Institute of Development Management

BIGGER IS BETTER IN POWER:

A STUDY OF THE BOTSWANA POWER CORPORATION

by: Steve McCarthy

Studies in Development Management

No. 5

April, 1978

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FOREWORD

The Institute of Development Management has undertaken a Series of Studies in Development Management. These have a twofold purpose: first to provide much needed additional materials based on local experience for use in IDM training courses and seminars; and second, to assist members of the IDM staff and others concerned in analysing development policies and programs and their implementation.

This Study is the fifth in the Series to be published. It was undertaken for the IDM by Mr. Steve McCarthy, who prior to preparing this Study served as Senior Planning Officer with the Ministry of Finance and Development Planning in Botswana. Mr. James Campbell, IDM Research Coordinator, is responsible for general supervision of the Series and editing the publications.

The author assumes full responsibility for the content of the Study. Provided acknowledgement is made, part or all the Study may be reproduced.

George V. Haythorne,
Director.

OUTLINE

I Introduction

- The Role of Power in Development.

II The Botswana Power Corporation

- Why it was set up.
- Legislation.
- The function and operation of the Board.

III Power Generation

- Different methods of generating power.
- Choosing between them.

IV Some Management Problems

- Piecemeal growth of the power station.
- Staffing.

V Power Transmission

- When it makes sense to transmit power.
- A central power station for Botswana?

VI Importing Power

- Political and economic considerations in deciding whether to import power from South Africa.

VII Rural Electrification

- The importance of rural electrification for rural development.
- How much should be charged for electricity in the rural areas?

VIII Subsidies

- Would subsidies encourage a much more rapid development of the power sector?
- Is this a good thing?
- Would subsidised power for industry encourage more industrial development?

IX Summary

1. Introduction

The development of a country always depends on expanding production in the national economy, whether by improved techniques of agriculture, opening mines or building factories. But modern methods of production require other facilities - roads and railways, telephone communications, water supplies and electric power; what is commonly called infrastructure. Much of the contribution made by a government to the process of development consists in providing this infrastructure either directly or through government institutions, leaving for the most part private individuals and companies to undertake the production itself.[1]

Because of Government's role as a provider of infrastructure civil servants are likely to find themselves having to deal with issues in the power sector - policy for its development, creating and staffing the necessary institutions, localisation, legislation for the power sector, and tariff and pricing policies. This case study, which is primarily intended for administrative civil servants, examines some of these issues in the context of the early history of the Botswana Power Corporation.

Almost every aspect of modern life requires electric power. Garages and workshops use it to operate drills, lathes, welders and other machines. A logging industry requires power to operate saws, a textile factory for its looms and spinning machines. Hospitals use power to run operating theatres. Even in the home while power is not strictly essential, its availability improves the quality of life - which is what development is all about. Thus the availability of power is a pre-requisite to modern development.

In another sense the consumption of power is also a measure of progress in development. We can see this in Botswana. In Gaborone and Lobatse the annual consumption of power per head was: approximately 450 units in 1968; 570 units in 1975.[2]

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1. In socialist countries of course governments go further and themselves get deeply and directly involved in the production process. But this is still not very common in developing countries.

2. A unit is a kilowatt hour. A small one-bar electric fire consumes about one unit each hour. A 100 watt light bulb consumes one unit in ten hours.

In the early stages of development power is not publicly available. Institutions which need power such as a garage or hospital in a village have to purchase a small diesel generator to provide their own power. Slowly the number of these local generators in any one place grows, first the hospital, then the garage, then the school and so on. Now it is not very efficient for everyone to be producing their own power like this. For one thing, if the hospital or the garage want to purchase a new electric machine they may also have to purchase another generator to produce the power. Secondly, any one who wants just a small amount of power, say for lighting a community centre in the evening, has to go to the expense of buying a generator. Thirdly, the bigger the generator, i.e. the more power that is generated in one place, the cheaper each unit of power becomes.[3] For all these reasons it is advisable to have one institution which then distributes and sells it to consumers.

II The Botswana Power Corporation

At the end of the 1960's there were several organisations in Botswana generating power for the public:

- In Gaborone the Gaborone Water and Electricity Unit (GWEU) which was a self accounting department of Government ran a power station which supplied Gaborone and also transmitted power to Lobatse.

- In Francistown the Town Council ran a small power station for the town.

- In Mahalapye and Palapye Rhodesia Railways generated power for its own use and sold some to the public through the intermediary of the Government.

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3. This is what economists call "economies of scale". Power generation is one of the situations where economies of scale demonstrably exist. For example the following table based on theoretical calculations show what the cost of generating power is in various sizes of power station:

Power Station Size	Cost/Unit Generated
12,5 MW (similar to Gaborone station)	5,44 thebe
50 MW (similar to Selebi-Phikwe station)	3,52 thebe
150 MW	2,48 thebe
2,500 MW	1,67 thebe

- In Maun the Government operated a small generating station.

In each case there was very little spare capacity to meet growth in demand for power. And, with the exception of the Francistown Town Council, which used the sale of power to subsidise other revenue, all these organisations were selling power at a loss.

In 1970 the Government decided to set up the Botswana Power Corporation, which would be a commercially operating parastatal corporation and which would eventually take over the generation and sale of power in all these places and anywhere else where power was required. An Act of Parliament establishing the BPC was passed in that year and the BPC came into existence the following year.

The first responsibility of the BPC was to take over the Gaborone power station of the old GWEU. After that the BPC's attention was almost entirely taken up with the construction of the new large power station at Selebi-Phikwe. Only very recently has the BPC extended its operations to other areas.

The legislation establishing the BPC provides for it to be run by a Board which is chosen by the appropriate Minister, normally after consultation with Cabinet, though this is not legally required. The Board is free to run the Corporation as it sees best subject to some rather important constraints. These are:

- The BPC is obliged to break even after paying all its debts and providing for the depreciation of its assets and for the necessary increases in working capital.

- The Minister responsible has to approve all the tariffs charged by the BPC.

- The Minister for Finance has to approve borrowing by the BPC.

- The Minister can give general or specific directions to the BPC in the national interest.

Other legislation, the Electricity Supply Act, obliges anyone who wishes to generate power for sale, or for his own use above 25 kilowatts, to apply for a licence. This enables the BPC to be given a monopoly over power generation in certain parts of the country, which is necessary if the economies of scale are to be achieved.

All this legislation is typical of that establishing nationalised industries in other countries such as the U.K., Zambia or Tanzania. There are several arguments for setting up a parastatal in this way:

- Generating power is essentially a commercial business. The business of Government is governing. Thus although the Government owns the BPC, and in the final analysis controls it, the BPC is much more likely to be run as an efficient commercial concern if it is run by a Board with considerable autonomy.

- If the BPC is run as a commercial concern it will be able to raise investment finance from commercial sources, thereby saving government funds. Of course this assumes that the BPC is sufficiently financially strong that commercial lenders will be willing to lend it money.

- The type of accounting used by commercial businesses, unlike government accounting, enables the true cost of generating power to be determined. So tariffs for the sale of power can be set at a realistic level, with consumers paying the full cost of power without subsidy.

- Giving monopoly powers to the BPC over the generation and sale of power in certain areas enables the economies of scale inherent in power generation to be exploited.

- The separation of the BPC from the Government frees it from some of the red-tape and more inefficient aspects of government bureaucracy.

- The retention of residual powers by the Government, such as the power to approve tariffs and the power to appoint and give directives to the Board enables it to control the BPC where national or political objectives are required.[4]

Unfortunately the theory has some deficiencies in practice. Firstly, Board members are generally appointed to represent various interest groups, those of individual government Ministries and those of the private sector. Thus the typical composition of the BPC Board would be:

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4. The Minister has given one such direction to the BPC, limiting the inducement allowances which could be paid to expatriate employees. The Minister was responding to considerable political concern that expatriates in this and other parastatals were being paid too much. However, there is a danger that this type of directive if too rigidly enforced will one day prevent the BPC from recruiting the necessary staff.

- Chairman and one member from the responsible Ministry.
- One member from the Ministry of Finance and Development Planning.
- One member from the Ministry of Commerce and Industry.
- One member from the Commonwealth Development Corporation, a lender to the BPC.
- One member from BCL, the major consumer of power from the Selebi-Phikwe power station.
- Two or three members from the private sector, in effect representing consumers.

Politically it may be sensible to bring various interest groups together on the Board. But the Board has a legal responsibility to run the Corporation commercially and efficiently and this usually requires the individual members to play two roles. As members of the Board they must work for the BPC. Outside the Board they have other frequently conflicting interests to follow. Most individuals find such a conflict of interests rather difficult to manage. In consequence the majority of Board decisions become a compromise between the various external interests, a compromise which is not necessarily in the interests of the BPC itself. The difficulty is starkest whenever the question of the introduction of new tariffs is raised. A majority of members on the typical Board had an external interest in keeping tariffs down even when the interest of the BPC itself is to require such a tariff increase in order to meet its statutory obligations to cover all costs. Put another way, the belief that the establishment of a Board outside Government takes the parastatal out of the realm of politics is a myth. The political process simply goes on within the Board. Whether the creation of a Board is a useful contribution to the political process or whether the parastatal would be better run simply by a general manager answerable direct to a Minister who would himself resolve political conflicts, is an interesting question.

A second difficulty is that Board members frequently have other important responsibilities and cannot devote sufficient time or attention to the affairs of the BPC. This again raises the question of the value of the existence of the Board if its members arrive at Board meetings without having read and studied the papers.

A third difficulty is one of communication. Although the creation of a Board brings political interests to bear on the running of a parastatal, the managers of the parastatal can become surprisingly out of touch with the

policy formulation and planning processes of the government. The hundreds of savingrams which circulate around government and which get copied to many government departments and the meetings which are held, together represent a sort of collective opinion of government on various issues. But such forms of communication rarely reach the management of parastatals. Conversely, civil servants in government can remain very ignorant of the sort of day to day problems faced by parastatal managers. This difficulty is surprisingly hard to overcome in practice, and the managers of parastatals frequently feel isolated from the planning and administration of government, while civil servants feel that parastatals are inclined to go their own way without regard to government policy.

III Power Generation

For an understanding of some of the issues which have faced the BPC since it was started it is necessary first to consider how power is generated. Three methods of generation are available in Botswana.[5]

- In diesel generation a diesel engine is coupled to an alternator or generator which produces the power. Normally both the engine and the alternator are built together as one unit.

- Generation by steam is rather more complex. A coal fired boiler raises steam to a high temperature and pressure. This is then passed through a turbine which drives the alternator which generates the power.

- Gas turbine generation from a planning and operating point of view is essentially similar to diesel generation. Because of this and because no gas turbine generators are currently used in Botswana this method will not be considered further.

Diesel generation has three main advantages. Firstly, for fairly small generators that are normally used in Botswana the capital cost of a diesel generator is less than for steam. Secondly, they can be started up and closed down much more quickly than can a steam plant. This is important because the demand for power consumers obviously varies during the course of the day. Thirdly, they are relatively easy to operate and maintain. Against

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5. In Lesotho or Swaziland hydro-electric generation may also be possible. However this option is not open to a flat dry country such as Botswana and is not considered in this Case Study.

these advantages diesel generation has two disadvantages compared with steam. Firstly, because coal is generally much cheaper than oil the running costs of steam plant are much lower than diesel plant. Secondly, for much larger power stations the capital cost of steam is less than for diesel. For this reason most large power stations in the world are coal fired. Diesel generation however is still very important in Botswana.

When building or extending a power station it has to be decided whether steam or diesel units will be used. This involves comparing the generally higher initial capital cost of the steam unit against the generally higher running costs for the diesel unit. The simplest procedure for doing this is to assume that the capital cost will be financed by a loan and see what annual repayments are necessary to repay the loan during the life of the unit. The running costs of the unit are also estimated for each year. This requires making a forecast of how the demand for power is likely to increase as the years go by. Then by adding the annual loan repayment and the running cost year by year the total cost of generating power with that unit is estimated. The exercise is done separately for the diesel and steam alternatives and the results compared.

An example of this exercise can be seen in Table I. This table shows the estimates made in 1969 by the BPC's consultants in order to decide whether the Corporation should install a new steam or diesel generating plant, from 1971 to 1980. It already has some of each. It will be seen that diesel plants appeared to be much cheaper and it was decided to install a diesel plant, the first generator in 1971 with the rest to follow in 1974, 1977 and 1979.

At any one time a decision has to be made on the sort of information given in Table I. But reality can unfold rather differently. For example the demand for electricity grew rather faster than was forecast when the estimates in Table I were made. The installation programme was therefore accelerated. The first unit was installed as planned in 1971, but the second unit was then brought forward for installation in early 1973, rather than 1974 as planned, and the third unit was installed in early 1975 rather than 1977 as originally planned. More importantly at the end of 1973 oil prices were increased considerably. This at once made the installation of the final diesel generator originally planned for 1979 uneconomic compared with steam. So the final seven years of the investment programme, which had been drawn up in 1969, were abandoned at the end of 1973 and a new steam plant was installed instead. This was completed in the middle of 1976. Similarly actual inflation played havoc with the cost figures which had been forecast in 1969. For example from Table I we see that the running and other cost of generation with new diesel plant was expected to be P403 000, in 1975. In the 1975/

TABLE I: COMPARISON OF STEAM AND DIESEL GENERATION

	Year									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
New Steam Plant	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)
New Capital Cost	1,630			640			990		700	
Loan Repayments to meet capital cost at 7 1/2%	146	146	146	204	204	204	292	292	355	355
Running Cost for new plant	54	61	69	98	107	118	144	159	181	199
Running Cost for old plant	64	74	84	60	66	70	55	59	49	55
Other Costs	48	48	48	82	82	82	122	122	157	157
Total Costs if New Steam Plant Installed	312	329	347	444	459	474	613	632	742	766
New Diesel Plant										
New Capital Cost	527	-	-	248	-	-	407	-	248	-
Loan Repayments to meet capital cost at 7 1/2%	59	59	59	87	87	87	133	133	161	161
Running Cost for New Plant	119	138	152	213	235	259	346	379	437	481
Running Cost for Old Plant	52	62	70	58	63	70	46	50	45	49
Other Costs	10	10	10	18	18	18	27	27	35	35
Total Costs if New Diesel Plant Installed	240	269	291	376	403	434	552	589	678	726
Additional Cost if Steam Plant installed	72	60	56	68	56	40	61	43	64	40

76 financial year the corresponding actual generation costs were more than P1 million.

A word about inflation. The calculations in Table I make no allowance for inflation. In 1969 when the Table was drawn up inflation in Botswana as in the rest of the world was relatively small and was not expected to increase, so it seemed quite reasonable to ignore inflation at that time. Nowadays one has to be much more careful. Table 2 reworks Table I assuming 10% inflation each year. Of course the inflation only affects the running costs and the capital costs for new plant in later years. The actual loan repayments to be made in any year are unaffected by inflation. It will be seen that the calculations in Table 2 åre more favourable to steam which actually appears to be cheaper than diesel in the later years. This illustrates an important general principle; periods of high inflation generally favour the alternative with higher capital costs and lower running costs. Nevertheless one has to exercise great caution in introducing inflation into calculations comparing alternative investments. Firstly, although consideration of inflation favours the alternative with higher capital it does this not just for power but for every other project. Are the capital resources available in the economy sufficient to choose the higher capital alternative in each case? Secondly, it is impossible to know what rates of inflation will apply in five or ten years' time. There are no simple solutions to these difficulties.

IV Some Management Problems

Table 3 shows how the demand for power in Gaborone and Lobatse, both of which towns have been supplied from Gaborone since 1967, has increased over the years. The growth rates for each year are shown and in fact the average growth rate has been over 18%. The third line shows the maximum recorded demand in each year, that is the maximum power which has to be supplied at any time. This too has grown very rapidly. The final line shows the installed capacity of the power station each year. For a power station to be able to supply all its consumers all the time the installed capacity has to be more than the maximum demand. In fact a considerable safety margin is always allowed as some installed plant is likely to be undergoing repair or maintenance at any given time.

An important feature of the table is the way in which the installed capacity of the power station has increased in 5 years out of the 8 shown. In effect the power station has been constantly expanded and modifications and construction have been underway the entire time, - it takes a year or more to install even the relatively straightforward diesel generators. Planning for and managing this continuous growth of the power station is

TABLE 2: COMPARISON OF STEAM AND DIESEL GENERATION WITH INFLATION AT 10%

	1971	1.1 1972	1.21 1973	1.33 1974	1.46 1975	1.61 1976	1.77 1977	1.95 1978	2.14 1979	2.35 1980
New Steam Plant	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)
New Capital Cost	1630	-	-	851	-	-	1752	-	1498	-
Loan Repayments to meet Capital cost at 7 1/2%	146	146	146	222	222	222	379	379	513	513
Running and other costs	166	201	243	319	372	410	568	663	828	966
Total Costs if New Steam Plant Installed	312	347	389	541	594	632	947	1042	1341	1479
New Diesel Plant										
New Capital Cost	527	-	-	329	-	-	720	-	531	-
Loan Repayments to meet Capital Cost at 7 1/2%	59	59	59	96	96	96	177	177	235	235
Running and other costs	181	231	281	384	461	559	742	889	1106	1328
Total Costs if New Diesel Plant Installed	240	290	340	480	557	656	919	1066	1341	1562
Additional Cost if Steam Plant Installed	72	57	49	61	37	-24	28	-24	-	-83

TABLE 3: GROWTH IN POWER CONSUMPTION AND INSTALLED CAPACITY GABORONE AND LOBATSE

(See p. 9)

	Year (1)							
	68/69	69/70	70/71	71/72	72/73	73/74	74/75	75/76
Electricity Generated (millions of units)	12	13	16	18	23	28	31	39 (2)
Growth in Generation		11%	27%	9%	29%	22%	11%	25%
Maximum Demand (millions of watts) (MW)	3,0	3,4	4,0	4,5	5,3	6,4	7,6	8,5
Installed Capacity (millions of watts) (MW)	4,6	5,7	6,7	9,1	11,4	11,4	12,8	12,8

Note: (1) The years shown are BPC financial years from 1st April to 31st March.

(2) Much of the increase from 74/75 to 75/76 is the result of power being supplied to the BMC in the latter year.

one of the biggest management problems facing a small rapidly growing power corporation. Before one project is finished the next one has to be started.

One way of avoiding this difficulty would be to install larger units each time so that the frequency with which a new project has to be implemented is slower. In retrospect the BPC might have done this. But one always has to consider the financial implications of installing larger units. Their initial capital cost will be higher and until the load builds up so that their capacity is fully utilised, a small number of consumers has to pay for, through the tariffs, the extra loan repayments for the larger unit. Another way of avoiding the problem which will be relevant in Botswana in the future will be discussed in the next section.

Another management problem derives from the difficulty in operating a power station which has developed in a piecemeal way - starting with a very small station to which are added several new small units. The staff have to be familiar with various types of machinery. The layout and design of the station is not as good as if a new station was built from scratch. Some of the units and equipment are very old and unreliable. For this reason the Gaborone power station is much more difficult to operate than the much larger Selebi-Phikwe power station, which has an installed capacity of 60 millions of watts (MW), and which was built at one time as a whole.

Partly in consequence of this piecemeal growth of the Gaborone power station it has been subject to a number of major breakdowns in recent years. At the peak period of 1974, the month of July and early August, the power station did not have sufficient available capacity to meet demand and some consumers had to be turned off for hours at a time. The seriousness of the breakdowns at that time can be judged from Table 3. Although the theoretical installed capacity at that time was 11,4 MW, the third new diesel unit not yet having been completed, the power station could only just meet peak demand of 7,6 MW. A less visible consequence of these breakdowns, which occurred generally in the older steam generating sets, was that the diesel units had to be operated for longer hours than planned. As the diesel units have higher running costs than the steam the cost of power produced at that time was considerably higher than expected.

It is likely that some or all of these breakdowns could have been avoided if there were not also staffing problems. In fact staffing the power station at Gaborone has been a constant headache for the management of the BPC. Unlike other institutions or government departments it is very difficult for a power station to "make do" with staff shortages. The station has to be operated continually, three shifts a day. Power station staff cannot afford to turn up late for work, or just to take a day off because of a hangover, or leave work in the middle of their shift to pay a visit to town.

To illustrate this type of problem it is worth considering shift supervisors, the men who are actually in charge of the power station at any time. Until recently the Gaborone power station had an establishment of 4 shift supervisors of whom 3 would work the shifts in any one day and one would have time off.[6] At one time in 1974 the BPC was one shift supervisor short. The previous incumbent had given the requisite three months notice and left, and it had not been possible to replace him in that time. Then one of the 3 remaining got sick. So the other shift supervisors had to then work 12 hour shifts day after day until more staff were available.

At the moment, and probably for some years to come, the BPC relies on expatriates to fill posts such as that of shift supervisor. This in itself causes problems as men can take a two year contract then leave. The management has to quickly search for new staff. It cannot afford the luxury of waiting to find the ideal man for the job, because, come what may, the power station has to be manned.

V Power Transmission

Just as it makes sense for individuals within a town to buy power from one power station in that town rather than everyone generating their own, so it makes sense on a larger scale to transmit power from one town to another. This permits larger power stations to be built at one place and larger power stations generally mean cheaper power. Already in Botswana power is transmitted from Gaborone to Lobatse, and from Selebi-Phikwe to Francistown. Most countries in the world have power transmission networks and certainly quite extensive networks exist in countries neighbouring Botswana: Zambia, Rhodesia and South Africa.

The transmission of power through a network has another advantage. It enables the installation of new units to meet increasing demands, which we have seen has been such a headache in Gaborone, to be concentrated in one or two locations. Perhaps this can best be illustrated by an imaginary example:

- Suppose there were five power stations in Botswana one in each of the five towns including Orapa. The demand in each town would grow little by little each year and small, and therefore relatively costly units, would be being constantly installed in each of these places.

- Now suppose that there was just one power station in the middle of Botswana with transmission lines from there to the five towns. All the increases in demand would be concentrated at that one central

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6. The establishment has since been increased to five.

power station. While that power station would obviously be growing rapidly as more and more larger units were installed to meet the growing demand, the planning and management problems of providing for the demand in this way would be considerably less. In addition because the size of the units at the central station would be larger the average cost of power would be expected to be cheaper - so long of course as the cost of transmitting it was not too great.

As we have seen the actual situation in Botswana lies between these extremes. One power station has supplied both Gaborone and Lobatse since 1967, another much larger power station now supplies both Selebi-Phikwe and Francistown and a third, not operated by the BPC, supplies Orapa. The possibility of building a transmission line between the two BPC stations so that growth and expansion could be concentrated at one or other of them, or at some place in between has always been attractive to power planners in Botswana. The questions to be considered are:

- The capital cost of the transmission line itself. The longer the line the greater this will be.

- The loss of power as it is transmitted along the line. Unless very high voltages are used this loss can be considerable, and high voltages mean higher costs for the construction of the line.

- Against these two costs have to be set the reduced cost of generating power if it is generated in one big station rather than two smaller ones.

The matter was first considered in 1969, when the Selebi-Phikwe station was still being designed. At that time the capital cost of the transmission lines between Gaborone and Selebi-Phikwe was estimated to be P2 million, leading to annual loan repayments and maintenance costs of about P248 000. The total estimated costs are given in Table 4 which also compares these with the estimated costs of generating power locally at Gaborone, which we already have from Table 1. It is clear from Table 4 that transmission would have been much more expensive.

But the annual cost of transmission line almost entirely consists of loan repayments and within broad limits does not depend on the amount of power it carries. Thus the more power that is transmitted the smaller the transmission cost for each unit of power. As the demand for power in Gaborone and Lobatse grows there must come a time when it is cheaper to transmit it from the north than to generate it in Gaborone. So the issue was studied again in 1974. At that time several new demands for power were expected:

TABLE 4: LOCAL GENERATION AT GABORONE OR TRANSMISSION FROM SELEBI-PHIKWE

	Year								
	1972	1973	1974	1975	1976	1977	1978	1979	1980
	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)
Transmission									
Capital Cost of Transmission Line	2000								
Loan Repayment to meet Capital Cost and line maintenance	248	248	248	248	248	248	248	248	248
Cost of Power at Selebi-Phikwe	457	486	513	540	574	606	643	686	734
Total Cost for Transmission	705	734	761	788	822	854	891	934	982
Total Cost for Generation from Table 1	269	291	376	403	434	552	589	678	726
Additional Cost of Transmission	463	443	385	385	388	302	302	256	256

- The mine at Selebi-Phikwe was expected to need more power than had been originally estimated when the power station there was built.

- The mining town at Orapa which currently generates its own power would soon require more.

- The power demand at Gaborone and Lobatse was growing at an average 18% a year.

- It was expected that a soda refinery and abattoir would be built at Dukwe and this also would need power.

Clearly new sources of power would be required. This could be provided in two ways:

- A new power station could be built at Dukwe and the existing ones at Gaborone, Orapa and Selebi-Phikwe could be extended.

- A single new power station could be built at Morupule the site of the local coal mine, thereby avoiding the need to transport coal, and transmission lines could be built from there to Gaborone, Orapa Selebi-Phikwe and Dukwe.

These two options were studied and the results are summarised in Table 5 which suggests that local generation would be P911 000 more expensive over a nine year period.[7] However, it would be quite wrong simply from this analysis to draw the conclusion that central generation is the cheaper option and should be adopted. There are far too many uncertainties in the estimates for that. For example:

- Will the interest rate on money borrowed be 10% or something different?

- Could the routes chosen for the transmission lines be shortened?

- How close would the actual costs of building these facilities be to the estimates?

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7. Strictly one should not just add the "additional costs of local generation" as has been done here. Rather they should be discounted, more weight being given to the costs in the early years than in the later years.

TABLE 5: LOCAL GENERATION, OR CENTRAL GENERATION AT AND TRANSMISSION FROM MORUPULE

	Year 1979	1980	1981	1982	1983	1984	1985	1986	1987	TOTALS
	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	P(000)	
Capital Costs of Central Station and Transmission	28 190	-	-	-	8 384	3 660	-	-	11 750	51 984
Loan Repayments to meet Capital Cost at 10% interest	3 080	3 080	3 080	3 080	4 005	4 408	4 408	4 408	5 698	
Running Costs of Central Station and Transmission:	4 954	5 097	5 236	5 389	5 367	5 604	5 781	5 953	6 029	
Total Costs of Central Station and Trans-mission:	8 034	8 177	8 316	8 469	9 372	10 012	10 189	10 361	11 727	
Capital Costs of Local Generation	15 870	3 422	6 022	22	24	5 629	2 031	29	5 497	38 546
Loan Repayments to meet Capital Cost at 10% interest	1 743	2 116	2 781	2 789	2 789	3 411	3 636	3 641	4 254	
Running Costs of Local Generation	5 668	5 733	5 993	6 204	6 441	6 674	6 987	7 180	7 533	
Total Costs of Local Generation	7 411	7 849	8 774	8 988	9 230	10 085	10 623	10 821	11 787	
Additional Cost of Local Generation	- 623	- 328	458	519	- 142	73	434	460	60	
Cumulative Additional Cost of Local Generation		- 951	- 493	26	- 116	43	391	851	911	

In short, the difference between the costs for the two schemes, unlike the previous examples, is well within the margin of error of the estimates.

At this point other arguments favouring one scheme or another came into particular prominence.

- Although the central scheme appears to be cheaper overall, the capital required for this scheme is much larger, P52 million compared with P39 million. Will it be possible to raise the additional P13 million for the central scheme? If so will this involve taking money from other important development projects in Botswana?

- On the other hand the central scheme would establish a power network extending from Dukwe in the north to Lobatse in the south. Any new major power demands which emerged in the future throughout eastern Botswana could be simply linked up with this network.[8] New mines might also be developed in the next ten years in still unknown locations. If the basic power network already existed it would be much easier to supply power to these mines than if a completely new power station had to be built for each mine.

- If considerable inflation is anticipated in the future then the scheme with the higher capital cost, that is the central scheme, would probably overall work out less expensive than the other scheme.

So the argument went backwards and forward. Let us see what actually happened. Firstly, it is necessary to go back to Table 5 and notice that although the estimates were done in 1974 the Table only starts in 1979. That is because at least five years would have been required to design and build either of the two alternatives. Power systems have to be planned a long way ahead. If a central system were to be ready by 1979 a start had to be made immediately. But it will be recalled that the estimates assumed increasing demand at Gaborone, Selebi-Phikwe and Orapa and a completely new demand at Dukwe. However the mine at Selebi-Phikwe was still not sure that it would require additional power. The abattoir and soda refinery proposed for Dukwe were still being discussed; there were no firm proposals. If the BPC were to proceed with building a central station and then these two expected demands were to

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8. By "major new power demands" is meant something like a new town or mine. It would not be economic immediately to connect villages to such a transmission network as large connecting transformers are required which could cost up to P500 000 each.

fall away then the costs of power from a central generating station would become very much more expensive. On the other hand demand at Gaborone was growing inexorably and some new power would have to be provided there by 1979 at the latest; while the management of the Orapa mine were anxious to proceed with their expansion. In short, the demands at Dukwe and Selebi-Phikwe were not firm enough for work to start on a central scheme while the demands at Gaborone and Orapa would not brook delay. In fact the Dukwe and Selebi-Phikwe demands have still not materialised and the proposal for central generation and transmission has had to be postponed probably until the mid-1980's. The mine at Orapa proceeded to expand its own power station while plans were made for expanding yet again the local power station at Gaborone.

A modified proposal was put forward in 1976 and has since been adopted. That is to expand the power station at Selebi-Phikwe, build a transmission line between Selebi-Phikwe and Orapa only and to use some of the surplus power which would then be available at Selebi-Phikwe to supply Orapa. It has been estimated that this would be worthwhile even though the Orapa power station will have already been extended. The proposal also has the advantage of saving foreign exchange as the power for Orapa will then be generated from locally produced coal rather than imported diesel oil.

VI Importing Power

In 1968 when the development of the mine at Selebi-Phikwe was being first studied, one of the options considered was to bring the necessary power for the town and the mine by means of a transmission line from South Africa. In detail the two alternatives considered were:

- To build a power station at Selebi-Phikwe which supplied power to the mine and town. The power station would be fired by coal from the Morupule coalfield, and a special mine for this purpose would be opened there.

- To build a transmission line from the South African border to Selebi-Phikwe and simply buy power from South Africa. A small power station would also be provided at Selebi-Phikwe sufficient to meet emergency needs in the event of the imported supply failing.

The capital cost of the first alternative was estimated to be P19,5 million. The second alternative was much cheaper at P4,1 million. But these were only the differences between the capital costs of the two power facilities themselves. In addition the first alternative required the construction of rail lines from Selebi-Phikwe to Serule and from Palapye to Murupule neither of which would have been built otherwise. It also required a

larger dam and pipeline from Shashe to Selebi-Phikwe. Taking all these costs into consideration the first alternative was estimated to be P18 million more expensive than the second. In addition the running costs of the first alternative were estimated to be 62% more expensive.

The financial arguments clearly favoured the second alternative. The World Bank, which was originally approached to finance the project was not willing to finance the more expensive first alternative. This is consistent with the usual stand of that organisation which sets financial and economic considerations above political ones. The Government however thought that to import power from South Africa would increase Botswana's dependence on that country. The political cost of this, in the view of the Government, outweighed the additional financial cost of generating power in Botswana. In the end the Canadian government came forward with an offer to finance the first alternative and so this was the course adopted.

However there was another non-political argument also favouring the first alternative of building a power station in Botswana. Essentially, this is the argument that the project would lead to secondary benefits within the country. Some of these are:

- The building of a power station at Selebi-Phikwe would be an important step in developing local skills in the operation of power systems. This will be a slow benefit to materialise. The power station had to be manned almost entirely by expatriates when it opened as there were few if any skilled Batswana in this sector. Training and localisation has started but will proceed slowly.

- A coal mine would be opened in Botswana. This would provide some employment, meet the local demand for coal and perhaps export some as well. The coal mine actually employs about 100 people, most of whom are citizens. It does now supply most of the local market for coal including that of the BPC in Gaborone. However it has never exported any coal and without substantial additional investment the mine has very little spare capacity for exporting.

- The rail spur from Serule to Selebi-Phikwe, which were justified in order to transport coal to Selebi-Phikwe could also be used for the transport of other goods. It does in fact do so.

VII Rural Electrification

So far the Botswana Power Corporation mainly operates in the towns where large identified demands for electricity exist. But the government was anxious to extend the availability of power to the rural areas, starting especially with the major villages. It was known that some demand al-

ready existed in these villages because there were a number of local generators operated by the schools, hospitals, garages and so on in the villages. However, only three villages, Maun, Mahalapye and Palapye had publicly available supplies and the amount of power available was actually very limited.

The government wished to encourage rural development and to slow down the drift of population to the towns. But people would not stay in the major villages unless there was employment for them there. This in turn meant that industry had to be attracted to, or develop in, the major villages. But modern industry depends on power.

So studies were commissioned to examine the best ways of making power available in all the major villages in Botswana. In some cases the choices were simple. The villages of Mochudi, Molepolole, Kanye, Ramotswa, Tlokweng were all close enough to Gaborone to make it economic to build transmission lines from Gaborone. Similarly Tonota and Shashe could be easily supplied from the Selebi-Phikwe power station. Maun was so isolated that it had to have a small power station of its own, indeed one already existed but required expanding. The three central villages of Palapye, Serowe and Mahalapye were more problematic. They were too far away from Selebi-Phikwe and the demand was too small for a transmission line to be economically justified, so a local power station seemed to be required. But if, as seems likely, a transmission line is in the future built from Selebi-Phikwe to Orapa this could pass through these villages and supply them directly, though there would still be considerable costs involved in "tapping" the transmission line for these villages.

A difficulty was that in all villages even the cheapest way of supplying power was estimated to be much more expensive than the cost of power in the towns. Even where power was to be transmitted from Gaborone the capital costs of the transmission line had to be met as well as that of establishing a small BPC office in the villages concerned. Here are the estimates for the cost of power in each of the villages in 1973 together with the cost then in Gaborone:

	Thebe per unit
Maun	17
Mahalapye	12
Palapye	12
Serowe	12
Kanye	12
Molepolole	13
Mochudi	17
Tonota	17
Shashe	17
Gaborone	4

If the BPC had gone ahead at that time and provided power to all of these villages, and if it were to follow its legal requirement to cover costs then it would have had to have done one of two things:

- Either it would have had to have charged the villages the tariffs shown above.

- Or it could have charged a lower tariff in the villages than those above but at the same time increased the tariff in the towns so that the urban consumers subsidised the village consumers.

Either of these courses of action could be expected to have political repercussions, so the issue was referred to Government for its consideration. In the meantime it was not possible to start work on the rural electrification scheme as it was expected that the demand for electricity in the villages would depend on the level of tariff which would be introduced. And the detailed design of the schemes in turn depended on the expected demand. For example, in the case of the village of Serowe the initial demand was expected to be 100 000 watts if the cost covering tariff were to be introduced but 415 000 watts if the same tariff as applied in Gaborone were to be introduced. (It is interesting to compare these maximum demands with those in Table 3 to see how small the rural loads are expected to be even in a large village).

As we have seen one of the Government's main objectives was to promote rural development by encouraging industries to set up in the major villages. On the whole modern industry is reluctant enough as it is to move to traditional villages which do not offer the same facilities as the towns. If now power was to be more expensive in the villages than in the towns would not industry be even less inclined to move there? That was one consideration before the Government. Another was a simple argument of equity. Why should people pay more for electricity just because they happen to live in villages rather than in towns? This argument was particularly strong in the case of the villages of Mochudi, Molepolole, Kanye, Ramotswa and Tlokweng which were to be connected to the Gaborone power station. After all the town of Lobatse was also connected to this power station but the consumers in Lobatse were not required to pay more than those in Gaborone.

In the end a rather complicated arrangement was worked out whereby the Government would provide a subsidy so that the rural consumers would only have to pay the same tariff as the town consumers. The details of the arrangement are not important. The main reason it is complicated is that the Government was anxious that any subsidy should go specifically to the rural consumers. The principle that urban consumers should pay the full unsubsidised cost for electricity, which as we have seen was one of the main reasons for establishing a parastatal corporation, was not changed.

VIII Subsidies

One of the most striking things about the development of the power sector, and a theme which runs through this case study, is how very difficult and expensive it is to get the sector started. Producing small amounts of power in isolated power stations in various parts of the country is expensive. In addition there is the constant problem of installing extra capacity in very small units in each of these stations as the demand builds up. Only when the national demand has reached such a level that large modern power stations and a transmission network is justified will the real cost of producing power begin to decline and will it become possible to provide power to large new consumers without always having to undertake new investment. Is there a short cut to this situation? It can be argued that if the government were willing to subsidise the cost of power for a decade or so then the demand would build up more rapidly and investment in big interconnected power stations could be made more quickly. Such a strategy might work but at some considerable cost. The current revenue of the Southern Division of the BPC is about P3,6 million a year. In order for unit costs of producing electricity in Botswana to fall by a half, demand would have to increase ten fold. Suppose the Government decided to encourage this growth of demand by halving prices now by means of a subsidy, how long would it take before demand in fact increased by a factor of ten and the subsidy could be phased out? Probably more than a decade and more likely nearer to twenty years. How much subsidy would have to be paid out over that period given that the current revenue of the BPC Southern Division is about P3,6 million a year? The amount of subsidy would almost certainly increase before it fell. Could the BPC raise the investment capital for an accelerated investment in a central power station and transmission lines? Remember, referring back to Table 5 that the capital cost of this scheme was estimated at P52 million in 1974 - even more today. Or is it more likely that the money could not be raised and the programme could not be accelerated and that some of the extra demand created through subsidy would be unsatisfied - that is there would be frequent black outs? Could and indeed should the Government provide such a subsidy, especially when its proclaimed priority is rural development?

Another argument is put forward for subsidising the cost of power, not this time in general, but only to industrial users. It is said that if tariffs for electricity were to be reduced to industrial consumers then more foreign investors would come and establish industries in Botswana. It is very hard to arrive at a definite conclusion on this matter. What are the reasons that discourage industrialists from coming to Botswana? Is it just expensive electricity or is it a combination of factors, including a shortage of skilled labour, a shortage of housing, immigration, labour and foreign exchange regulations and a small market within Botswana?

Would subsidising electricity make such a difference? Or do a whole range of things need to be done in order to encourage more foreign investment? How much foreign investment is desirable anyway? And of course against the possible advantages of encouraging more industry by electricity subsidies has to be set the actual cost to the Government of providing the subsidy. The cost of generating power is going to remain much the same whether it is subsidised or not. Either the consumer pays it all or the government pays some. So far the Government has come out of this argument on the side that subsidising electricity tariffs for industrial consumers would not encourage much, if any, more industry to establish itself.

What frequently happens with the running of parastatals, and the BPC is no exception, is that the government initially decides that the parastatal should be cost covering and not subsidised but then later begins to lose the courage of its convictions. It is often very difficult to see precisely how this happens. Board members are torn between on the one hand, their legal responsibility as Board members to see that the Corporation covers its costs, and on the other hand their knowledge that the government, and especially the politicians, will be displeased about any proposal to raise the level of tariffs in order to meet this responsibility. So the Corporation begins to get into a deficit and this deficit gets larger and larger while, firstly the Board, and later the Government, screws up the courage to right the situation. This has happened with the Southern Division of the BPC. A proposal for a 20% tariff increase right at its very inception when it took over from the former Gaborone Water and Electricity Unit was refused by the Government for 20 months. This Division made a deficit in the first year of its operation and since then the deficit has steadily increased year by year. The annual deficits were in thousands of Pula:

1971/72	1972/73	1973/74	1974/75	1975/76
41	59	82	330	600

Of course it would be wrong to infer that the size of these deficits were simply the result of delays in increasing tariffs. This was just one factor. Others were the series of major breakdowns in the power station, some which might have been avoided, and the considerable increase, in oil prices particularly, and inflation generally, from the end of 1973.

By the end of 1975/76 the accumulated deficit placed the Southern Division in a very serious situation indeed, as will be seen from the Balance sheet for 31st March, 1976 reproduced at Table 6. At this point in time a real crisis had developed which necessitated government intervention. In the end the government agreed to a further 30% increase in the tariffs, but only after considerable political hesitation.

TABLE 6: BPC SOUTHERN DIVISION
BALANCE SHEET AT 31.3.76.

	P millions	P millions
Fixed Assets:		3,4
Capital Work in Progress		4,3
		7,7
Current Assets:		
Cash	-	
Other	0,7	
	0,7	
Current Liabilities:		
Overdraft	0,6	
Other	1,3	
	1,9	
Net Current Liabilities:		(1,2)
		6,5
Financed by:		
Equity Capital		0,2
Consumer Financed Capital		0,7
Loans		6,7
Accumulated Deficit		(1,1)
		6,5

IX Summary

The provision of power is such an important ingredient in development that governments invariably take great interest in this sector. The most common institutional arrangement is to set up a parastatal corporation to generate and distribute power. This arrangement has considerable advantages, especially as it permits a commercial approach to be adopted. But the arrangement has some disadvantages, and power supply will always be to some degree a political matter.

Great economies of scale are experienced in power generation and transmission. But power demand in Botswana is still so small that these potential economies are as yet scarcely realised. As a result power remains expensive in Botswana. In the meantime the high rates of growth of demand for power, the appearance of new demands in new places, and the long time it takes to open new power stations all give rise to considerable planning and management problems. The need for a reliable staff, fully manned at all times and willing to work shifts, has also caused problems in recent years.

At the moment power is mostly provided in the towns in Botswana. But if rural development is to be achieved and urban migration slowed power has to be provided in the villages also. Often this involves subsidising the cost of power provided in the rural areas. More generally subsidising the cost of power to industry might encourage faster industrial growth but only if there are not other more serious impediments to industrial development.

Finally, Botswana can look forward to the day when the country is served by power transmission networks. But this is still likely to be a decade away. Until then there is little prospect for significant reductions in the real cost of power.

Questions for Discussion

1. Most parastatal corporations are run by a Board appointed by and answerable to a Minister. What other ways could they be run? Would they be more likely to achieve the parastatal's objectives?

2. Suppose that when the calculations behind Table 1 were being done in 1969 it was possible to know that oil prices would increase from 1974 by 25% relative to other prices, what decision would then have been taken - to install diesel or steam plant?

3. We have seen that the actual costs incurred in running the power station were quite different from those estimated in Table 1. Does this mean that the sort of exercise undertaken in that Table is complete nonsense?

4. Why is power expensive in Botswana? What could be done to reduce the cost of power here?

5. In recent years the rate of inflation has been much higher than ever before - why does this make running a parastatal like the BPC more difficult?

6. There is frequent criticism of the salaries which parastatals pay to expatriates. Discuss the advantages and disadvantages of stricter controls on these salaries e.g. limiting inducement allowances to 10% of the local salary.

7. What have been the major headaches for the BPC management since it was established?

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