Sustainable financing of electrification in South Africa

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Preface

This report describes the results of a financial modelling exercise carried out by the Palmer Development Group at the request of the Energy and Development Research Centre, University of Cape Town. Although produced as a stand-alone report, this document forms part of a larger EDRC research programme addressing the role of electricity in integrated rural energy provision.

Underlying much of the analysis in this report is an Excel-based financial model, which was developed primarily by Bee Thompson of PDG, with some assistance from Clive van Horen. The running of the model and writing of the report were done mainly by the latter, with help from the former. Overall responsibility for the report rests with both.

The assistance of a number of EDRC staff in providing information and data is gratefully acknowledged. Thanks are also due to Dr. Mark Davis of EDRC for his comments on an earlier draft of the report. Although it was initially hoped that much of the data would be available from the National Electricity Regulator, it proved impossible to secure this data in the project's time frame; nevertheless, thanks are due to the NER staff who did offer their time and published data.

The restructuring of South Africa's electricity industry is a complex and controversial issue at present; the intention in this study is to make a constructive contribution to the transformation process by providing as rigorous an analysis as allowed by time and resource constraints. We hope this report will make a contribution in this way.

Executive summary

Introduction

South Africa's national electrification programme has been underway since 1991, and well over two million new connections have been made in the intervening period. Questions are, however, increasingly arising regarding the future of the electrification programme beyond 1999, as urban areas become fully electrified, the capital and operating costs of electrifying rural areas rise, and revenues remain low. Mixed service levels and the question of the subsidisation of electrification are therefore receiving further attention.

This study was undertaken by Palmer Development Group at the request of the Energy and Development Research Centre (EDRC), University of Cape Town, with the aim of analysing the financial impacts of the electrification programme and especially the subsidy implications of various scenarios. The analysis was based on the provisional boundaries of regional electricity distributors (REDs) as proposed in the government's most recent document (ERIC 1996).

Methodology

The approach taken in this project involved three steps. Firstly, a spreadsheet-based financial model was developed, using Microsoft Excel software. This model, termed the Electrification Financing Model (or EFM), has been designed to include all the main input variables which influence the financial viability of electrification projects, and to report a number of output variables which collectively provide an indication of the performance of an electricity distributor. The second step was the running of the EFM using data from the five provisional regional distributors. Important output variables were analysed by adjusting input assumptions, particularly around the financing of the electrification programme, target service levels and the allocation of subsidies. Finally, these results have been written up in this report.

Financing options for electrification

A central feature of this project was the attention given to various sources of finance for the electrification programme. Potential sources include:

- operating revenues from electrification customers themselves (self-financing);
- additional operating revenues extracted from other electricity consumers by charging higher prices (cross-subsidies);
- borrowings obtained from the capital markets; and
- capital subsidies secured from government and other sources.

It is, however, unlikely that the government will be willing to provide (much) grant finance in the foreseeable future, and so the issue arises over how the electrification programme can be financed beyond 1999.

In practice, the level of borrowings is normally limited by an organisation's target debt/equity and interest cover ratios, as these influence its ability to raise debt as well as the cost of that debt. These ratios were therefore used in the study as indicators of the financial health of the REDs and to identify when capital grants may be required.

The data

A large number of inputs are required in order to accurately model the financial position of a restructured electricity distribution industry. At the commencement of this project, it was expected that the most important variables – such as population, levels of service, capital and operating costs, losses and average tariffs – could be accessed for each of the five REDs from the National Electricity Regulator (NER) database. This was not possible, however, and the NER was unable to release information other than that which is published in its statistical report (NER 1996a). Consequently, a margin of error exists in some data used for the REDs, since data have been collected from a range of other sources, although the margin of error is unlikely to be so great as to affect the overall conclusions of this study.

The scenarios

Three scenarios were analysed as follows:

- The base scenario, which involves providing mixed levels of service for lower income households, including a fairly large proportion of 2.5 Amp and solar connections in rural areas. Results are presented for combined grid and non-grid supply, and for non-grid only.
- A scenario aiming for 'equity in outcome', in which all lower income households receive 20 Amp connections.
- A scenario applying 'equity in finance', in which all (lower-income) consumers benefit from the same amount of external grant finance.

Further analysis of solar electrification with grid-equivalent subsidies was also conducted.

Results and conclusions

In modelling the financial performance of the REDs, a number of important financial parameters have been selected:

- Tariffs in each RED are based on Eskom's 1997 tariffs and this means that the large number of existing tariffs will converge to these levels. In the absence of data on this, it is difficult to assess whether there will be a net increase or decrease in tariffs for those consumers currently supplied by municipalities, although it is possible that tariffs would rise for residential consumers and decline for non-residential consumers.
- Likewise, operating costs are assumed to converge towards those used by Eskom in its financial planning, thus implying an increase in operating efficiency on the part of municipal distributors.
- The new REDs are expected to commence operations with relatively strong balance sheets, with debt/equity ratios of 1:1. This is a fairly favourable opening position which is considered necessary in order for REDs to be able to raise the necessary loan finance at competitive rates. The implication is that Eskom's generation and transmission divisions may have to accept somewhat higher debt loadings.
- The REDs are expected to make transfer payments to municipal service authorities in their jurisdiction, equivalent to the rate of surpluses currently earned from the trade of electricity. According to the ERIC report (1996), these amounted to R1.5 billion per annum and so the surplus retained within the REDs will be reduced by the equivalent percentage.
- Fairly conservative financial constraints have been imposed on REDs in terms of price increases and debt levels. For instance, a maximum real price increase of 5% has been selected and a maximum debt/equity ratio of 1.5, on the basis that any higher price increases or gearing levels could lead to financial problems of their own.
- The analysis has not accounted for the possible introduction of income taxation or dividend payments in the electricity industry. In both cases, the effective price of electricity will increase (all other things equal), probably resulting in some loss of revenues as consumption decreases.

The first conclusion emerging from the study is that two of the five REDs – Northern and Central – will be unviable if they maintain prices at their starting position. Both produce net losses for the entire 20-year period of analysis and are clearly not sustainable without some intervention. When their prices are increased by 5% in real terms, their position improves considerably. In the case of Central RED, a further external subsidy transfer of R595 million over seven years to 2006 is required to keep its financial position within the prescribed parameters (1997 Rands).

This financial situation raises difficult policy questions, as it indicates that the most recent proposal of five REDs is sustainable with a narrow margin of safety and with numerous provisos which have to satisfied. Several policy options exist to secure this position:

- Firstly, government could provide the capital grants required to sustain the viability of Central RED. The analysis suggests that these would be required during the first ten years after 1997, after which all REDs would be viability on their own. To-date, however, government has not provided any grant finance specifically for electrification (other than through its municipal grant programmes) and it is unlikely to begin doing so, particularly while other REDs are making healthy surpluses. This position could change, though, with the introduction of corporate income tax and divided payments in the electricity industry in the near future.
- Secondly, a mechanism could be established through which transfers are made from healthy to unviable REDs, based on as yet unspecified criteria. However, this could seriously distort the financial incentives faced by both categories of distributor, effectively discouraging the wealthier REDs from making surpluses, whilst reducing the incentive for the poorer REDs to cut their losses.
- Thirdly, a levy could be introduced on sales to all electricity consumers; the proceeds would then be paid into a central fund and redistributed to REDs according to a set of criteria which will ensure their financial viability. This option has been considered for several years, but is not favoured by the Department of Finance as it remains outside of central fiscal control. Needless to say, this option, like the previous two options, carries an opportunity cost insofar as both the higher electricity tariffs paid by consumers and the use of limited government grant finance, preclude the use of those resources for other, potentially more productive purposes.
- Finally, the boundaries of the REDs could be re-drawn in such a way that each remaining distributor is financially viable on its own. Although this will require more initial desk-based analysis to model the financial viability of the REDs before they can be set up, it is likely that the long-term cost effectiveness of such a system will be considerably greater than in the case of the above three options. The regulatory and governance responsibilities attached to any option where financial transfers are made on an annual basis, in terms of complex and potentially politically-loaded criteria, will be very significant and costly.

This issue of RED boundaries, and the financial parameters within which they operate, is one of the most important policy questions to be settled in the restructuring process. Although it is beyond the scope of this project to propose revised RED boundaries, it is possible that, say, three or four REDs could be more viable: by combining Northern and Wits, and incorporating some or all of Central RED (particularly the former Transkei area) in more profitable neighbouring REDs such as Eastern or Western. This issue is one which merits further analysis.

The analysis of off-grid electrification suggests that, as a stand-alone operation, it is not financially viable at the tariff levels used in this study, which were set at a similar level to 2.5A supplies. It is clear that on a purely financial level, subsidies will be required to sustain an off-grid electrification programme. Although large in relation to the off-grid programme itself, these subsidy requirements are very modest in relation to the grid programme. This is not to say off-grid electrification is financially unattractive – on the contrary, in many rural areas, it will result in smaller losses being incurred by the REDs and therefore carries a lower opportunity cost than grid electrification.

Also important, are the conclusions emerging from the analysis of an alternative electrification scenario in which ‘equity in outcome’ is taken as the objective. Providing 20A supplies to all unelectrified households has a large negative effect on RED performance, especially the two weaker distributors – Northern and Central. Their total subsidy requirement in this scenario increased by a cumulative R9.1 billion over the life of the programme – funds which could almost certainly be put to better use elsewhere in the economy, given the social and economic benefits which could accrue from the productive use of those funds. Thus the current direction being taken by the industry, namely that of providing consumers with choices of various service levels, with costs and tariffs better matched to their affordability profiles, makes sound financial sense.

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1. Introduction

South Africa's national electrification programme has been underway since 1991, with over two million new connections having been made by the end of 1996, at a total capital cost of some R6 billion (NER 1996). The result of this enormous effort is that the level of household access to electricity rose from around 33% in 1991 to 55% by the end of 1996. Based on this track record, the government's target, of 2.5 million connections between 1994 and 1999, bringing total households access to around 70%, seems achievable.

Increasingly, however, questions are arising regarding the future of the electrification programme beyond 1999, particularly as urban areas become fully electrified, causing electricity distributors to move their attention to less densely settled rural areas. Both the capital cost of electrifying these areas and the operating costs of serving them are higher, whilst revenues are lower. This unfavourable financial situation has been the catalyst for several innovations, such as mixed levels of grid electricity supplies, the introduction of off-grid solar electricity options, and tariff structures linked to limited supply capacities. At the same time, the question of subsidisation of electrification is receiving further attention, particularly if government's goal beyond 1999 will be to continue to extend supplies to rural communities.

Consequently, this study has been undertaken by Palmer Development Group at the request of the Energy and Development Research Centre, University of Cape Town, with the aim of analysing the financial impacts of the electrification programme and especially the subsidy implications of various scenarios. This study forms part of a larger EDRC project investigating the role of electricity in the integrated provision of energy in South Africa's rural areas.

2. Objectives of this study

As stated in the terms of reference for the study, the overall objective is to investigate the financial implications of scenarios around the subsidisation of rural electrification in the context of the overall programme, including various grid and non-grid technology options. The project involves three main components: firstly, the development of a financial modelling tool for use in analysing the electrification programme and the distribution industry as a whole; secondly, financial analysis of electrification scenarios and especially their subsidy implications; and, thirdly, the preparation of a report describing the results of the analysis. This document describes the results of the analysis in some detail, and provides an overview of the modelling tool.

Several prior financial modelling exercises have been undertaken in recent years (NEES 1993; Van Horen 1994; Els 1994; Davis 1996; ERIC 1996) and the intention is not to repeat or re-analyse these studies. Although there are areas of overlap, this study differs from previous ones in two main respects:

- its focus is explicitly on the subsidy implications of electrification scenarios;
- secondly, its analysis is based on a provisional set of boundaries of five regional electricity distributors (REDs), whereas (with the exception of the ERIC report) the above-mentioned studies did not address questions of RED boundaries.

To this extent, the work builds upon and extends previous studies. It has also been undertaken at about the same time as the National Electricity Regulator (NER) is commencing a large modelling exercise in support of the restructuring process in the electricity supply industry. It must be stressed that the choice of five REDs (as opposed to any other number) is *not* intended to imply any necessary preference for this number of REDs, nor is it intended to pre-empt the policy debate and transformation process. Instead, the five REDs used here have been selected simply because this was the last 'officially tabled' proposal emanating from the work of the government's Electricity Restructuring Inter-department Committee (ERIC). Since then, a number of other proposals have been put forward, although none have been accepted by government. It is hoped that this analysis will represent a useful further input into the transformation process.

Two further items underline the relevance of this study. Firstly, there is a contradictory view regarding the financial viability of a small number of (about five) REDs. The Electricity Working Group (EWG) report, although not containing results of any financial analysis, stated that 'initial financial modelling indicates that it is not possible to establish a small number of REDs (e.g. 5 – 15) because they will not be financially viable' (EWG 1995: 15). One of the main aims of the ERIC study, on the other hand, was to test the financial viability of the proposed five REDs – and found that these were indeed potentially viable (1996: 20). Clearly, there is no unanimity on this issue and it merits further investigation.

Secondly, an assumption throughout the NELF, EWG and ERIC work was that the electrification programme can and should be financed from within the industry, as opposed to seeking finance from the fiscus. At the same time, the existing surpluses produced by municipal distributors are intended to remain dedicated to municipal services. Further, most previous analyses have taken a five- or ten-year time horizon, even though the impacts of electrification endure far longer than this. In this context, it is important to investigate what financing options are feasible in the longer term and whether, in fact, external finance from government will be required to sustain the electrification programme.

3. Methodology and approach

3.1 Financial modelling and analysis

The approach taken in this project involves several steps. Firstly, a spreadsheet-based financial model has been developed, using Microsoft Excel software. This model, termed the Electrification Financing Model (EFM), has been designed to include all the main input variables which influence the financial viability of electrification projects, and to report on a number of output variables which collectively provide an indication of the performance of an electricity distributor. Although large, the model is relatively user-friendly and does not require a high level of spreadsheet expertise to be used successfully.

An important feature of the EFM is that it includes default data for the main costing, consumption and financial variables. These defaults are based on a collection of published and unpublished sources, representing the best available information at the time. Provision is made in the model to enter alternative values for any of these variables, and this has been done in several cases in the present study. Input variables used in the study include all the main items related to costs, revenues, demographics, connection targets, borrowing costs and so on. These variables are too numerous to describe in the body of this report – instead, they are presented, together with the default values, in Appendix 1 at the end of the report. Likewise, the model outputs are shown in Appendix 2.

Another key feature of the EFM is that it integrates the electrification programme (essentially one element of a distributor's capital investment programme) into the overall operations of a distributor. Consequently, the entire financial position of a RED can be modelled, rather than treating the electrification programme on a stand-alone basis.

The second main step in the project has been the running of the EFM using data from the five provisional regional distributors. Important output variables have been analysed by adjusting input assumptions, particularly around the financing of the electrification programme and target service levels. Similar analyses have also been undertaken using alternative assumptions, especially around the subsidy framework.

Finally, these results have been written up in this report; a higher level of detail regarding inputs and outputs is contained in the Appendices.

3.2 The conceptual framework for electrification financing

A central feature of this project has been the attention given to various sources of finance for the electrification programme. Early financial analyses simply quantified the financing requirement – in other words, they have 'costed' the programme by estimating the amount of money which must be raised if the electricity industry is to meet its connection targets (NEES 1993; Van Horen 1994). In some cases, the analyses have gone further by investigating the effective cross-subsidy which is required to meet this financing requirement, or variants of this approach (Els 1994; Davis 1996). None of the previous studies, however, have attempted to link these financing options with debt financing, and particularly the parameters within which distributors would have to operate to maintain their borrowing capacity and risks at acceptable levels. This is a key feature of the present study, in that it attempts to integrate the main financing options available to distributors.

These financing sources are as follows, in the order in which they will be used:

- operating revenues from electrification customers themselves, combined with borrowings to cover some or all of the initial capital investment;
- additional operating revenues extracted from other electricity consumers by charging higher prices; in other words, a cross-subsidy is drawn from the consumer base at large, either in a hidden manner or explicitly through a levy of sorts;
- borrowings will be taken on from the capital markets, either in the form of bonds or bulk loans from banks and other financial institutions; and finally,
- capital subsidies will be secured from government and other sources.

Of course, most organisations would seek to use capital subsidies first, if they had the choice, but, given the status quo in South Africa's electricity industry, it is unlikely that government will provide grant finance in the foreseeable future, and so this is likely to be the last source of finance to become available. Indeed, the central question in this study could be phrased as: 'if the industry is to continue to electrify at the given rate, and if cross-subsidies are to be utilised (up to a point), and if borrowings are to be maintained at healthy levels, then will there be a financial shortfall to be met from external financing sources and, if so, how much will this shortfall be?'

An important feature of the EFM is that it allows for parameters to be set on the extent to which each of the above financing sources will be tapped. Clearly, there is a limit to the amount of cross-subsidy which can be extracted from the consumer base without causing severe disruptions, both economically, because rising prices will encourage the substitution effect, and politically because of resistance to very large price increases. Consequently, the model allows for a maximum real price increase to be set (say 5%).

Beyond this, distributors would turn to capital markets for borrowings to finance capital expenditure. At the very least, operating revenues should cover operating costs in full, and ideally, contribute also to capital expenditure. If, however, revenues are insufficient to cover operating costs, and the utilities borrow funds, they could enter a debt trap scenario (assuming that lenders would be willing to lend them anything). Consequently, as with cross-subsidies, there will be a limit to the amount of debt which can be taken on before the utility's balance sheet becomes too weak and its finance charges too large to bear.

Two important indicators of the level of gearing (borrowing) are the distributor's debt/equity ratio and its interest cover.[1] In practice, the level of borrowing will normally be limited by an organisation's target debt/equity and interest cover ratios, which in turn, influence both its ability to raise debt and the cost of that debt. Consequently, the EFM calculates these values and displays them in such a manner that the user is guided as to the maximum amount of borrowing the distributor can incur.

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1 The debt/equity ratio is the ratio of long-term liabilities to accumulated reserves (equity), whilst the interest cover is the ratio of net operating income (before finance charges) to finance charges.

Having exhausted all the above financing options – operating revenues, cross-subsidies and capital borrowing – distributors may still be faced with a shortfall. This represents the subsidy they require to remain financially viable. If this is not provided by government, the distributor will either run into serious financial problems leading to its insolvency, or it will have to cut back on its electrification investment levels, or both.

The financial flows described above are depicted graphically in Figure **1** below, using illustrative cross-subsidy levels and debt/equity ratios of 5% and 1.5 respectively.

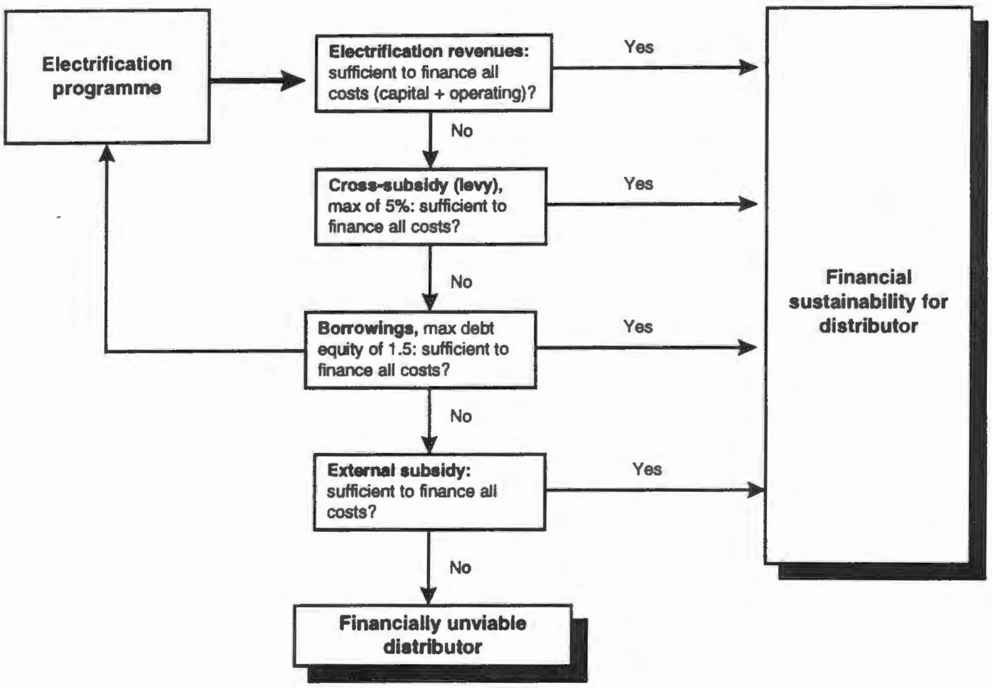

Figure 1: Financing flows of electricity distributors

It is evident from this figure that there is a progression of financing options which will be utilised, usually starting with the lowest cost of capital before moving to higher cost options. The exception to this is grant finance which – although it has the lowest cost to the utility, if not necessarily to the economy as a whole – is likely to be made available by the fiscus only as a last resort.

Another important aspect of the financing approach used for the present study relates to the match between cash inflows and outflows. As noted above, it is essential that distributors have sound financial foundations if they are to be sustainable in financial terms. This has implications for the mix of financing options, which is shown graphically in Figure 2. The absolute sizes of the bars are not important, but they illustrate the relative balance between components of cash inflows and outflows, both capital and operating. If revenues from electrification customers, plus revenues from other customers do not at least equal the sum of (bulk purchase costs + O&M costs + finance charges), then the distributor is likely to move into a debt trap situation. Instead, it should at least be able to finance a portion of its capital expenditure from operating revenues (plus connection fees). By the same logic, if it does not receive a subsidy, it will be unable to fully cover its funding requirements, and would run into insolvency problems.The subsequent analysis of RED viability will be undertaken within this conceptual framework. In all cases, real 1997 Rands are used in the analysis and results.

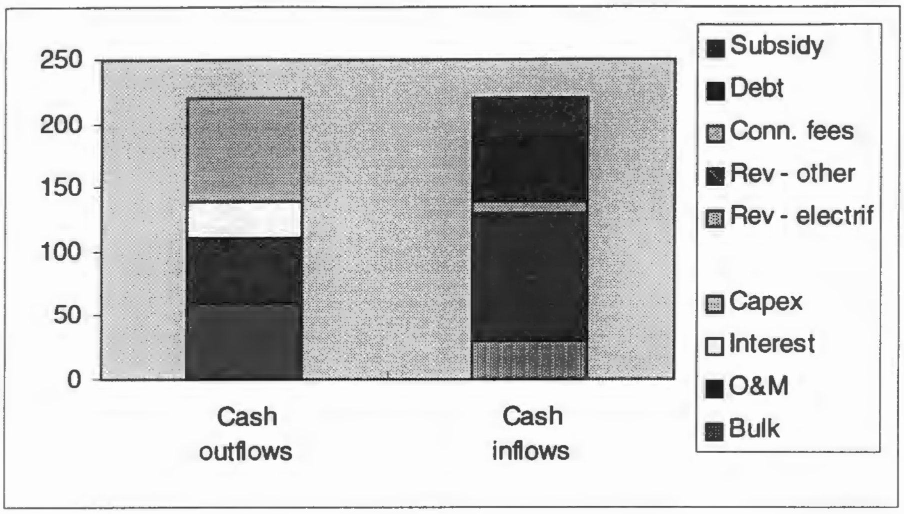

Figure 2: Balance between cash inflows and outflows

4. Key assumptions and inputs into the financial analysis

A large number of inputs are required in order to accurately model the financial position of a restructured electricity distribution industry. In some cases, reasonably good data exist and are published, but for many important variables, there is a high level of uncertainty. Appendix 1 contains printed versions of the input sheets from the EFM model, containing all the input variables for one of the REDs (Northern/RED A). In this section, the most important inputs and assumptions are described.

4.1 RED boundaries

In the absence of any firm indication of the number of REDs to be deployed in future, this study has used the five REDs as proposed in the ERIC report. These approximate the boundaries of Eskom's five internal distributors and are named as follows (refer to Figure 3, which is taken from ERIC (1996)):

- Northern (RED A): comprising most of Northern, Mpumalanga and North West Provinces, and the northern portion of Gauteng;
- Western (RED B): comprising all of the Western Cape and a portion of the Northern Cape;
- Central (RED C): comprising all of the Eastern Cape, most of the Northern Cape and Free State, and a portion of North West Province;
- Eastern (RED D): comprising all of KwaZulu-Natal and the eastern portion of the Free State;
- Wits (RED E): comprising the remainder of Gauteng province.

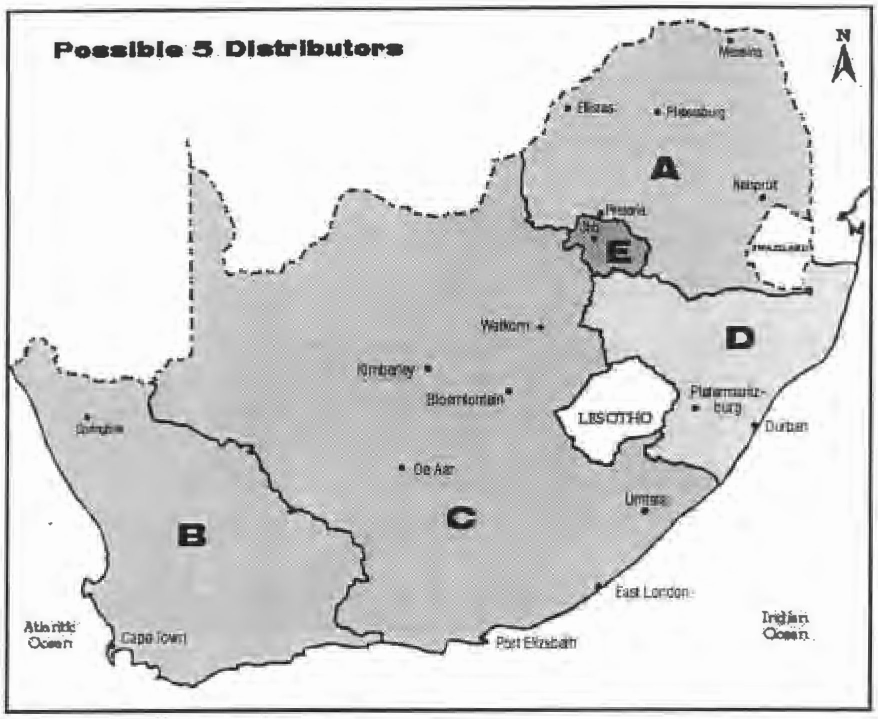

Figure 3: Boundaries of the five regional electricity distributors

As noted earlier, the use of these RED boundaries does not imply any endorsement or otherwise of them.

At the commencement of this project, it was expected that the most important variables – such as population, levels of service, capital and operating costs, losses and average tariffs – could be accessed for each of the five REDs from the NER database which includes all these data (and more) as supplied by individual licence holders. This was not possible, however, and the NER was unable to release information other than that which is published in its statistical report (1996a). Consequently, a margin of error exists in some data, since data have had to be obtained from a range of other sources, although the margin of error is unlikely to so great as to affect the overall conclusions of this study.

4.2 Demographics

The total number of households used in this study is 8.6 million, with 1996 as the base year. For modelling purposes these have been split into three categories: urban, rural 1 (dense) and rural 2 (dispersed), where the latter group is that portion of the rural population which lives in dispersed settlements of less than a thousand or so and which are presently located far from the electricity grid. The number of households as used in each RED is shown in Table 1.

Table 1: Distribution of households in each RED

RED	*Urban*	*Rural 1 (dense)*	*Rural 2 (dispersed)*	*Total*
Northern (A)	975 551	1 350 762	578 898	2 905 211
Western (B)	736 349	100 943	25 236	862 527
Central (C)	847 524	414 870	414 870	1 677 264
Eastern (D)	848 629	510 823	510 823	1 870 276
Wits (E)	1 225 875	55 816	6 202	1 287 893
Total SA	4 633 928	2 433 215	1 536 029	8 603 172

In the absence of better data, assumptions have had to be made about the split between Dense and Dispersed rural populations. Population data were derived from the NER database as reported in their statistical report (NER 1996a), with some adjustments being made.[2]

4.3 Service levels of existing households

Whilst there is reasonable certainty about the number of electrified households, the quality of information about the number of unelectrified households in South Africa is extremely poor. Overall, the NER reported that 55% of all households had electricity by the end of 1996, with urban access of 79% and rural access of 27% (NER 1996b: 17).

For purpose of this exercise, provision has been made for up to nine service levels: no service at all, Solar 1 (a photovoltaic system with a single 50 W solar panel and 100 Amp-hour battery), Solar 2 (a higher level solar system with two panels, total 100 W and 150-200 Amp-hour battery), 2.5A grid supply, 8A grid, 20A grid and 60A grid, with a distinction in the latter case between low-, middle- and high-income households (since these income groups consume different amounts of electricity).

Information about the existing service levels in each RED was not available for this study, so published provincial information was used, together with certain assumptions. In particular, these included the portion of new connections made since 1991 which were 20A and 60A. It was assumed that as at the beginning of 1997, there were to all intents and purposes, no 2.5A or 8A supplies in South Africa. The resulting service levels as at the beginning of 1997 are shown in Table 2.

Table 2: Service levels in each RED at the beginning of 1997

RED	*Urban*				*Rural 1 (dense)*				*Rural 2 (dispersed)*				*Total*
	None	*20A*	*60A low inc*	*60A total*	*None*	*20A*	*60A low inc*	*60A total*	*None*	*20A*	*60A low inc*	*60A total*	*electrif*
Northern (A)	24%	30%	13%	33%	72%	15%	1%	12%	73%	23%	0%	3%	42%
Western (B)	11%	8%	2%	79%	49%	7%	2%	41%	50%	30%	0%	20%	83%
Central (C)	24%	18%	8%	50%	65%	24%	2%	9%	66%	16%	0%	18%	54%
Eastern (D)	17%	15%	7%	61%	81%	16%	1%	2%	82%	11%	0%	7%	47%
Wits (E)	20%	10%	2%	67%	46%	23%	6%	25%	49%	0%	0%	51%	78%
Total SA	20%	17%	7%	57%	71%	16%	2%	11%	74%	17%	0%	9%	55%

4.4 Electricity consumption levels

Electricity consumption data as published in the NER statistical report were used for the base year, 1996, for residential, agriculture, mining, manufacturing, commercial, transport and general consumer categories. These consumption data, as reorganised into the REDs, are shown in Table 3 and Table 4.

2 There is a discrepancy of 564 000 households between two figures reported by the NER as the number of electricity consumers (NER 1996: 17ff). Adjustments have therefore had to be made to the published data to account for this discrepancy.

Table 3: Electricity consumption in each RED, 1996

RED	*Domestic MWh*	*Agriculture MWh*	*Mining MWh*	*Manufact MWh*	*Commerc MWh*	*Transport MWh*	*General MWh*	*Total MWh*
Northern (A)	4 078 740	906 209	5 852 776	28 715 493	4 303 000	682 568	79 948	44 618 734
Western (B)	4 355 494	688 817	66 210	5 879 816	1 420 920	303 860	279 070	12 994 187
Central (C)	3 752 856	1 250 983	19 476 972	5 056 338	1 124 344	791 442	35 776	31 488 711
Eastern (D)	10 118 721	655 485	295 739	17 314 608	486 530	1 234 640	823 204	30 928 927
Wits (E)	9 514 301	249 742	6 166 008	16 939 289	5 812 467	791 627	143 838	39 617 272
Total SA	31 820 112	3 751 236	31 857 705	73 905 544	13 147 261	3 804 137	1 361 836	159 647 831

It is apparent from Table 4 that the average consumption within some groups varies widely. For example, the average consumption per household varies from a low of 3 759 kWh per annum in RED C to 11 518 kWh in RED D. There is no obvious explanation for this, aside from general economic welfare, but this variable has important impacts on the revenue base and therefore financial viability of electricity distributors.

Future electricity consumption by non-residential consumers is assumed to grow by around 3% per annum, in line with historical trends, with lower rates for mining and agriculture, and higher rates for commercial and industrial sectors. Although it might be argued that higher growth rates will occur if the economy achieves the government's target of 6% by the year 2000, unfortunately this scenario appears somewhat unlikely to materialise. Furthermore, it is likely that the economy's future growth path will be less electricity-intensive, especially with the relative decline of gold mining. Consequently, a modest growth rate has been used for non-residential consumers.

For residential consumers, electricity consumption is assumed to be much lower than originally expected at the commencement of the electrification programme in 1991, but with reasonably high annual growth rates for new consumers (albeit off a low base), in line with the experience of the last five years (see NER (1996b: 24) for more details and see Appendix 1, sheet 2.5 for assumptions at each service level).

Table 4: Average consumption per consumer, by RED, 1996

RED	*Domestic kWh pa*	*Agriculture kWh pa*	*Mining kWh pa*	*Manufact kWh pa*	*Commerce kWh pa*	*Transport kWh pa*	*General kWh pa*	*Total kWh pa*
Northern (A)	4 609	37 374	16 674 575	6 239 786	137 582	4 266 050	255 425	47 170
Western (B)	6 212	47 166	1 614 878	1 143 266	36 850	4 823 175	82 859	17 032
Central (C)	3 759	34 094	89 343 908	774 799	27 581	3 382 231	92 206	29 068
Eastern (D)	11 518	110 370	4 224 843	6 685 177	27 708	13 134 468	120 457	33 929
Wits (E)	9 696	40 036	67 021 826	1 772 078	160 176	3 549 897	389 805	38 314
Total SA	7 160	42 764	41 266 457	2 600 477	79 948	4 914 906	120 816	33 697

4.5 Target electrification levels

The electrification scenarios used in this study are based on target service levels and the period over which the backlog is to be eliminated. Although the targets until 1999 are clear, there has been little analysis thus far of longer term electrification coverage levels. The base scenario used in this study is summarised in Table 5.

Table 5: Base electrification targets and coverage levels

	Year 10			*Year 20*		
	Urban	*Rural 1 (dense)*	*Rural 2 (dispersed)*	*Urban*	*Rural 1 (dense)*	*Rural 2 (dispersed)*
None/inadequate	0%	0%	32%	0%	0%	0%
Solar 1	0%	0%	16%	0%	0%	28%
Solar 2	0%	0%	4%	0%	0%	7%
2.5 Amp grid	0%	14%	11%	0%	14%	20%
8 Amp grid	0%	0%	0%	0%	0%	0%
20 Amp grid	56%	69%	33%	55%	69%	40%
60 Amp, low income	19%	11%	3%	17%	12%	4%
60 Amp, other	25%	5%	2%	27%	5%	2%

The key aspects of this scenario are that it is assumed that the existing backlog (that is, households with no electricity service at all in 1997) would be completely eliminated within five, ten and 20 years in the case of urban, rural 1 (dense) and rural 2 (dispersed) respectively.

4.6 Capital subsidies

The base scenario assumes that there will continue to be no capital subsidies for grid electrification, although a R1 500 grant is made available for every non-grid household connection. This is consistent with the Cabinet decision made during 1997.

4.7 Bulk purchase costs

The base bulk purchase cost for electricity purchased by the REDs from the transmission system is estimated at 10 c/kWh. For those REDs whose consumer bases are located far from the main locus of generation, a small transmission surcharge is added, resulting in net purchase costs as follows:

Northern (RED A)	10.0 c/kWh
Western (RED B)	10.3 c/kWh
Central (RED C)	10.2 c/kWh
Eastern (RED D)	10.1 c/kWh
Wits (RED E)	10.0 c/kWh.

This surcharge is nominal only and probably does not reflect the actual cost differentials in supplying electricity to areas which are far from the main locus of generating plants. Until a more cost-reflective tariff is available, however, the above numbers have been used.

These costs all exclude Value Added Tax, as do all other financial values used in this report.

4.8 Opening financial positions

The financial position inherited by each RED will have an important impact on subsequent financial performance, particularly in relation to the value of liabilities taken over from Eskom and municipal distributors. Indeed, deciding on the appropriate level of debt is likely to be one of the more challenging issues in the restructuring process.

For purposes of this modelling exercise, assumptions have been made about the value of assets and the level of gearing with which REDs will commence operations. In the case of their asset bases, these values have been estimated as the replacement costs of existing distribution infrastructure, with a level of gearing corresponding to a debt/equity ratio of 1:1. Admittedly, this is a somewhat arbitrary assumption – albeit reasonably favourable for the REDs – but it is necessary to make some estimate of their .opening financial positions. The resulting balance sheets for each of the five REDs are summarised in Table 6.

Table 6: Opening balance sheets for the five REDs

	Assets	*Liabilities*	*Reserves*
Northern (A)	4 664	2 332	2 332
Western (B)	942	471	471
Central (C)	2 773	1 386	1 386
Eastern (D)	2 271	1 135	1 135
Wits (E)	1 820	910	910
Total	12 470	6 234	6 234

Clearly, the opening liabilities faced by the REDs will have a strong influence on their net profitability particularly in the prevailing context of high real interest rates. Higher debt/equity ratios will place the REDs under considerably more pressure from the beginning, both in terms of their ability to raise additional capital at acceptable costs, and insofar as existing debt has to be serviced.

4.9 Key financing assumptions

There are several critical assumptions related to the financing of the REDs' operations. The first of these relates to the transfer which has historically been made by local authorities from their electricity trading account to their general rates and other service accounts. Nationally, the size of this annual surplus was estimated at around R1.5 billion for 1994, 50% of which was earned by just four municipal distributors (ERIC 1996).

In all the policy development to-date, the principle has been adopted that this source of municipal revenue should continue to be available to local authorities even under a RED-type structure – the most probable mechanism through which this will be achieved is by allowing local authorities the right to levy a tax on the RED's electricity sales in their jurisdiction.

In the present modelling exercise, this assumption has also been adopted in the base case. Data on municipal electricity surpluses for 1994 have been taken from the ERIC report. The treatment of these amounts in the EFM model is as follows: first, these amounts accrue to the RED through its normal revenues; secondly, they are then paid out to local authorities based on a fixed percentage of revenues. In other words, the 'tax' would reduce the gross operating surpluses available to the REDs, without changing the price paid by end-users. Clearly, therefore, this is a critical assumption since it directly reduces the REDs' bottom-line by a total of R1.8 billion (1997 figures). These amounts are summarised for each RED in Table 7.

Table 7: Financial transfers to municipal distributors, Rm 1994

RED	*Gaut*	*W Cape*	*KZN*	*E Cape*	*Mpum*	*NW*	*FS*	*N'thern*	*N Cape*	*Total*
Northern (A)	148				71	7		43		269
Western (B)		212							0	212
Central (C)	40			100		57	58		9	264
Eastern (D)			161		1		3			165
Wits (E)	588				1		2			591
Total SA	777	212	161	100	73	64	63	43	9	1 502

For purposes of the modelling, these values have been inflated to 1997 Rands, yielding a total transfer of R1 789 million for that year.

A second important financing assumption relates to the size of the cross-subsidy burden imposed on electricity consumers for the purpose of financing the electrification programme. Most analyses to-date have worked with an effective cross-subsidy of about 5%, this being the real increase in tariffs for all consumers attributable to the cross-subsidisation of electrification consumers.

There is no absolute limit to the amount (a form of 'levy') which other consumers would be willing and able to bear, nor is there any literature suggesting what a reasonable burden might be. Aside from the simple price-related substitution effect (accounted for in the EFM model through elasticity assumptions), there could be significant political and economic costs if the levy becomes too large. For present purposes, a ceiling of 5% – as a one-off across the board real increase applicable to all consumers – has been assumed in the base case. This could obviously be increased or decreased for analytical purposes.

A third financing assumption relates to the tariff levels used in the model. As noted below, Eskom's tariffs have been used as proxies for those of the REDs. In fact, this means that there is already an implicit source of finance already included, to the extent that Eskom's prices are higher than they would otherwise have been without the electrification programme. Although it is difficult to quantify this exactly, since the scale is changed so quickly, the implicit cross-subsidy is of the order of a few percentage points. Moreover, for some municipal distributors, moving onto these tariffs would cause prices to rise, thus representing an additional source of financing available to the REDs. At this stage, insufficient data is available to estimate how significant this increased source of finance would be.

A further assumption relates to the issue of inter-RED financial transfers. This is a policy issue which is yet to be resolved by government, but it is possible that any losses (or a portion thereof) made by some distributors could be covered by transfers from more profitable REDs. However, this option has not been incorporated into this financial analysis, primarily because this would significantly distort the incentives faced by REDs on both sides: there would be impaired incentives both for loss-makers to increase efficiency levels or tariffs, and for profitable REDs to continue seeking efficiency gains. Nonetheless, it is possible that government could introduce a mechanism for making such transfers.

The last financing assumption of importance concerns the debt/equity ratio which is assumed to apply to REDs. As noted earlier, it has been assumed that each RED will take over a balance sheet with a debt/equity ratio of 1:1, reflecting a healthy balance sheet with modest debt levels. Regarding future gearing levels, although there are no absolute guidelines or rules of thumb dictating what gearing levels are sustainable, a fairly conservative assumption has been made for present purposes, namely that distributors would have a debt/equity ceiling of 1.5:1, thus permitting an increase in gearing levels from their opening positions. Above this, their risk profiles would begin to deteriorate considerably and the cost of borrowing would rise rapidly, to the point where their credit worthiness would be limited; hence for present purposes the analysis has assumed a cap of 1.5:1.

4.10 Treatment of inflation

An inflationary environment introduces complexities into a modelling exercise such as this one, where a 20-year time frame is being analysed. Although it is possible to use nominal values in all cases (that is, actual Rand amounts as inflated), it is more meaningful to use real values (that is, to express all monetary amounts in the base year's currency). Methodologically, the model caters for an inflationary environment such as the South African one by converting all financial flows to real terms. In the case of finance charges, for example, this means that interest costs (and revenues) are calculated using the nominal interest rate, based on the nominal value of the liabilities (and cash reserves) for the relevant period, and the result is then discounted back to 1997 Rands.

In the case of fixed assets, it is assumed that the REDs have an accounting policy of revaluing their assets annually to reflect their value in real terms. This is standard practice in an inflationary environment where current cost (that is, 'real' value) accounting statements are produced. Similar logic applies to depreciation charges against those assets.[3]

3 In the EFM, this means that unlike other balance sheet items such as debt and equity, fixed assets and accumulated depreciation are not deflated from one year to the next. Instead, their real value is held constant, with the difference (that is, the amount by which they are being revalued – or *not* deflated) being credited to a revaluation reserve.

For modelling purposes, an inflation rate of 6% has been used, with interest rates of 16%, 14% and 10% respectively on short-term borrowings, long-term borrowings and positive cash deposits. These translate into real rates of 9.4%, 7.5% and 3.8% respectively. Although these rates have been used for the full 20-year period, the model has the facility to adjust the rates for intermediate five-year periods.

4.11 Other assumptions

Other important assumptions include those around capital costs of new connections, operating costs, average electricity tariffs and asset replacement costs. All values used for these variables are shown in Appendix 1. In the case of capital costs, the estimated costs have distinguished between urban, rural 1 (dense) and rural 2 (dispersed) settlement types, each level of service (both grid and off-grid) and between different time periods. The effect of these categories is that grid connection costs are obviously expected to be much higher in more remote rural areas in a number of years' time. Capital cost estimates have been based on published reports in the case of off-grid costs (Banks et al 1996); for grid electrification, 2.5A and 20A costs are based on data supplied by Eskom's Electrification Planning department, while other levels of service are based on published reports from the NER (1996b) and Davis (1996).

The same data sources have been used for support and operating cost estimates. It should be noted that the use of Eskom's cost values embodies a further assumption that there will be convergence between the operating and support costs of Eskom and municipal distributors. Although it is generally acknowledged that efficiencies in many distributors can improve, there are few data at present to indicate how significant these cost decreases will have to be. This remains something of an unknown factor, so the issue is merely highlighted here.

Average tariffs have been based on the 1997 schedule of tariffs used by Eskom in the case of grid options for both residential and non-residential, whilst in the case of the solar options, the same tariff has been used for 'Solar 1' as for the 2.5A supply (R15 per month), compared to a slightly higher level of R20 per month for the 'Solar 2' level of service.

5. Results of the analysis

In the following sections, the most important results of the modelling exercise are presented, firstly for the REDs with grid and off-grid electrification combined, and, secondly, for off-grid electrification alone.

5.1 Financial position of REDs with grid and off-grid combined

5.1.1 Reasonableness of overall results

It has been well established from previous analyses that the electrification programme, as an investment in its own right, is financially unattractive, producing a negative net present value of about R20 billion over 20 years (Davis 1996: 16). At the level of individual households, this equates to an average net present value of around negative R3 250, although this obviously varies considerably between households around the country, depending on capital connection costs, consumption levels, and types of service.

The results in this analysis confirm the above observations, although it is worth pointing out that the range in net costs (negative NPV) of electrification connections is very wide for different levels of service at different times: for 2.5A consumers, for instance, these could be as low as negative R1 500 in urban areas but as high as negative R5 500 in the remote rural areas. Similar orders of magnitude apply to other service levels, with the exception of 60A middle- and high-income consumers who generate positive net present values (in other words, they produce a positive return on investment). In principle, therefore, an electrification scenario which better matches levels of service with affordability will have a lower net cost.

The consolidated results of all five REDs appear to correlate closely with the estimated financial picture of the industry at present, as reported in other studies and published reports. The ERIC report estimated total revenue of R22.2 billion in 1995 which, if adjusted for sales volume growth of 3% per annum and inflation of 8% from 1996 to 1997, yields total revenues of R25.4 billion for 1997. The total revenue estimated by the present model for 1997 was R24.4 billion (before any real price increases). Likewise, comparison of the operating income in the two modelling exercises yields broadly similar results: the ERIC report estimated an operating income of R3.6 billion (before interest and municipal transfers) which, if adjusted for growth and inflation, amounts to R4.0 billion. By comparison, this study calculated a slightly lower amount of R3.7 billion.

A somewhat larger difference in the results concerns interest costs: ERIC estimated these at R1.1 billion, whereas this study put them at R0.7 billion in 1997. However, the ERIC study did not state all of its assumptions, so it is difficult to account for this difference; it is possible that the present study assumed a lower level of debt which REDs take over upon their creation. It has been assumed that they will have to be created with fairly strong balance sheets (that is, low debt levels) if they are to be able to borrow on capital markets – especially since they will no longer have the 'Eskom' name and underlying generation and transmission asset base as security. Also, the present exercise has modelled three sets of interest flows: short-term interest expense (at higher cost), long-term interest expense on capital borrowings, and interest earned on positive cash balances. The latter, in particular, has the effect of reducing the net finance charges.

Overall, it would seem therefore that the financial results produced by the EFM model are broadly plausible in relation to those produced by the ERIC and other studies.

5.1.2 Financial performance of REDs with no price increases

As a starting point, the financial position of the five REDs has been modelled, without any real price increase or injections of external subsidy finance.[4] In this case, three of the REDs – Western, Eastern and Wits – are financially sound, but the remaining two – Northern and Central – incur heavy losses. This is evident from Figure 4, which also shows that for both Northern and Central REDs their net loss after finance charges exceeds R1 billion in 2006. This is clearly completely unsustainable, and these REDs require some intervention if they are to be viable. The other three REDs are in comfortable financial positions, producing healthy net profits (even after making the transfer to local authorities in respect of their original surpluses). In these cases, no further interventions are required, in the form of price increases or external subsidies.

For Northern and Central REDs, the first response would be to raise tariffs across the board, within the limits of what will be affordable to their consumers and avoid any significant substitution effects. Also, large regional differences in tariffs could prejudice the poorer regions since they would be unable to compete on the basis of price with the other REDs. Consequently, a cap on real price increases has been modelled.

4 Other than the R1 500 subsidy per off-grid connection. This, however, has a negligible impact on the overall positions discussed here.

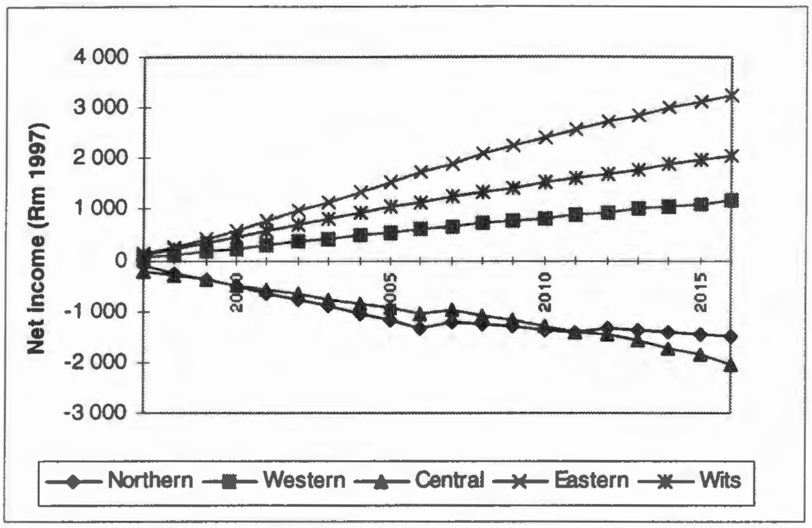

Figure 4: Net income/loss for REDs with no price increases or subsidies

5.1.3 Financial performance of REDs with price increases and subsidies

A real increase in electricity tariffs will clearly have a positive impact on the finances of the two REDs which are making losses, although this will also be partly offset by revenue lost due to reduced consumption.[5] For present purposes, a cap on real price increases of 5% has been used. In the case of Northern RED, this is sufficient to return it to profitability, although for Central RED a small shortfall remains. This amounts to some R595 million over the years 2000 to 2006 representing the amount which, in principle, would have to be transferred to the RED to keep it within the financial parameters previously described. Table 8 summarises key elements from the financial statements of the five REDs; full copies of the statements are contained in Appendix 3 of this report.

[5] In the absence of better information, a price elasticity of -0.20 has been used for all consumer classes.

Table 8: Financial results of the five REDs (grid and off-grid) in 1997, Rm

	Northern (A)	*Western (B)*	*Central (C)*	*Eastern (D)*	*Wits (E)*	*Total*
Financing:						
Real price increase	5%	nil	5%	nil	nil	-
External subsidy	nil	nil	nil	nil	nil	-
Income statement:						
Sales revenue	6 829	2 271	4 681	4 911	6 291	24 983
Operating costs	(5 944)	(1 750)	(4 153)	(4 028)	(4 906)	(20 781)
Municipal transfers	(320)	(252)	(314)	(197)	(704)	(1 787)
Operating surplus	565	269	214	686	681	2 415
Interest paid	(270)	(35)	(164)	(98)	(59)	(632)
Net surplus	294	234	51	588	622	1 783
Balance sheet:						
Fixed assets	5 290	1 053	3 072	2 660	2 038	14 113
Liabilities	2 440	428	1 492	1 057	825	6 242
Financial ratios:						
Debt/equity[6]	1.0	0.6	1.1	0.6	0.5	0.7
Interest cover[7]	2.1	7.6	1.3	7.0	11.6	3.8
Return on equity[8]	11%	34%	4%	34%	41%	21%
Return on sales[9]	8%	11%	5%	14%	11%	10%

It can be seen from the summarised results for 1997 that each RED is able to generate positive operating results, even after payment of the municipal transfer (based on an adjusted level of R1.8 billion in 1997), although obviously in the two weaker REDs, this would not have been possible without the 5% increase in price levels. Importantly, their debt levels appear are reasonable, with debt equity levels of 1.1 or less in each case. Interest cover is very strong for the three healthy REDs, reasonable for Northern RED, and marginal for Central RED at 1.3. The rates of return for the latter are also low, at 4% on equity, which suggests that problems could arise in later years.

Thus it is evident from the above that the financial position of the five REDs is reasonably secure in 1997, subject to the provisos related to their financing interventions. In considering how this changes over time, it is worth considering another 'snap shot' of their financial position in five years (2002). In most cases, this is the point at which REDs' financial positions can be expected to be at their worst, since the bulk of the backlog will by then have been eliminated, with access levels of about 100% in urban areas and 70% in rural areas, whilst consumption (and therefore revenue) levels of newly electrified households are still low. Table 9 summarises the results in 2002 in the same format as for 1997.

6 The debt/equity ratio equals long term liabilities divided by accumulated reserves (accumulated surpluses, or equity).

7 The interest cover ratio equals net operating income (before interest) divided by interest paid.

8 Return on equity equals net income (after interest) as a percentage of accumulated reserves.

9 Return on sales equals net operating income (before interest) as a percentage of total sales revenue.

Table 9: Financial results of the five REDs (grid and off-grid) in 2002, Rm

	Northern (A)	*Western (B)*	*Central (C)*	*Eastern (D)*	*Wits (E)*	*Total*
Financing:						
Real price increase[10]	5%	nil	5%	nil	nil	-
External subsidy						
– 2002	nil	nil	90	nil	nil	90
– 1997 to 2006	nil	nil	595	nil	nil	595
Income statement:						
Sales revenue	8 627	2 861	5 633	6 243	7 811	31 175
Operating costs	(7 746)	(2 261)	(5 093)	(5 300)	(6 163)	(26 563)
Municipal transfers	(404)	(318)	(378)	(249)	(874)	(2 223)
Operating surplus	477	283	162	694	773	2 389
Interest (paid)/earned	(429)	58	(247)	76	233	(309)
Net surplus	48	341	(85)	770	1 007	2 080
Balance sheet:						
Fixed assets	7 874	1 492	4 205	4 295	2 832	20 698
Liabilities	3 348	234	1 883	703	442	6 610
Financial ratios:						
Debt/equity	1.2	0.1	1.5	0.2	0.1	0.3
Interest cover	1.1	na[11]	0.7	na	na	7.7
Return on equity	2%	18%	-7%	17%	20%	10%
Return on sales	6%	10%	3%	11%	10%	8%

Comparison of the REDs' financial positions in 1997 and 2002 as shown in Table 8 and Table 9 respectively reveals that three of them (Western, Eastern and Wits) continue to enjoy favourable financial positions five years down the line, although in all cases their rates of return are lower than in 1997. Again, the remaining two REDs clearly show greater signs of financial stress, with Central RED continuing to make a financial loss in 2002. Examination of its financial statements (Appendix 3) shows that net losses of up to R89 million occur in the period up to 2006 when the capital expenditure programme slows down considerably.

Based on the above analysis and assumptions, Central RED will require approximately R595 million (1997 Rands) over the next ten years in order to maintain its balance sheet in a reasonably healthy state. This subsidy is paid over seven years and so if the amount is smoothed out, it represents an average of about R85 million per annum. This is a fairly modest amount, representing just 1.4% of the RED's annual revenue during those years. It would be possible, for instance, to avoid the need for an external subsidy by raising prices beyond the initial 5% cap: an additional 4.1% increase in 2000 would achieve an equivalent result. Whether this would be feasible or desirable is an important question, but one which is beyond the scope of this study.

In the wider context, however, this subsidy requirement is very modest, representing just 0.3% of total industry revenue for the year 2002. Put differently, if electrification policy were that this had to be financed within the industry, it would require an additional 'levy' of 0.3% for the seven years to 2006. Although this percentage is small in relative terms, it is worth stating the obvious point that it would carry an opportunity cost insofar as electricity consumers would have to reduce their expenditure on other items as a result, with possibly a lower overall level of utility in society as a whole.

In 2002, Central RED has a higher debt/equity levels – at the 'financial policy' limit in this study, of 1.5 – compared to 1.1 in 1997. It must be remembered that this is *after* taking account of the 5% real price increase in 1997, any price increases caused by adopting Eskom's

10 One-off increase, in 1997.

11 Interest cover ratio is not applicable since there is net interest *earned*.

tariffs, as well as the external subsidy inflows referred to above. As shown earlier, without these inflows Central (and Northern) REDs would not be financially viable.

One result which is somewhat surprising is the relatively good financial position of the Eastern RED, which encompasses all of KwaZulu-Natal. It might have been expected that the RED which includes these areas would have financial problems because of the large number of unserved rural households in the province. Further analysis of these results suggests that one reason for these results could be around the high level of consumption applicable to domestic consumers (refer to Table 4). As noted earlier, these data were derived directly from the NER's statistical report (1996a), which showed a high level of consumption by Durban Electricity in the domestic consumer group. The figures are based on returns by distributors, in which a margin of error exists. Although no other data could be secured from the NER, it should be noted that these data – if incorrect – could possibly have the effect of distorting the results for the Eastern RED.

Interestingly, the modelling shows that the gearing levels of the other three REDs (Western, Eastern and Wits) are lower in 2002 than in 1997, and they have moved into a net cash positive situation which yields net interest earnings. This is a result of their large consumer bases which are able to easily finance the electrification programme and its associated costs.

As can be seen from the longer-term financial results of the REDs (Appendix 3), their finances remain viable over the remainder of the 20-year period. Thus, overall, the results of this study can partially confirm those of the ERIC report, since the three of the five REDs are clearly viable whilst the remaining two will be viable if their prices increase by 5% across the board and, in the case of Central RED, further finances are forthcoming in the form either of external subsidy finance or an additional 4% price increase in 2000. This conclusion is also subject to the provisos mentioned earlier, for example, around the convergence of tariffs and operating costs to those of Eskom.

5.2 Financial position of off-grid electrification

The above results have consolidated off-grid electrification with the grid programme, as if the RED is responsible for carrying out both. Given the relative scales of the grid and off-grid programmes, however, the latter tend to be overshadowed by the former. In this section, the results of the off-grid programme are reported separately as if this was the responsibility of separate off-grid agencies (operating within the same RED boundaries).

Table 10 below summarises the financial results of off-grid electrification agencies in each of the five RED areas, for the year 2002. Results are not shown for 1997, as in the initial years of the programme, the amounts involved are generally small and so it is not very meaningful to analyse the results at that stage.

Table 10: Financial results for off-grid electrification in 2002, Rm

	Northern (A)	*Western (B)*	*Central (C)*	*Eastern (D)*	*Wits (E)*	*Total*
Connections:						
Cumulative yrs 1-5	79 219	2 585	52 286	76 564	624	211 278
Financing:						
Capital grant (per connection)	R1 500	R1 500	R1 500	R1 500	R1 500	-
Income statement:						
Sales revenue	16	0	11	15	0	42
Operating costs	(36)	(1)	(24)	(35)	0	(96)
Operating loss	(20)	(1)	(13)	(20)	0	(54)
Interest (paid)/earned	(30)	(1)	(20)	(29)	0	(80)
Net loss	(50)	(2)	(33)	(49)	0	(134)
Balance sheet:						
Fixed assets	216	7	142	208	2	575
Accumulated losses	(142)	(5)	(94)	(140)	(1)	(382)
Liabilities	132	4	87	128	1	352
Financial ratios:						
Debt/equity	negative	negative	negative	negative	negative	negative
Interest cover	negative	negative	negative	negative	negative	negative
Return on equity	negative	negative	negative	negative	negative	negative
Return on sales	negative	negative	negative	negative	negative	negative

It is evident that a total of 211 000 off-grid connections are envisaged in terms of this scenario (all in remote rural areas), and with the current subsidy policy, whereby each of these new connections receives R1 500, the total burden on the fiscus from 1997 to 2002 for capital costs is R317 million. This is about 53% of the cumulative subsidy requirement for grid connections in Central RED, or 1.3% of the industry's consolidated revenue for 1997.

It seems improbable that the government will wish to continually subsidise off-grid connections to this extent, especially when the grid-based industry's own revenue base is so large. Although it is beyond the scope of this study to analyse institutional and policy options for off-grid electrification, it would seem from the figures reported above that the solar programme would be best integrated with the grid programme, since on a stand-alone basis the programme is not financially sustainable. It is evident from the consolidated financial statements (in Appendix 3) that the effect of combining grid and off-grid makes little difference to the overall financial picture because of the small scale of the latter.

Regarding operating results, it is clear that with the tariff options used in this scenario, off-grid electricity supply will result in financial losses to the supplier (even with the R1 500 capital subsidy). On its own, therefore, the solar electrification programme will not be financially viable, especially because consumer demand for solar electricity is low to begin with, and it therefore has to compete with 2.5A and 20A grid connections, both on price and quality of service. Nonetheless, the fact that solar electrification will result in a loss does not mean it should be ruled out – rather, the point is that it will probably result in a *smaller loss* to the service provider than the alternative electricity supply option (2.5A or 20A) and from a financial point of view, would therefore be the preferable option in those cases.

6. Analysis of alternative scenarios

One of the requirements for this study is that it examines alternative criteria for applying 'equity' objectives. In the base case scenario analysed earlier, the broad approach taken was one in which levels of service (solar 1, solar 2, 2.5A, etc.) were varied considerably in order to match level of service with income and affordability indicators – effectively, to achieve a more cost-effective supply mix in the face of low demand and high costs. The scenario was therefore intended to more-or-less correspond with current trends in the industry. As far as equity criteria are concerned, the base scenario applied a mixed approach of grant finance: solar consumers all received the same capital grant from government (R1 500) whilst grid consumers received no capital grant from external sources (e.g. the fiscus), except in the Central RED where this was necessary to maintain its financial health; low-income grid consumers also benefited considerably from cross-subsidies.

Two alternative interpretations of 'equity' may also be considered:

- equity in outcome: in terms of which all consumers receive the same level of service, taken in this case to be a 20A grid supply;
- equity in finance: in this case, all consumers benefit from the same amount of external grant finance, whether they are urban or rural, and regardless of their service level.

Both of these scenarios have been modelled and their results are presented below.

6.1 Financial effects of aiming for 'equity in outcome'

In this scenario, all input data remain the same as in the base scenario, with the exception that all households with incomes below R3 500 per month are provided with 20A connections (it is assumed that households who pay for higher levels of service – 60A – will not be prevented from receiving those). Time periods for elimination of backlogs in urban, rural 1 (dense) and rural 2 (dispersed) areas remain as before, namely 5, 10 and 20 years respectively. The impact of such a scenario on the REDs is summarised in Table 11; full financial statements for the 20-year period for each RED are contained in Appendix 4.

Table 11: Financial results for REDs in 2002, equity in service levels, Rm

	Northern (A)	*Western (B)*	*Central (C)*	*Eastern (D)*	*Wits (E)*	*Total*
Financing:						
Real price increase	5%	nil	5%	nil	nil	-
External subsidy						
- 2002	361	nil	254	nil	nil	615
- 1997 to 2016	3 179	nil	6 537	nil	nil	9 716
Income statement:						
Sales revenue	8 555	2 846	5 596	6 208	7 781	30 986
Operating costs	(7 824)	(2 262)	(5 132)	(5 357)	(6 162)	(26 737)
Municipal transfers	(402)	(317)	(377)	(249)	(872)	(2 217)
Operating surplus	328	267	88	601	747	2 032
Interest (paid)/earned	(516)	51	(267)	7	225	(500)
Net surplus/(loss)	(187)	318	(179)	609	972	1 532
Balance sheet:						
Fixed assets	8 395	1 503	4 485	4 724	2 817	21 924
Liabilities	4 018	230	2 141	596	441	7 426
Financial ratios:						
Debt/equity	1.5	0.1	1.5	0.2	0.1	0.4
Interest cover	0.6	na	0.3	na	na	4.0
Return on equity	-7%	18%	-13%	15%	20%	8%
Return on sales	4%	9%	2%	10%	10%	7%

It is evident from these results that an electrification scenario in which all unelectrified households receive a 20A supply will require very substantial increases in subsidy finance. Both Northern and Central REDs still require the 5% general price increase, but their subsidy requirements have increased considerably as well: for Northern, this has increased from zero to R3.2 billion (over years 4 to 14), and for Central from R0.6 billion to R6.5 billion over the same period. The total subsidy requirement therefore increases by R9.1 billion in the next years. This is highly significant, both in relation to the fiscus and to the electricity industry; this represents 31% of the total industry's turnover in 2002. Although a proper cost-benefit analysis is beyond the scope of this study, it is highly improbable that such an increase in government spending could be justified on economic grounds through externalities, public health benefits and economic multipliers.

If this was financed not from the fiscus but from the industry itself in the form of a 'levy' on all consumers over seven years to 2006 (when the worst of the backlog is eliminated), this levy would have to increase from 0.3% in the base case to 4.5% in this scenario – with considerable negative economic multipliers. Even if this was financed from the industry, there would still clearly be an opportunity cost, borne mainly by consumers – although it is beyond the scope of this project to quantify that impact.

Comparison of Table 11 with Table 9 (the equivalent results in the base case) shows that the operating surpluses for all REDs decline with the higher service level, although, in the case of the three stronger REDs, these declines are all marginal. Provided Northern and Central REDs receive the external subsidies, they will remain financially viable over the 20-year period. For Northern RED, its retained income drops to a lowest point of just R285 million in 2007 after which it increases rapidly, reaching R3 557 million by 2016. Central RED shows a similar trend although its position is weaker throughout, reaching a low point of negative R352 million in 2008, ending at R175 million in 2016. This suggests that the latter RED in particular will require tight management if it is to recover from the burden of electrification in the early years of the next decade, notwithstanding the large external subsidies it is assumed to receive.

The reason for the differentiation between the two groups of REDs is mainly related to the larger backlogs of unelectrified households in the Northern and Central REDs, which would otherwise have been electrified with off-grid and 2.5A options in the base scenario. In the case of Western and Wits REDs especially, the number of additional 20A supplies compared to the base scenario is small.

The level of service issue is a complex debate which extends beyond the financial realm into political, philosophical and social realms. Clearly, there are political and other benefits to investing public funds in higher levels of service for poorer households. However, the above results show clearly what the financial cost to the country would be were it to pursue the route of higher service levels across the entire population. The public policy questions which arise are, firstly, whether the benefits of spending more on electrification would outweigh the costs of doing so, and secondly, even if they do, whether or not there are other more productive uses to which those public funds should be put.

6.2 Financial effects of applying 'equity in finance'

In another alternative scenario, government may decide to provide an equivalent financial grant to all qualifying (that is, low income) households, along the same lines as the national housing subsidy and the Consolidated Municipal Infrastructure Programme (CMIP) subsidy for connector and bulk services.

There is no guideline as to what the amount of the subsidy might be. Until now, government has been unwilling to provide any grant finance at all, since the industry has maintained that it is able to finance the electrification programme entirely from within. Indeed, given the above results, which show that with a mixed service level approach (the base scenario) the industry is viable in aggregate, it is unlikely to be willing to commit further resources to the electricity industry when it faces such stringent fiscal constraints as at present.

Assuming that the absolute amount of subsidy finance made available by the fiscus to the REDs remains the same as in the base case (R595 million over the first ten years), then the individual allocation would be less than R500 per household. The effect on the REDs would be to reduce the subsidy flowing to Central RED and to re-allocate it to the other REDs proportionately. The net effect on the industry as a whole would be zero.

6.3 Pricing of solar with grid-equivalent subsidies

The financial flows in the base scenario for off-grid consumers are relatively simple, as summarised in Table 12. The table also shows the impact on both the NPV and average monthly surplus/(loss) per connection, of having a higher up-front capital subsidy. The exact amount of the subsidy which is currently received by grid consumers from within the electricity industry is difficult to assess, but for present purposes the average from Davis (1996) can be used, namely R3 250 per connection. Not shown in the table are certain cash flows such as battery replacement costs (15% of equipment costs, every three years) and consumer connection fees (R10 each). Also, the effect of declining real capital costs over time has not been included here.

Table 12: Financial flows of off-grid consumers in two cases, 1997

	Capital cost	*Subsidy*	*Tariff (R/m)*	*NPV*	*Equivalent monthly cost*
Solar 1:					
- base case	3 000	1 500	15	(2 531)	(21)
- equal subsidy	3 000	3 250	15	(911)	(8)
Solar 2:					
- base case	5 000	1 500	20	(3 343)	(28)
- equal subsidy	5 000	3 250	20	(1 723)	(15)

It can be seen from the results in the table that the introduction of equivalent grant finance into the off-grid portion of the electrification programme would considerably reduce the negative NPV for both solar options, but does not move them sufficiently to reach a financially viable position. In the case of Solar 1, the net monthly cost decreases from R21 to R8, whilst for Solar 2 this decreases from R28 to R15. This is mainly because of the need for the supplier to recover the costs of battery replacement every three years (not shown in the table), and because support costs are relatively high at R16 per month.

Put differently, in order for the supplier to break even in the above cases, the monthly tariffs would need to rise to the sum of: the tariffs used in the calculations in Table 12 (R15 for Solar 1 and R20 for Solar 2) and the net monthly cost – a total of R36 per month in the base case for Solar 1 and R48 in the case of Solar 2. This underlines the high effective cost of solar options, especially in the rural context where income and affordability levels are low, and demand for off-grid is much lower than grid electricity. It also underlines the likelihood that off-grid electrification will not financially viable on its own, even if fairly large capital subsidies were to be made available.

This does not, however, imply that solar options should be abandoned. As mentioned earlier, the loss per solar connection may well be lower than the loss per grid connection in remote rural areas, and it would therefore make financial sense to pursue the solar options in these areas.

7. Conclusions

The objective of this study was to analyse the subsidy implications of electrification scenarios, based on the provisional boundaries of REDs as proposed in the government's most recent document (ERIC 1996). The first broad conclusion emerging is that only three of the five REDs appear to be financially viable based on their starting position, using the range of assumptions and scenarios elaborated in this report. The two REDs with financial difficulties are Northern and Central – they will require real price increases of 5% across the board and, in the case of Central, additional external subsidy transfers of R595 million over the seven years to 2006. In arriving at these results, it is worth summarising the most important financial parameters impacting on the modelling exercise:

- Tariffs in each RED are based on Eskom's 1997 tariffs and this means that the large number of existing tariffs will converge to these levels. In the absence of data to this effect, it is difficult to assess whether there will be a net increase or decrease in tariffs for those consumers currently supplied by municipalities, although it is possible that tariffs would rise for residential consumers and decline for non-residential consumers.

- Likewise, operating costs are assumed to converge towards those used by Eskom in its financial planning, thus implying an increase in operating efficiency on the part of municipal distributors.
- The new REDs are expected to commence operations with relatively strong balance sheets, with debt/equity ratios of 1:1. This is a fairly favourable opening position which is considered necessary in order for REDs to be able to raise the necessary capital finance at competitive rates. The implication is that Eskom's generation and transmission divisions may have to accept somewhat higher debt loadings.
- The REDs are expected to make transfer payments to municipal service authorities in their jurisdiction, equivalent to the percentage surpluses currently earned from the trade of electricity. According to the ERIC report, these amounted to R1.5 billion per annum and so the surplus retained within the REDs will be reduced by the equivalent percentage each year.
- Fairly conservative financial constraints have been imposed on REDs in terms of price increases and debt levels. For instance, a maximum real price increase of 5% has been selected and a maximum debt/equity ratio of 1.5, on the basis that any higher price increases or gearing levels could lead to financial problems of their own.
- The analysis has not accounted for the possible introduction of income taxation or dividend payments in the electricity industry. In both cases, the effective price of electricity will increase (all other things equal), probably also resulting in some loss of revenues as consumption decreases as a result.

The results of the analysis raise difficult policy questions, as they indicate that the most recent proposal of five REDs is only marginally sustainable in two REDs but easily manageable for the other three. Different financial conditions (for example, higher interest rates or heavier initial debt loadings) could push the Northern and Central REDs into unsustainable territory. The situation is therefore rather tenuous; and several options exist to address it:

- Firstly, government could provide the capital grants required to sustain the viability of Central RED. To-date, however, government has not provided any grant finance specifically for electrification (other than through its municipal grant programmes) and it is unlikely to begin doing so, particularly while other REDs are making healthy surpluses. On the other hand, this position could change with the introduction of corporate income tax and divided payments in the electricity industry in the near future, as government may agree to provide some grant finance in lieu of the additional tax burden.
- Secondly, a mechanism could be established through which transfers are made from healthy to unviable REDs, based on as yet unspecified criteria. However, this could seriously distort the financial incentives faced by both categories of distributor, effectively discouraging the three wealthier REDs from making surpluses, whilst reducing the incentive for the two poorer REDs to cut their losses.
- Thirdly, a levy could be introduced on sales to all electricity consumers; the proceeds would then be paid into a central fund and redistributed to REDs according to a set of criteria which will ensure their financial viability. This option has been considered for several years, but is not favoured by the Department of Finance as it remains outside of central fiscal control. Needless to say, this option, like the previous two options, carries an opportunity cost insofar as both the higher electricity tariffs paid by consumers and the use of limited government grant finance preclude the use of those resources for other, potentially more productive purposes.
- Finally, the boundaries of the REDs could be re-drawn in such a way that each distributor is financially viable on its own. Although this will require more desk-based analysis to model the financial viability of the REDs before they can be set up, it is likely that the long-term cost effectiveness of such a system will be considerably greater than in any of the above

three options.[12] The regulatory and governance responsibilities attached to any option where financial transfers are made on an annual basis, in terms of complex and potentially politically-loaded criteria, will be significant and costly.

This issue of RED boundaries and the financial parameters within which they operate is one of the most important policy questions to be settled in the restructuring process. Although it is beyond the scope of this project to propose revised RED boundaries, further analysis might reveal that, say, three or four REDs could be financially viable: for instance, by combining Northern and Wits, and by incorporating some or all of Central RED (particularly the former Transkei area) in more profitable neighbouring REDs such as Eastern RED. This issue is one which merits further analysis.

The analysis of off-grid electrification suggests that, as a stand-alone operation, it is not financially viable – that is, at the tariff levels used in this study, which were set at a similar level to 2.5A supplies. It is clear that on a purely financial level, subsidies will be required to sustain an off-grid electrification programme. Although large in relation to the off-grid programme itself, these subsidy requirements are very modest in relation to the grid programme. This is not to say off-grid electrification is financially unattractive – on the contrary, in many rural areas, it will result in smaller losses being incurred by the REDs and therefore carries a lower opportunity cost than grid electrification.

Also important are the conclusions emerging from the analysis of an alternative electrification scenario in which 'equity in outcome' is taken as the objective. In this scenario, all unelectrified households were assumed to receive 20A supplies, and this had a large negative effect on the performance of the two weaker distributors – Northern and Central. Their total subsidy requirement in this scenario increased by a cumulative R9.1 billion over the 20 years of the programme – funds which could almost certainly be put to better use elsewhere in the economy. Thus the current direction being taken by the industry, namely that of providing consumers with choices of various service levels, which have costs and tariffs better matched to their affordability profiles, makes good financial sense. Obviously, political and social issues have to be traded off with financial ones in deciding on the right mix of service levels.

Finally, the question arises of whether subsidies can be effectively targeted at the poor. This is less a question of raising subsidy funds than one of allocating them. Various options exist for allocating subsidy funds, for example:

- direct transfer payments to the poor, such as through a stamp/voucher system based on means testing; or as a proxy, through pensions which are usually the main source of income for the poorest rural people;
- cross-subsidies through the electricity tariff, which occur in the case of single energy rate tariffs at low levels of consumption, and flat monthly charges at higher levels of consumption – at present, most new electrification customers fall into one of these categories;
- capital grants to new electricity consumers, financed either from the fiscus or from within the electricity industry – the latter applies to the funds allocated by Eskom to the NER for onward granting to municipal distributors.

Each of the above mechanisms has its advantages and disadvantages, both in theory and in practice. One of the most important considerations arising in the South African context is their relative 'transaction costs': given an overburdened and underdeveloped administrative capacity at many levels in the public sector, it is suggested that the use of tariffs can be a cost-effective means of targeting the poor. The usual argument advanced against this option is that it can seriously distort prices, with negative knock-on effects throughout the economy. As this analysis has shown, provided the finances of the industry are tightly managed and the financial viability of utilities is kept intact, the extent of these cross-subsidies is generally modest and, on the whole, sustainable. Particularly in an environment where each RED faces clear objectives with

12 The model used here, the EFM, has been designed to easily accommodate different RED boundaries.

the potential to manage its finances sustainably, it will be possible to achieve a balance between financial viability and redistributive electrification.

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Appendix 1
MODEL INPUTS

In the pages which follow, the input sheets in the Excel spreadsheet model are shown using Northern RED (A) as the example. These sheets include default variables wherever these have been entered.

Appendix 2
MODEL OUTPUTS

In the pages which follow, the output sheets in the Excel spreadsheet model are shown.

Appendix 3
FINANCIAL STATEMENTS FOR REDS

In the pages which follow, complete financial statements – consisting of an Income Statement, Balance Sheet and Cash Flow Statement – are presented for each of the five REDs. Results are shown for the grid and off-grid sectors combined and separately.

Appendix 4
FINANCIAL STATEMENTS FOR REDS – ALTERNATIVE SCENARIO WITH 'EQUITY IN OUTCOME'

In the pages which follow, complete financial statements are presented for the five REDs, based on the alternative scenario in which all unelectrified households receive 20A supplies.

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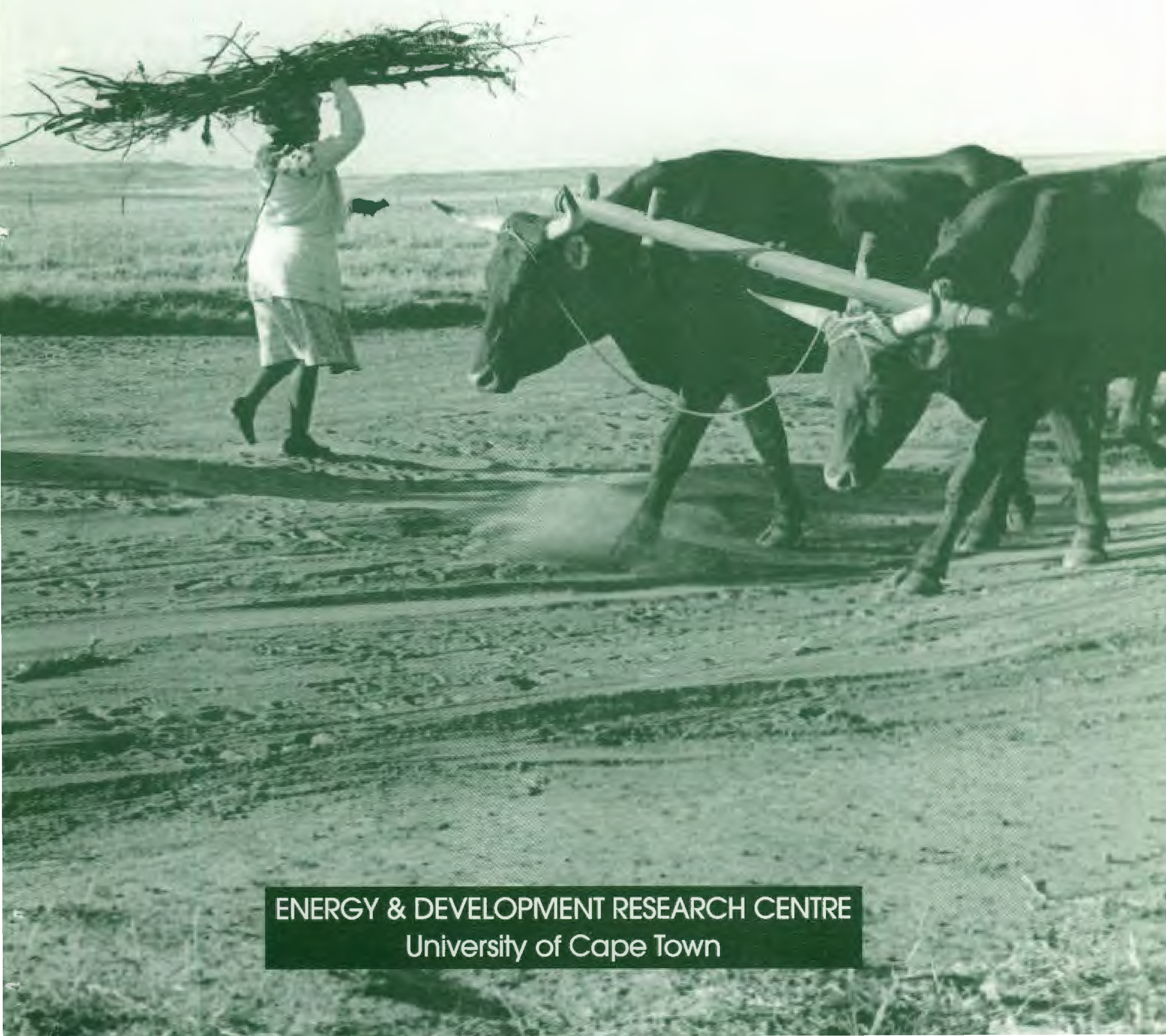

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