. 7 m. and the remaining Shs. 13 m. is for transport vehicles and construction of buildings, etc. It is understood that the EEC mission has made an aid commitment of Shs. 20 m. for the power sector. Together with UEB's own resources and capabilities, this should meet the immediate requirements for finance. There does not seem to be a case for any further outside financial assistance so far as recent damages are concerned.

- The sustenance of industrial growth and the needs of a developing economy make it imperative that there be adequate growth in the power sector - say a growth rate of 13 to 15% p a.

- Power programmes, especially the hydel-based, take a long time to be implemented - conception to commissioning period may run to five to seven years or even more. The time to plan for the power scene in 1985, therefore, is right now. One cannot but take a long term perspective when it comes to power.

- According to present reckoning, demand will outstrip supply in or around 1983/84 depending upon the rate of economic growth. Unless immediate and urgent steps are taken, it may be too late for Uganda to avoid shortages in power generation within the next four to five years.
- Uganda will need to have additional generating capacity preferably elsewhere than in the Eastern Region. UEB adjudges the Ayago project (with a total capacity of 500 MW) as the best scheme with a first phase of 60 MW (1979-80) costing around Shs. 270 m. The Ayago site was not visited but the estimate seems to be reasonable. Together with the needs of the transmission and distribution system, the power development programme of Uganda in the next four to five years is estimated to cost over Shs. 400 m.
- The capital - intensive power scheme will obviously need outside assistance, notably from the World Bank. It is recommended that a provision of Shs. 2-3 m. be made for site surveys and other preparatory work during the year 1979-80.[1]
- The Government may like to revise upwards the power tariff, unchanged since 1961, with a view to providing internal resources for development financing or building up a fund for the subsidised rural electrification programme.
- The factories for producing electric lamps and cables should be delinked from UEB as the business of making and selling these products requires exclusive attention.

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1 The bulk of external funding when negotiated and finalised, would, of course, be specific to projects/schemes spread over a number of years

ANNEX 13.1

Power Generating Capacity Installed in Uganda

	MW
Owen Falls Hydro-electric Station	150
Mabale Hydro-electric Station	1
Diesel stations at Arua, Koboko, Adjumani and Moyo	3
Total	154

ANNEX 13.2

Supply and Demand of Electricity over 1966-78

	Unit	1966	1968	1969	1971	1973	1975	1977	1978
Installed Capacity	MW	138	153	154	154	154	154	154	154
Simultaneous maximum demand	MW	114	132	128	130	130	122	114	119
Simultaneous maximum demand as % of installed capacity	%	83	86	80	84	84	80	74	74
Total Units generated	mkwh	635	731	731	816	793	727	688	639

ANNEX 13.3

Power Consumed by Different Market Segements

	Unit	1966	1967	1969	1971	1973	1975	1977	1978
Total Units generated	mkwh	635	731	731	816	793	727	688	630
Transmission losses	mkwh	56	73	67	73	52	84	84	80
	%								
Units Available	mkwh	579	658	664	744	701	643	604	550
Total supplied to Kenya	mkwh	203	224	218	293	302	261	272	217
	%	35.1	34.1	32.9	39.4	43.1	40.6	45.1	39.5
Total consumed by Uganda		376	434	446	451	399	382	332	333
	%	64.9	65.9	67.1	60.6	56.9	59.4	54.9	60.5
Consumed by domestic sector	mkwh	50	59	64	83	70	82	88	98
	%	13.3	13.6	14.3	18.4	17.5	21.5	26.5	29.4
Consumed by commercial sector	mkwh	46	55	59	81	76	77	69	74
	%	12.2	12.7	13.2	18	19	20.1	20.8	22.2
Consumed by industrial sector	mkwh	280	320	323	287	253	223	175	161
	%	74.5	73.7	72.5	63.6	63.5	58.4	52.7	48.4

Analysis of Power Consumption and Contribution to Revenue (%s)

Market Segment	1970		1972		1974		1976		1977		Average Cost per unit in cents
	Cons.	Cont.	Cons.	Cont.	Cons.	Cont.	Cons.	Cont.	Cons.	Cont.	
Domestic	10.4	20.7	10.5	20.5	11.1	21.3	14.3	25.8	14.5	26.8	31
Hotels, clubs etc.	2.7	5.2	3.6	6.1	3.1	5.7	3.3	5.9	3.2	5.9	31
Commercial power and heating	3.6	10.4	3.4	12.5	3.4	9.1	3.4	9.2	3.1	8.4	44
Commercial and security lighting	3.2	13.5	3.5	13.2	3.9	14.4	4.1	15.3	4.1	15.3	62
Street lighting	0.8	1.7	0.8	1.7	0.9	1.8	1.1	2.1	1.1	2.0	31
Industrial power - standard	17.0	24.5	17.6	23.3	17.5	25.3	14.7	21.6	14.1	21.4	24
Industrial power - special	24.8	14.2	21.4	12.5	17.5	10.9	17.7	12.1	14.9	10.8	11
Sub-total Uganda	62.6	90.7	61.0	90.7	57.4	89.7	58.8	92.1	55.0	90.7	26
Kenya	37.4	9.3	39.0	9.3	42.6	10.3	41.2	7.9	45.0	9.3	3.8

Cons. - Consumption % of total units sold

Cont. - Contribution to total revenue

UEB's Estimated Requirements to Replace Materials and Equipment Looted or Destroyed During Recent Military Operations in Uganda

	Shs. m.
DISTRIBUTION SYSTEM	
33 KV line Kampala - Masaka	0.45
House service lines	0.15
100 transformers	1.80
200 meters and cut-outs	0.06
Linesmen's tools and equipment	0.12
Sub-Stations:-	
Masaka - 5 OCBs and protective gear	0.12
Mbarara - One 2.5 MVA transformer	2.22
One 1.0 MVA transformer	0.11
5 11 KV OCBs	0.07
3 air-break switches	0.01
COMMUNICATION SYSTEM	
Radios in Board's vehicles	0.04
Fixed radio stations	0.12
DOMESTIC REPAIR WORKSHOPS	
Tools and spare parts	0.07
TRANSPORT	
68 vehicles	7.15
Tools and equipment - main repair centre	0.03
OFFICES AND HOUSES	
Furniture and equipment	0.03
Repairs	4.50
New offices at Mbarara and Mityana	0.75
New house at Mbarara and Masaka	0.45
GENERATION	
No damage, but diesel stations in Arua, Koboko, Adjumani, and Moyo are feared destroyed and if so, cost of new generators as well as provision for mains and services is estimated at	3.30
Total	19.82
or, say	Shs. 20 m.

ANNEX 13.6

Projects Considered in the Past and Subsequently Abandoned

Year	Brief Description of Project	Estimated Cost (Shs. m) Foreign Exchange	Total Cost	Mode of Finance	Reason for Abandoning
1966	180 MW Hydro-Electric station at Bujagali about 4½ miles below Owen Falls with transmission to Kampala initially	14	23	World Bank loan contemplated with contribution from UEB revenue surplus	World Bank wanted to consider East Africa as a unit and so Murchison Falls next considered
1968	600 MW Hydro-Electric station at Murchison Falls (now Kabalega) with transmission to Kenya and Kampala	40	65	World Bank loan contemplated with contribution from UEB revenue surplus	Kenya backed out after having agreed to participate
1970	A revised scheme at Murchison to provide for Uganda only. This provided for an initial installation of 150 MW based on run-of-river leaving a dam to be constructed in later development together with transmission to Kampala. Meantime the output would be 80 MW.	12	19	World Bank loan contemplated with contribution from UEB revenue surplus	Uganda Government declined to approve the contract negotiated by UEB thinking they could get better terms which they did not
1971	Extension of Owen Falls to provide an additional 60 MW	4	6	UEB Revenue over 4 years	Contract due to be signed on same day as Asians expelled from Uganda but frustrated as Norwegian Govt. disapproved of Uganda's action

ANNEX 13.7

Potential Sites

	Estimated Capacity MW
Bujagali - 4½ miles below Owen Falls	180
Busowoko (below Bujagali)	160
Kalagala (below Busowoko)	115
Kabalega (formerly Murchison) Falls	600
At the confluence of the Rivers Ayago and Nile about 15 miles east of Kabalega	500
Kamdini - about 25 miles east of Ayago	200
	1,755 MW

Schemes Identified by UEB

(i) A major extension of the transmission system:-

The construction of a high voltage line (initially at 132 kV)from Ayago to Kampala is an obvious procedure and we would tap this line at Kigumba and connect to Masindi at 33 kV thus avoiding the necessity of building a new line all the way from Kampala to Masindi with which we would soon be faced;

Completion of a 132 kV ring - Owen Falls, Lira, Ayago, Kampala, Owen Falls - we would build a line from Ayago to Lira. Thus the many places at present on supply from Owen Falls would be given an alternative source from Ayago;

A 132 kV line Ayago/Arua will go direct and at Arua be stepped down to supply places en route to Moyo at 33 kV;

A 33 kV line will go from Ayago through Pakwach and on to Nebbi thenceforth to Arua, thus enabling service to all parts north and south of Arua;

A 33 kV line out of Ayago will divide, one part going to Gulu and the other to Chobe;

A 33 kV line Lira to Kitgum;

A 33 kV line Soroti to Moroto;

A 33 kV line from Hoima to Mubende and then west to Fort Portal;

The 33 kV line already in use at Katunguru south of Kasese will be extended to Rukungiri but before getting there the line will branch off at Bushenyi and go to Mbarara. Again there will be the alternative of supply from Owen Falls or Ayago;

The ultimate aim is to enable all areas of supply to have access to power provided by both Owen Falls and Ayago

(ii) An important sub-station at Mutundwe, Kampala. This will contain a 15 MW transformer with attendant plant and lines to Kampala North Station thus providing greater security of supply. Cost is estimated at Shs. 5 m, of which about half has already been spent.

(iii) A new sub-station at Entebbe to reinforce supply there. Cost is estimated at Shs. 1 m.

(iv) Lines to hospitals at Kitagata, Yumbe, Anaka, Ithozho, Kagadi and Nebbi at a total estimated cost of Shs. 20 m.

(v) A suggestion has been made that additional power should be made available at Kabale for possible major mining development in that area. The line could start from the 132 kV terminal at Masaka and involve construction of about 170 miles of 132 kV line to Kabale at an estimated cost of Shs. 65 m.

(vi) Supply to water pumping stations at Mityana Kitgun Moigi Kaberamaido Rukungiri Adjumani and Koboko at an estimated cost of Shs. 2 m.

(vii) Diesel stations on four islands and another at Kisoro in the extreme south-west beyond Kabale at estimated cost of Shs. 12 m.

(viii) Television stations at Kaguli, Biko, Kigulya and Ibanda at an estimated cost of Shs. 2 m.