Cross-subsidies and sensitivities: Further analysis of sustainable financing of electrification in South Africa

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CONTENTS

1. Introduction

This short report extends the analysis of electrification financing reported in "Sustainable financing of electrification in South Africa" by Van Horen and Thompson. It aims to further the analysis by reporting on cross-subsidies within REDs and by conducting sensitivity analyses on a set of key variables. These variables are:

- the scale of the programme, i.e. the targeted number of connections per annum;
- initial debt load;
- interest rates; and
- overall consumption growth.

The variables measured included the maximum D:E ratio and the level of cross-subsidy implicit in the programme. For REDs where D:E exceeded 1.5, further analysis was conducted to determine the level of capital grant support and the level of price increase required to make the distributors financially viable.

2. Financial viability and subsidisation

The base case results for each of the five REDs, plus the consolidated picture for the entire industry, are presented in **Table 1**.

Table 1: Results for a ten-year period

RED	Ave connec-tions p.a.	Average Capex p.a.	Maximum D:E	Lowest interest cover	Maximum debt	Average cross-subsidy	Cross subsidy / revenue
Northern	178 083	R740m	11.08	0.05	R6 930m	R591m	6.9%
Central	85 167	R347m	5.74	0.05	R3 609m	R260m	4.6%
Eastern	98 750	R417m	0.61	7.27	R1 033m	R394m	6.5%
Western	34 500	R122m	0.62	7.64	R427m	R92m	3.4%
Wits	59 250	R200m	0.54	11.63	R825m	R122m	1.8%
Total	**455 750**	**R1 826m**	**0.96**	**1.84**	**R10 999m**	R1 459m	4.8%

2.1 Connections and capital costs

Average connections per annum are high - very close to the peak of the RDP programme. In fact, total annual connections in the first five years (1997 to 2001) are higher than this - around 600 000 per annum. The need to improve access levels in provinces with large rural populations means that the targeted connection rates in the model are substantially higher than current practice in the Northern RED and the Eastern RED. These connection rates are calculated on the basis of target access rates for grid electricity. If these targets are to be met, it seems likely that connection rates will have to be spread more evenly over the ten-year period.

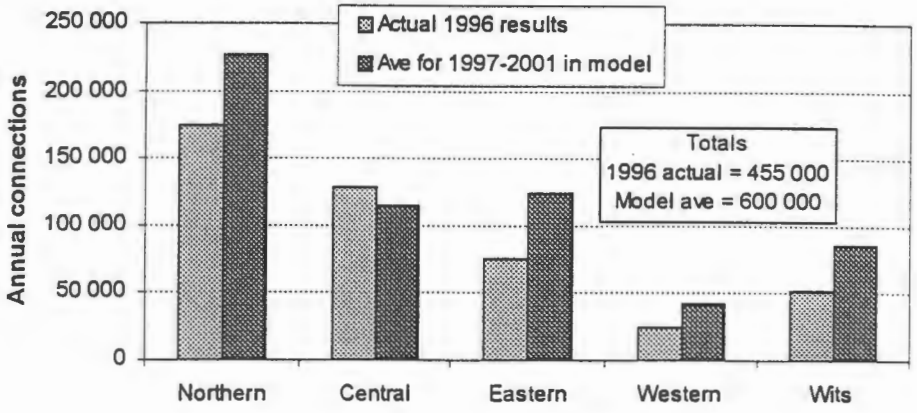

Figure 1: Comparison of connection rates per RED for a five-year period

Total capital costs for the entire country are, on average, R1.8 billion per annum. This is approximately 25% higher than has been experienced to date and is caused by the increase in capital costs as the programme reaches more rural areas. **Figure 2** compares modelled capital costs on low-income electrification with actual costs in 1996. In all cases, modelled capital costs are higher than those experienced to date, especially if a longer time horizon is adopted. While it may be argued that this will unjustifiably inflate capital costs, it should be noted that over time capital costs (in real terms) are likely to increase substantially as the programme has to reach more remote rural areas.

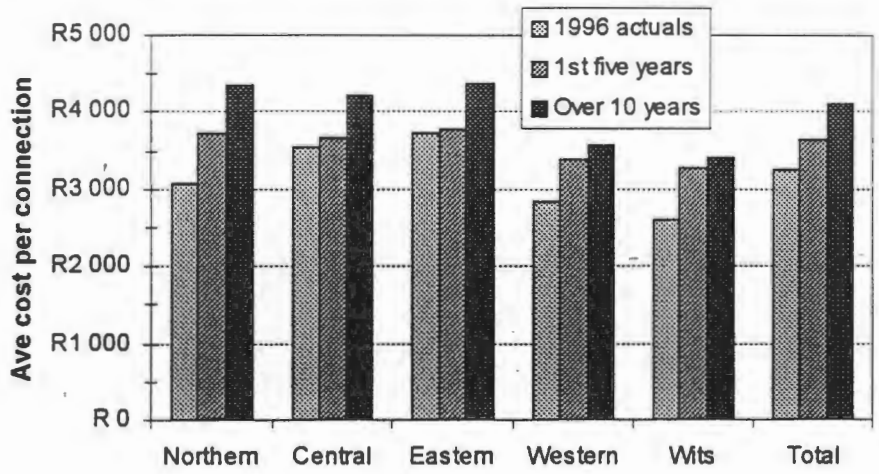

Figure 2: Comparison of capital costs per RED

2.2 Financial viability

Since this work has defined financial viability as a maximum D:E of 1.5, it can be seen from **Table 1** that two of the five REDs are not viable. Northern and Central both have a maximum D:E way in excess of the maximum allowed. Similarly, the indicator interest cover also indicates that these two distributors are not viable without price changes or grants.

Financial viability can also be detected in the net income stream, after interest payments and transfers to municipalities. **Figure 3** illustrates the trends in income streams for each of the five REDs. It can be seen that while the three viable REDs have positive income streams for the entire duration of the ten-year period presented, the Northern and Central RED generate large net losses. These losses are clearly unsustainable and lead to the poor debt equity ratios for these distributors. It is noteworthy that for the country as a whole, the total net income remains positive for the entire period, and even begins to grow after the first five years.

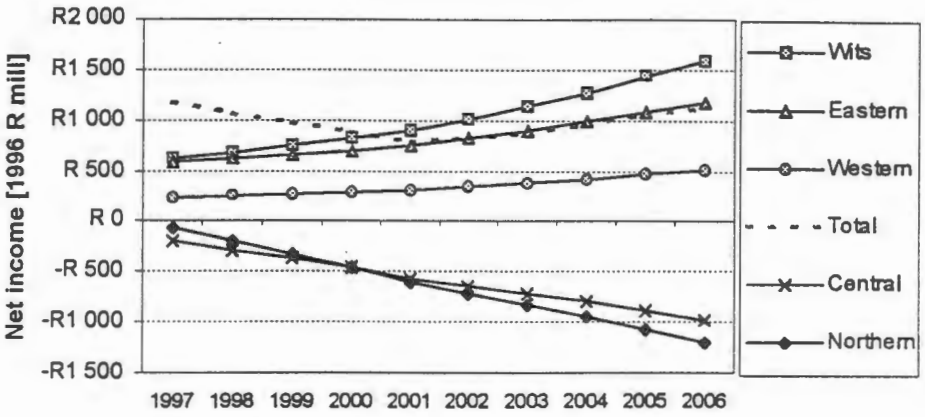

Figure 3: Net income (after interest and transfers to municipalities)

It is possible to calculate the level of support which these distributors would require to remain viable. Two support mechanisms were investigated here: across-the-board price increases for these two REDs, and grants towards capital expenditure. While the former results in revenue increases which are sustained throughout the programme, the latter are annual grants which are made on an as-needs basis.

For the Northern RED to be viable, a total real price increase of 11%, spread over the first five years, is required. Alternatively, capital expenditure grants are required over a ten-year period, and the present value of these is calculated to be R2.2 billion. These grants represent a subsidy of 40% of low-income electrification capital expenditure.

For the Central RED to be viable, price increases totalling 13%, spread over four years, are required. The alternative support mechanism, i.e. capital grants, is in the same order as for Northern RED, and the present value of these grants is calculated as being R2 billion. However, this subsidy represents a very high portion (75%) of capital expenditure on electrification for the Central RED.

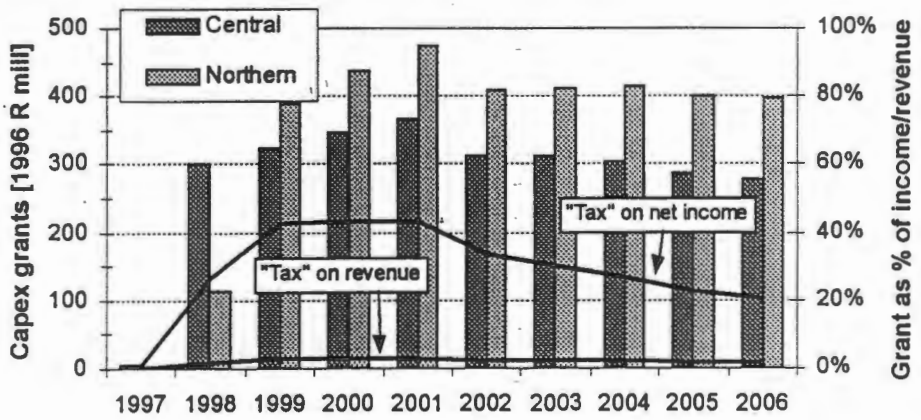

Figure 4: Capital grants required for Central and Northern REDs

Figure 4 shows the distribution of these capital grants for the two REDs over a ten-year period. The total grant for both REDs is expressed as a percentage of the combined net income of the other three REDs, i.e. the level of the tax if these grants are to be sourced from within the industry. The 'tax' is high and would no doubt impact on the viability of the other REDs. However, if REDs were allowed to pass this "tax" through as a price increase, then the average increase (as a percentage of revenue) would only be 2% to 3%.

It is possible to ensure the viability of these two REDs through a combination of price increases and capital grants. A once-off price increase of 5% would reduce

the required capital grants substantially. In the case of the Northern RED, no additional grants would be required since this initial price increase would be adequate to ensure viability. For the Central RED, the total grant would decline to only R125 million in present value terms. This level of grant is more easily funded through transfers from other REDs.

2.3 Cross-subsidisation

While three of the five REDs are financially viable, this does not necessarily mean that their electrification programmes as viable as stand-alone programmes. In fact, all of the REDs have to cross-subsidise their low-income household electrification activities. This cross-subsidy is effected in two ways. Firstly, REDs with a positive net income can use some of their cash balances to pay for the capital costs of electrification. In the modelling work undertaken here, this occurs for the three viable REDs, viz. Eastern, Western and Wits. Secondly, these REDs may still find that there are losses associated with their electrification programmes, attributable to operating plus any finance changes associated with capital expenditure financed by debt. This occurs for the three viable REDs only in the first few years. Thereafter, the internal capital subsidies are sufficient for electrification to be cash positive.

Table 1 shows that the average subsidy required for electrification is around R1.4 billion per annum. The three REDs with high rural electrification loads account for 85% of this requirement. If this required subsidy is expressed as a percentage of total revenue, it varies between 1.8% (for Wits) and 6.9% (for Northern). It is interesting to note that, while the Eastern RED requires a high level of cross-subsidisation (6.5% of revenues), it remains financially viable without price increases or capital grants. This is due to the high level of industrial and commercial electricity consumption in the region.

On a national basis, the over-all cross-subsidy is, averaged over 10 years, equivalent to 4.8% of total revenues. This figure is consistent with other estimates of the national level of cross-subsidy required by electrification. This modelling indicates that a portion of this can be obtained from net income without price increases, and the rest must be obtained from additional sources of income, i.e. either additional revenue from price increases or capital grants.

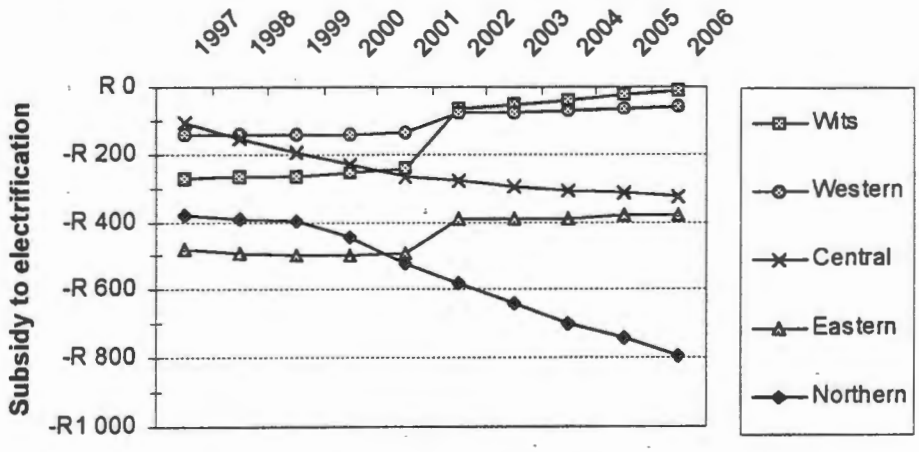

Figure 5: Losses for low-income household electrification

3. Sensitivity analysis

The sensitivity analysis will examine the following variables:

- the scale of the programme;
- the initial debt load;

- interest rates;
- overall consumption growth.

The intention of the analysis is to determine the robustness of the results. If the main conclusions of the analysis remain consistent for all sensitivities, it can then be concluded that the results are robust

3.1 Sensitivity to scale of programme

For the two failing REDs, the analysis determined the extent to which the programme would have to be scaled down in order for these distributors to be financially viable.

In the case of the Northern RED, connection rates would have to be scaled down to 60% of the original targets, giving average annual connection rates of 120 000 to low income households. This is approximately double the level needed to keep up with population growth, and implies access levels in the region of 75% after ten years.

Central RED is in a more vulnerable position. For the RED to remain viable, the electrification programme would have to be scaled down to only 20% of the base case targets. This is equivalent to an average connection rate of only 18 000 per annum, which is only half the rate required to maintain current levels of access by keep up with population growth. This reduced connection rate gives a total access to grid electricity of only 54% after ten years.

Table 2: Reducing the scale of the programme to ensure viability

		Northern RED	Central RED
Connections per annum	Base case	200 000	95 000
(for 1st 10 years)	Reduced programme	118 000	18 000
Access after 10 years	Base case	90%	62%
	Reduced programme	75%	54%
Percentage the programme is reduced by		41%	81%

3.2 Sensitivity to initial debt loads

The base case assumes an initial debt to equity ratio of 1:1. This means that exactly 50% of the value of assets in year 1 is financed through debt. This is taken to be a fairly strong balance sheet. This assumption means that total debt in the industry at the commencement of the RED structure is taken to be R6.2 billion. Under the base case, this debt load is found to rise substantially over the next ten years, to R11 billion (in 1996 terms), despite using net income to fund capital expenditure where possible.

Since financial viability is taken to be a debt to equity ratio less than 1.5, it is possible that redistributing the initial debt load may mean that unviable distributors become viable, and *visa versa*. This was tested by varying the initial debt to equity ratio for each distributor. In the case of Northern and Central REDs, the ratio was set at 1.0, 0.5 and 0.0. In the case of the other three REDs, the ratio was set at 1.0, 1.5 and 2.0.

The analysis shows that the underlying conclusions, i.e. that only Northern and Central are unviable, hold. **Table 3** presents the results for these two distributors. The maximum D:E refers to the maximum level which this parameter reaches over a ten-year period. It can be seen that in all cases, this figure is negative, which occurs with negative equity, i.e. liabilities are greater than total assets. The price increase required to make the two distributors viable is more or less constant for all areas. However, the timing of the price increase changes. Where there is a low initial debt to equity ratio, the price increase is delayed until later in the programme. The grants required to ensure viability decrease as the initial debt

load decreases. This is because the model allows the utility to build up debt in the early years, thereby reducing the amount which must be made available in grants.

Table 3: Sensitivity to initial D:E ratio for Northern & Central

	Northern RED			Central RED		
Initial D:E	Max D:E	Price increase	Grants required	Max D:E	Price increase	Grants required
0.0	Negative	9.5%	R680m	Negative	12.4%	R1 100m
0.5	Negative	11.6%	R1 700m	Negative	13.9%	R1 700m
1.0	Negative	10.6%	R2 200m	Negative	13.0%	R2 000m

For the other three distributors, it was found that increasing their initial debt load made no difference to their viability, although it did decrease net income due to the higher interest charges which were associated with the higher initial debt levels. In all cases, the debt to equity ratio declines in every year for the entire period. The small variation in the debt to equity ratio in year five, as well as the relatively small change in net income levels, suggests that the initial starting debt is not of great significance to their financial performance.

Table 4: Sensitivity to initial D:E ratio for Eastern, Western and Wits REDs

	Eastern RED		Western RED		Wits RED	
Initial D:E	D:E in year 5	Net income in year 5	D:E in year 5	Net income in year 5	D:E in year 5	Net income in year 5
1.0	0.17	R750m	0.16	R310m	0.12	R900m
1.5	0.21	R730m	0.21	R300m	0.15	R880m
2.0	0.24	R715m	0.24	R295m	0.17	R870m

3.3 Sensitivity to interest rates

The third variable examined in the sensitivity analysis was the level of interest rates. These were varied by +3% and -3% from the base assumptions for each of the REDs.

For Northern and Central REDs, it can be seen from **Table 5** that the change in interest rate does not affect the overall viability of the operation, i.e. debt to equity ratios remain unacceptable, and each of the two distributors generates negative equity unless there are price increases or capital grants. **Table 5** also shows the price increases or capital grants required if these REDs are to be viable. As would be expected, an increase (decrease) in the interest rate increases (decreases) the amount of support required.

Table 5: Sensitivity to interest rates for Northern & Central

Interest Rate	Northern RED			Central RED		
	Max D:E	Price increase	Grants required	Max D:E	Price increase	Grants required
-3%	Negative	9.0%	R1 700m	Negative	12.1%	R1 700m
Base	Negative	10.6%	R2 200m	Negative	13.0%	R2 000m
+3%	Negative	12.2%	R2 700m	Negative	13.3%	R2 200m

For the other three REDs, changes to interest rates have a relatively small effect on their overall profitability. All three REDs remain viable, and changes in interest rates (within the band considered here) have only a very small impact on the overall financial position. This is because by year five, these distributors have very small debt levels in comparison with their revenue base.

Table 6: Sensitivity to interest rates for Eastern, Western and Wits REDs

Interest rate	Eastern RED		Western RED		Wits RED	
	D:E in year 5	Net income in year 5	D:E in year 5	Net income in year 5	D:E in year 5	Net income in year 5
-3%	0.17	R710m	0.16	R310m	0.12	R870m
Base	0.17	R750m	0.16	R310m	0.12	R900m
+3%	0.16	R800m	0.16	R310m	0.12	R930m

3.4 Sensitivity to overall consumption growth

Estimates were made in the base case for consumption growth in each of the main categories. While the same assumptions were applied to each RED, the different structure of the customer base in each case meant that overall consumption growth was different for each distributor. The results of this are presented in **Table 7** where it can be seen that all REDs have a growth rate of around 3.5%, except for Central where the growth is only 2.4%. This is due to the relatively high proportion of mining demand in this RED.

Table 7: Consumption growth rates per customer class and RED

Customer class	Growth rate	RED	Overall growth rate
Agriculture	2.0%	Northern	3.5%
Mining	2.0%	Central	2.4%
Manufacturing	3.8%	Eastern	3.6%
Commercial	4.0%	Western	3.6%
Transport	3.0%	Wits	3.4%
General	3.0%	**Total**	**3.3%**

In the sensitivity analyses, the consumption growth rate was set at 2.5%, 3.5% and 4.5%. The results for Northern and Central are presented in **Table 8**. It can be seen that changes in overall consumption growth have a relatively minor effect on the overall viability of these distributors.

Table 8: Sensitivity to consumption growth for Northern & Central

	Northern RED			Central RED		
Consum growth	Max D:E	Price increase	Grants required	Max D:E	Price increase	Grants required
2.5%	Negative	11.8%	R2 500m	Negative	13.0%	R2 000m
3.5%	Negative	10.6%	R2 200m	Negative	12.2%	R1 950m
4.5%	Negative	9.6%	R1 900m	Negative	11.6%	R1 850m

For the other three REDs, changes in consumption growth have a similarly small effect on their overall financial position, as can be seen in **Table 9**.

Table 9: Sensitivity to consumption growth for Eastern, Western and Wits REDs

	Eastern RED		Western RED		Wits RED	
Consum growth	D:E in year 5	Net income in year 5	D:E in year 5	Net income in year 5	D:E in year 5	Net income in year 5
2.5%	0.17	R740m	0.16	R300m	0.12	R870m
3.5%	0.17	R750m	0.16	R310m	0.12	R900m
4.5%	0.16	R770m	0.16	R330m	0.12	R930m

4. Conclusions

The results of this sensitivity analysis show that, in general, the overall conclusions of the study are robust. That is, reasonable changes to the base assumption do not affect the main conclusions of the study, at least with respect to changes in the initial debt load, interest rates and consumption growth.

This implies that the financial viability of the REDs lies in the structure of the system. In other words, the underlying factors which determine the financial trends in these distributors relate to their geographical scope, pricing structure and the scope of electrification duties imposed on them.

It may be possible for the financial performance of the two failing REDs to be improved by changing RED boundaries. However, in order to do so, it is necessary to associate regions with a heavy rural electrification load with an urban/industrial load centre. Given the geographical constraints in doing this, it seems unlikely that all REDs will be financially viable.

The alternative options are:

1) to reduce the electrification load on these distributors;
2) increase prices substantially in these distributors
3) to arrange financial transfers to cover a portion of capital costs in these REDs; and
4) a combination of the preceding options.

Even if options 1 or 2 are adopted, it seems inevitable that some form of capital subsidies will be required. The scale of price increases seems too high to be acceptable, and the option of reducing electrification targets would seem to be politically unacceptable.

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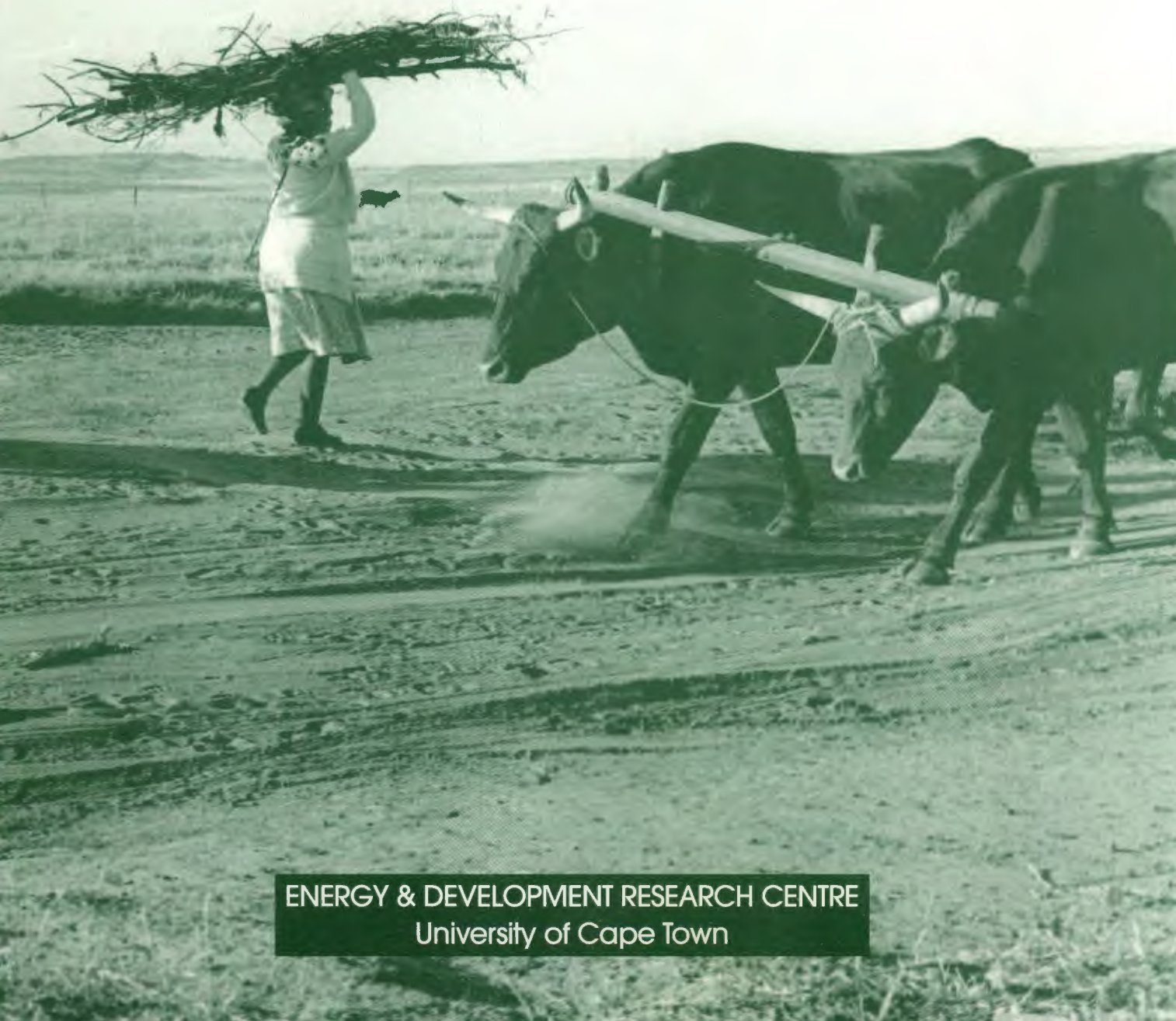

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